PTO/SB/81 (01-09)
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POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Application Number	
Filing Date	11/05/10
First Named Inventor	C. Earl Woolfork
Title	Wireless Digital Audio Music System
Art Unit	2614
Examiner Name	Andrew Flanders
Attorney Docket Number	1028.5

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith: **68533**

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

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City		State		Zip	
Country					
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I am the:

☒ Applicant/Inventor.

OR

☐ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on ______________

SIGNATURE of Applicant or Assignee of Record

Signature	[signature]	Date	11/05/10
Name	C. Earl Woolfork	Telephone	
Title and Company			

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☒ *Total of 1 forms are submitted.

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1028.5
	Application Number	

Title of Invention	Wireless Digital Audio Music System

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 [Remove]

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
Mr.	C.	Earl	Woolfork	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Pasadena	State/Province	CA	Country of Residence i	US

Citizenship under 37 CFR 1.41(b) i	US

Mailing Address of Applicant:

Address 1	PO Box 70848		
Address 2			
City	Pasadena	State/Province	CA
Postal Code	91107	Country i	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. [Add]

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	68533
Email Address	melyman@lymanpatents.com [Add Email] [Remove Email]

Application Information:

Title of the Invention	Wireless Digital Audio Music System		
Attorney Docket Number	1028.5	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)	2614		
Total Number of Drawing Sheets (if any)	3	Suggested Figure for Publication (if any)	1

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1028.5
	Application Number	
Title of Invention	Wireless Digital Audio Music System	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	68533		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12570343	Continuation of	10648012	2008-07-12		

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
10648012	Continuation of	10027391	2003-08-26

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
10027391	Continuation in part of	abandoned	2001-12-21

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. [Add]

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

PTO/SB/14 (11-08)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1028.5
	Application Number	
Title of Invention	Wireless Digital Audio Music System	

Application Number	Country i	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			◯ Yes ⦿ No

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Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1

If the Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the **Add** button. Add

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Megan Lyman/			Date (YYYY-MM-DD)	2010-11-05
First Name	Megan	Last Name	Lyman	Registration Number	57054

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Filer:	Megan Elizabeth Lyman
Attorney Docket Number:	1028.5

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility filing Fee (Electronic filing)	4011	1	82	82
Utility Search Fee	2111	1	270	270
Utility Examination Fee	2311	1	110	110
Pages:				
Claims:				
Independent claims in excess of 3	2201	3	110	330
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
	Total in USD ($)			**792**

Electronic Acknowledgement Receipt

EFS ID:	8782755
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	05-NOV-2010
Filing Date:	
Time Stamp:	17:14:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$792
RAM confirmation Number	3843
Deposit Account	
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Claims	Claims.pdf	43794 4959c7bc17bcbfb2543b2666fb358c3cea3da3cb	no	4
Warnings:					
Information:					
2	Specification	SpecificationContof343.pdf	67269 27d78812b5fd73ca7ffa90f1c2ae6de377633e05	no	7
Warnings:					
Information:					
3	Drawings-only black and white line drawings	Figures.pdf	3282322 47492ad819f03739204d7bb0a7cee33bb436d66e	no	3
Warnings:					
Information:					
4	Oath or Declaration filed	DeclarationSigned.pdf	874562 1b64a296c57c32c148972a01088e3f1051c276a8	no	2
Warnings:					
Information:					
5	Power of Attorney	POASigned.pdf	834338 39fbbd4abcd9610b8361c3cec2dc906a70327708	no	2
Warnings:					
Information:					
6	Application Data Sheet	ADS.pdf	1364824 141cc4a41f3382515c8b370fbb911e9a0bf9393d	no	4
Warnings:					
Information:					
7	Fee Worksheet (PTO-875)	fee-info.pdf	36190 54d3ea33ce5c442f0490e447ae97253863338338	no	2
Warnings:					
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		Total Files Size (in bytes):	6503299		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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CLAIMS

I claim:

1. A wireless digital audio headphone comprising:

a portable digital audio headphone receiver configured to receive a unique user code bit sequence and a original audio signal representation in the form of packets, said portable digital audio headphone receiver comprising:

a direct conversion module configured to capture said packets embedded in the received spread spectrum signal;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode reduced intersymbol interference coding of original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized.

2. A wireless digital audio headphone for receipt of a unique user code and a digital audio music representation signal in the form of a packet, said wireless digital audio headphone comprising:

a digital audio receiver, capable of mobile operation, configured for direct digital wireless communication with a mobile digital audio transmitter;

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

a decoder operative to decode the applied reduced intersymbol interference coding of said audio music representation signal; and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence is being recognized.

3. A wireless digital audio transmitter operatively coupled to a portable audio source and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio source, and configured to be communicable with a mobile receiver, is capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a channel encoder to reduce transmission errors; and

a digital modulator module configured for independent code division multiple access (CDMA) communication operation.

4. A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be communicable with a mobile digital audio transmitter, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio source virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

5. A wireless digital audio transmitter operatively coupled to a portable audio source and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio source, and configured to be communicable with a mobile receiver, is capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

an interleaver to reduce transmission errors; and

a digital modulator module configured for CDMA communication; independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation.

6. A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be communicable with a mobile digital audio transmitter, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent CDMA communication operation;

an de-interleaver generating a corresponding digital output;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio source virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

WIRELESS DIGITAL AUDIO MUSIC SYSTEM

This continuation application claims the benefit of U.S. Patent Application No. 12//570,343, which claimed the benefit of U.S. Patent Application Serial No. 12/144,729 filed July 12, 2008, now U.S. Patent No. 7,684,885, which claimed benefit of U.S. Patent Application Serial No. 10/648,012 filed August 26, 2003, now U.S. Patent No. 7,412,294, which claimed benefit from U.S. Patent Application Serial No. 10/027,391, filed December 21, 2001, for "Wireless Digital Audio System," published under US 2003/0118196 A1 on June 26, 2003, now abandoned, both of which are incorporated herein in their entirety by reference.

BACKGROUND OF THE INVENTION

[0001] This invention relates to audio player devices and more particularly to systems that include headphone listening devices. The new audio system uses an existing headphone jack (i.e., this is the standard analog headphone jack that connects to wired headphones) of a music audio player (i.e., portable CD player, portable cassette player, portable A.M./F.M. radio, laptop/desktop computer, portable MP3 player, and the like) to connect a battery powered transmitter for wireless transmission of a signal to a set of battery powered receiving headphones.

[0002] Use of audio headphones with audio player devices such as portable CD players, portable cassette players, portable A.M./F.M. radios, laptop/desktop computers, portable MP3 players and the like have been in use for many years. These systems incorporate an audio source having an analog headphone jack to which headphones may be connected by wire.

[0003] There are also known wireless headphones that may receive A.M. and F.M. radio transmissions. However, they do not allow use of a simple plug in (i.e., plug in to the existing analog audio headphone jack) battery powered transmitter for connection to any music audio player device jack, such as the above mentioned music audio player devices, for coded wireless transmission and reception by headphones of audio music for private listening without interference where multiple users occupying the same space are operating wireless transmission devices. Existing audio systems make use of electrical wire connections between the audio source and the headphones to accomplish private listening to multiple users.

[0004] There is a need for a battery powered simple connection system for existing music audio player devices (i.e., the previously mentioned music devices), to allow coded digital wireless transmission (using a battery powered transmitter) to a headphone receiver (using a battery powered receiver headphones) that accomplishes private listening to multiple users occupying the same space without the use of wires.

SUMMARY OF THE INVENTION

[0005] The present invention is generally directed to a wireless digital audio system for coded digital transmission of an audio signal from any audio player with an analog headphone jack to a receiver headphone located away from the audio player. Fuzzy logic technology may be utilized by the system to enhance bit detection. A battery-powered digital transmitter may include a headphone plug in communication with any suitable music audio source. For reception, a battery-powered headphone receiver may use embedded fuzzy logic to enhance user code bit detection. Fuzzy logic detection may be used to enhance user code bit detection during decoding of the transmitted audio signal. The wireless digital audio music system provides private listening without interference from other users or wireless devices and without the use of conventional cable connections.

[0006] These and other features, aspects and advantages of the present invention will become better understood with reference to the following drawings, description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Some aspects of the present invention are generally shown by way of reference to the accompanying drawings in which:

Figure 1 schematically illustrates a wireless digital audio system in accordance with the present invention;

Figure 2 is a block diagram of an audio transmitter portion of the wireless digital audio system of Fig. 1.;

Figure 3 is a block diagram of an audio receiver portion of the wireless digital audio system of Fig. 1; and

Figure 4 is an exemplary graph showing the utilization of an embedded fuzzy logic coding algorithm according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0008] The following detailed description is the best currently contemplated modes for carrying out the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention.

[0009] Referring to Figures 1 through 3, a wireless digital audio music system 10 may include a battery powered transmitter 20 connected to a portable music audio player or music audio source 80. The battery powered wireless digital audio music transmitter 20 utilizes an analog to digital converter or ADC 32 and may be connected to the music audio source 80 analog headphone jack 82 using a headphone plug 22. The battery powered transmitter 20 may have a transmitting antenna 24 that may be omni-directional for transmitting a spread spectrum modulated signal to a receiving antenna 52 of a battery powered headphone receiver 50. The battery powered receiver 50 may have headphone speakers 75 in headphones 55 for listening to the spread spectrum demodulated and decoded communication signal. In the headphone receiver 50, fuzzy logic detection may be used to optimize reception of the received user code. The transmitter 20 may digitize the audio signal using ADC 32. The digitized signal may be processed downstream by an encoder 36. After digital conversion, the digital signal may be processed by a digital low pass filter. To reduce the effects of channel noise, the battery powered transmitter 20 may use a channel encoder 38. A modulator 42 modulates the digital signal to be transmitted. For further noise immunity, a spread spectrum DPSK (differential phase shift key) transmitter or module 48, is utilized. The battery powered transmitter 20 may contain a code generator 44 that may be used to create a unique user code. The unique user code generated is specifically associated with one wireless digital audio system user, and it is the only code recognized by the battery powered headphone receiver 50 operated by a particular user. The radio frequency (RF) spectrum utilized (as taken from the Industrial, Scientific and Medical (ISM) band) may be approximately 2.4 GHz. The power radiated by the transmitter adheres to the ISM standard.

[0010] Particularly, the received spread spectrum signal may be communicated to a 2.4 GHz direct conversion receiver or module 56. Referring to Figures 1 through 4, the spread spectrum modulated signal from transmit antenna 24 may be received by receiving antenna 52 and then processed by spread spectrum direct conversion receiver or module 56 with a receiver code generator 60 that contains the same transmitted unique code, in the battery powered receiver 50 headphones. The transmitted signal from antenna 24 may be received by receiving antenna 52 and communicated to a wideband bandpass filter (BPF). The battery powered receiver 50 may utilize embedded fuzzy logic 61 (as graphically depicted in Figures 1, 4) to optimize the bit detection of the received user code. The down converted output signal of direct conversion receiver or module 56 may be summed by receiver summing element 58 with a receiver code generator 60 signal. The receiver code generator 60 may contain the same unique wireless transmission of a signal code word that was transmitted by audio transmitter 20 specific to a particular user. Other code words from wireless digital audio systems 10 may appear as noise to audio receiver 50. This may also be true for other device transmitted wireless signals operating in the wireless digital audio spectrum of digital audio system 10. This code division multiple access (CDMA) may be used to provide each user independent audible enjoyment. The resulting summed digital signal from receiving summary element 58 and direct conversion receiver or module 56 may be processed by a 64-Ary demodulator 62 to demodulate the signal elements modulated in the audio transmitter 20. A block de-interleaver 64 may then decode the bits of the digital signal encoded in the block interleaver 40. Following such, a Viterbi decoder 66 may be used to decode the bits encoded by the channel encoder 38 in audio transmitter 20. A source decoder 68 may further decode the coding applied by encoder 36.

[0011] Each receiver headphone 50 user may be able to listen (privately) to high fidelity audio music, using any of the audio devices listed previously, without the use of wires, and without interference from any other receiver headphone 50 user, even when operated within a shared space. The fuzzy logic detection technique 61 used in the receiver 50 could provide greater user separation through optimizing code division in the headphone receiver.

[0012] The battery powered transmitter 20 sends the audio music information to the battery powered receiver 50 in digital packet format. These packets may flow to create a digital bit stream rate less than or equal to 1.0 Mbps.

[0013] The user code bits in each packet may be received and detected by a fuzzy logic detection sub-system 61 (as an option) embedded in the headphone receiver 50 to optimize audio receiver performance. For each consecutive packet received, the fuzzy logic detection sub-system 61 may compute a conditional density with respect to the context and fuzziness of the user code vector, i.e., the received code bits in each packet. Fuzziness may describe the ambiguity of the high (1)/low (0 or -1) event in the received user code within the packet. The fuzzy logic detection sub-system 61 may measure the degree to which a high/low bit occurs in the user code vector, which produces a low probability of bit error in the presence of noise. The fuzzy logic detection sub-system 61 may use a set of if-then rules to map the user code bit inputs to validation outputs. These rules may be developed as if-then statements.

[0014] Fuzzy logic detection sub-system 61 in battery-powered headphone receiver 50 utilizes the if-then fuzzy set to map the received user code bits into two values: a low (0 or -1) and a high (1). Thus, as the user code bits are received, the "if" rules map the signal bit energy to the fuzzy set low value to some degree and to the fuzzy set high value to some degree. Figure 4 graphically shows that x-value -1 equals the maximum low bit energy representation and x-value 1 equals the maximum high bit energy representation. Due to additive noise, the user code bit energy may have some membership to a low and high as represented in Figure 4. The if-part fuzzy set may determine if each bit in the user code, for every received packet, has a greater membership to a high bit representation or a low bit representation. The more a user code bit energy fits into the high or low representation, the closer its subsethood, i.e., a measure of the membership degree to which a set may be a subset of another set, may be to one.

[0015] The if-then rule parts that make up the fuzzy logic detection sub-system 61 must be followed by a defuzzifying operation. This operation reduces the aforementioned fuzzy set to a bit energy representation (i.e., -1 or 1) that is received by the transmitted packet. Fuzzy logic detection sub-system 61 may be used in battery-powered headphone receiver 50 to enhance overall system performance.

[0016] The next step may process the digital signal to return the signal to analog or base band format for use in powering speaker(s) 75. A digital-to-analog converter 70 (DAC) may be used to transform the digital signal to an analog audio signal. An analog low pass filter 72 may be used to filter the analog audio music signal to pass a signal in the approximate 20 Hz to 20 kHz frequency range and filter other frequencies. The analog audio music signal may then be processed by a power amplifier 74 that may be optimized for powering headphone speakers 75 to provide a high quality, low distortion audio music for audible enjoyment by a user wearing headphones 55. A person skilled in the art would appreciate that some of the embodiments described hereinabove are merely illustrative of the general principles of the present invention. Other modifications or variations may be employed that are within the scope of the invention. Thus, by way of example, but not of limitation, alternative configurations may be utilized in accordance with the teachings herein. Accordingly, the drawings and description are illustrative and not meant to be a limitation thereof.

[0017] Moreover, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Thus, it is intended that the invention cover all embodiments and variations thereof as long as such embodiments and variations come within the scope of the appended claims and their equivalents.

ABSTRACT

[0018] A wireless digital audio system includes a portable audio source with a digital audio transmitter operatively coupled thereto and an audio receiver operatively coupled to a headphone set. The audio receiver is configured for digital wireless communication with the audio transmitter. The digital audio receiver utilizes fuzzy logic to optimize digital signal processing. Each of the digital audio transmitter and receiver is configured for code division multiple access (CDMA) communication. The wireless digital audio system allows private audio enjoyment without interference from other users of independent wireless digital transmitters and receivers sharing the same space.

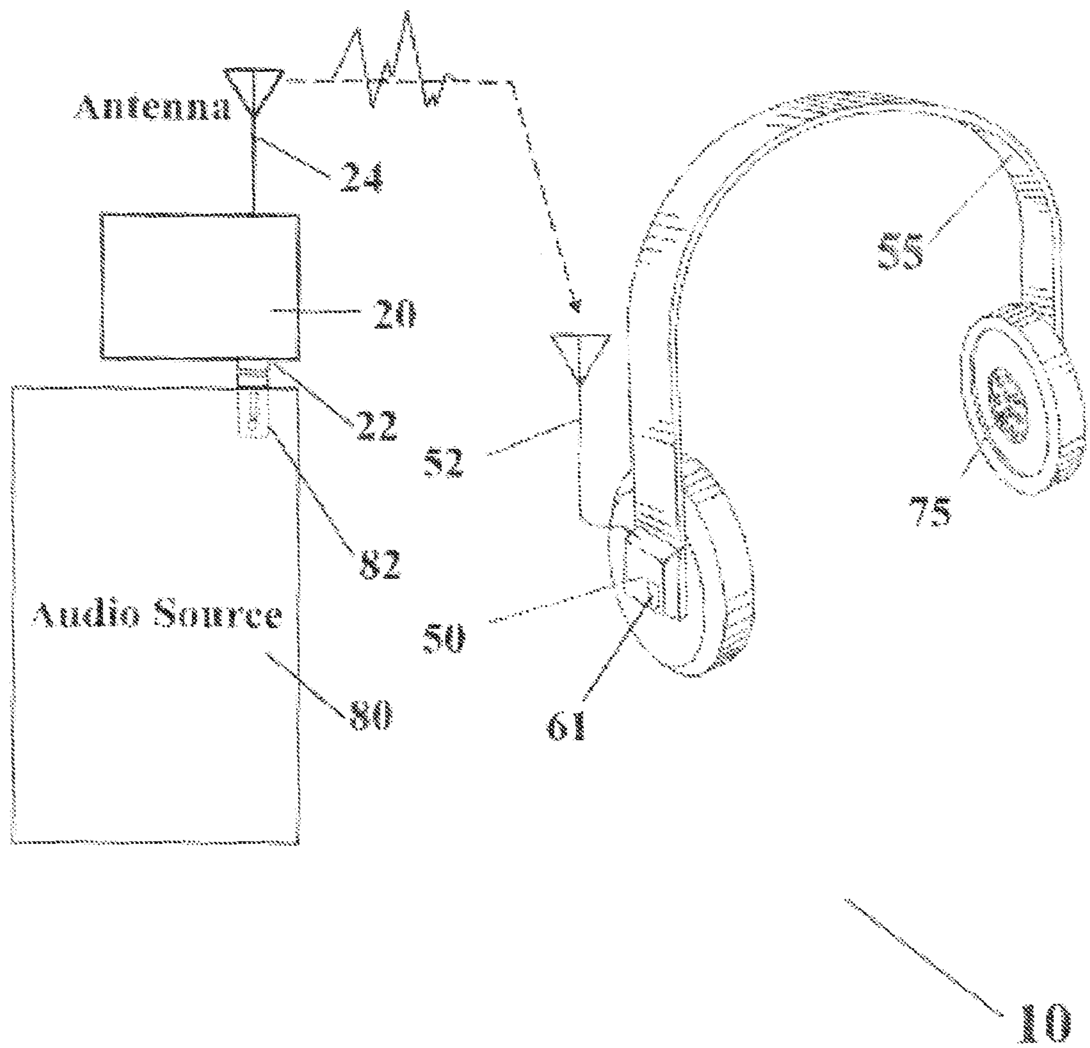

FIG.1

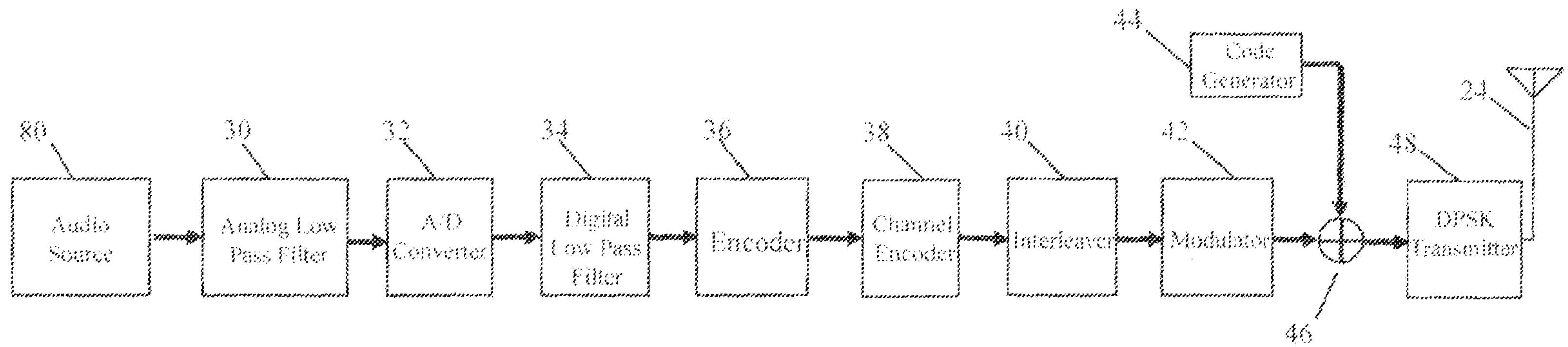
80
Audio Source
30
Analog Low Pass Filter
32
A/D Converter
34
Digital Low Pass Filter
36
Encoder
38
Channel Encoder
40
Interleaver
42
Modulator
44
Code Generator
46
48
DPSK Transmitter
24

FIG. 2

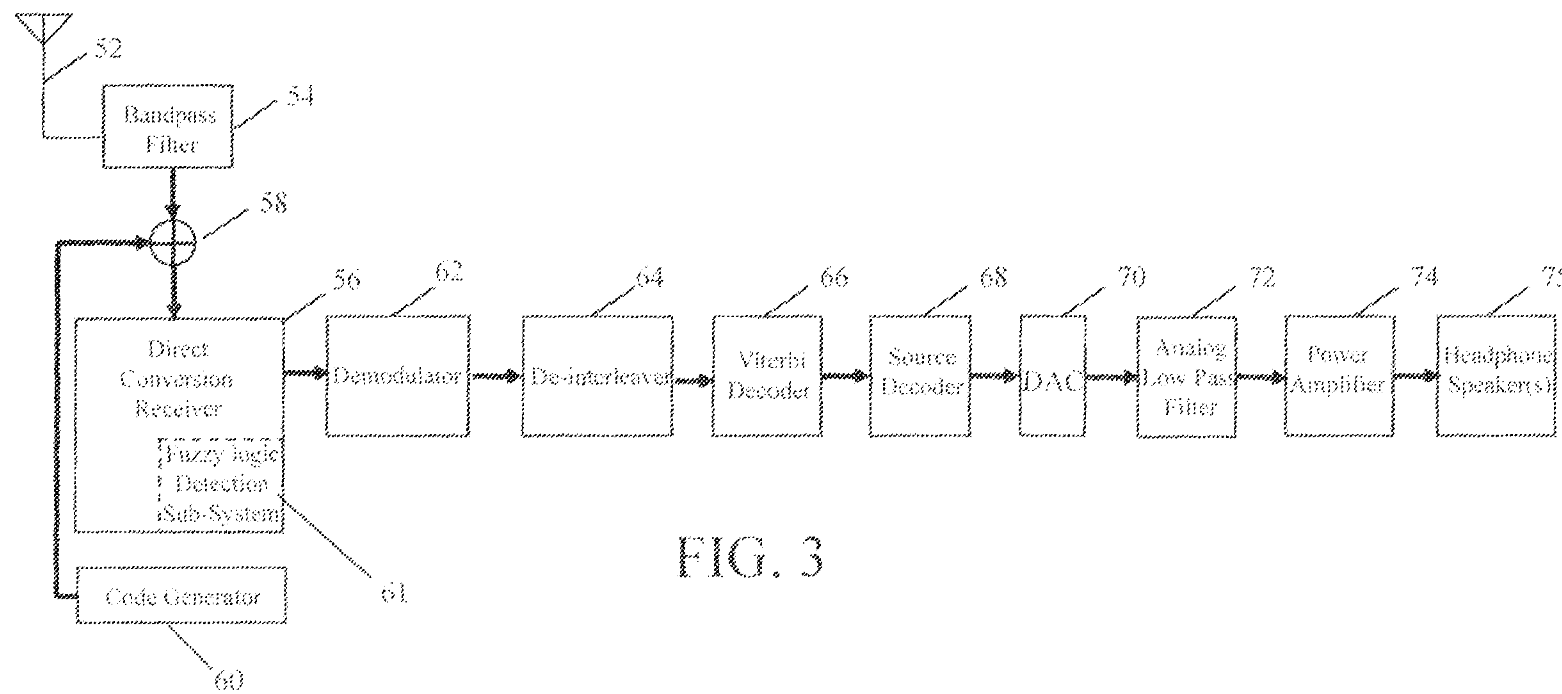
52
Bandpass Filter
54
58
56
Direct Conversion Receiver
Fuzzy logic Detection Sub-System
61
Code Generator
60
62
Demodulator
64
De-interleaver
66
Viterbi Decoder
68
Source Decoder
70
DAC
72
Analog Low Pass Filter
74
Power Amplifier
75
Headphone Speaker(s)

FIG. 3

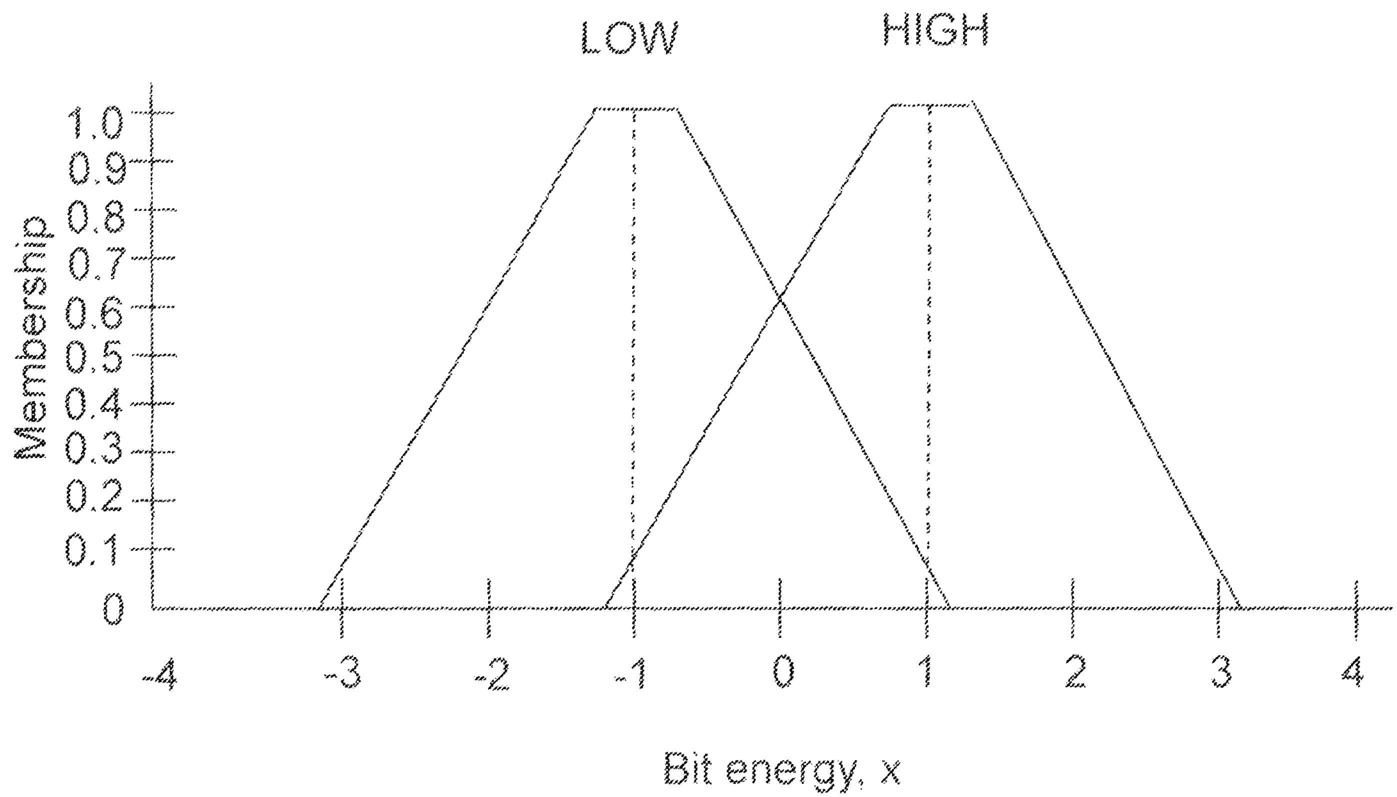
LOW
HIGH
Membership
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-4
-3
-2
-1
0
1
2
3
4
Bit energy, x

Fig. 4

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Wireless Digital Audio Music System

As the below named inventor(s), I/we declare that:

This declaration is directed to:

- [✓] The attached application, or
- [ ] Application No. ____________ filed on ____________
  - [ ] As amended on ____________ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

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All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: C. Earl Woolfork Date: 11/05/10

Signature: [signature] Citizen of: US

Inventor two: ____________ Date: ____________

Signature: ____________ Citizen of: ____________

- [ ] Additional inventors or a legal representative are being named on ____________ additional form(s) attached hereto.

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Application Number: 12940747

Document Date: 11/5/2010

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Form Revision Date: February 8, 2006

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number	Filing Date	
12/940,747	11/05/2010	☐ To be Mailed

APPLICATION AS FILED – PART I

SMALL ENTITY ☒ OR OTHER THAN SMALL ENTITY

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)		OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☒ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	**165**		N/A	
☒ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	**270**		N/A	
☒ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	**110**		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	6 minus 20 =	* 0	X $26 =	**0**	OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	6 minus 3 =	* 3	X $110 =	**330**		X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	**875**		TOTAL	

APPLICATION AS AMENDED – PART II

SMALL ENTITY OR OTHER THAN SMALL ENTITY

AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

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The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/PAMELA ROGERS/

Date: 11/05/10

PTO/SB/06 (12-04)
Approved for use through 7/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 12/940,747

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	82		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	270		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	110		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	6 minus 20 =		x$26		OR	x$52	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	6 minus 3 =	3	x$110	330		x$220	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			195			390	
			TOTAL	792		TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT A

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

AMENDMENT B

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/940,747	11/05/2010	2614	792	1028.5	6	6

CONFIRMATION NO. 8175

FILING RECEIPT

68533
MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

OC000000044539397

Date Mailed: 11/19/2010

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

C. Earl Woolfork, Pasadena, CA;

Power of Attorney: The patent practitioners associated with Customer Number 68533

Domestic Priority data as claimed by applicant

This application is a CON of 12/570,343 09/30/2009
which is a CON of 10/648,012 08/26/2003 PAT 7,412,294 *
which is a CON of 10/027,391 12/21/2001 ABN *
(*)Data provided by applicant is not consistent with PTO records.

Foreign Applications

If Required, Foreign Filing License Granted: 11/17/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/940,747**

Projected Publication Date: 02/24/2011

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****

Title

Wireless Digital Audio Music System

Preliminary Class

381

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/940,747	11/05/2010	C. Earl Woolfork	1028.5

CONFIRMATION NO. 8175

POA ACCEPTANCE LETTER

OC000000044539152

68533
MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

Date Mailed: 11/19/2010

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/05/2010.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/sgorems/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/940,747	11/05/2010	C. Earl Woolfork	1028.5

CONFIRMATION NO. 8175

PUBLICATION NOTICE

OC000000046167963

68533
MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

Title: Wireless Digital Audio Music System

Publication No.US-2011-0044466-A1
Publication Date:02/24/2011

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	12940747
	Filing Date	2010-11-05
	First Named Inventor	C. Earl Woolfork
	Art Unit	2614
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6728585		2004-04-27	Neoh	
	2	7409064		2008-08-05	Watanuki	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	12940747
	Filing Date	2010-11-05
	First Named Inventor	C. Earl Woolfork
	Art Unit	2614
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Authors: ISHIGURO, TAKAHASHI, YOSHIDA, MIYAJIMA Title: Single-Chip Transceiver LSI For Spread Spectrum Communication With Smart Synchronization Technique Date: November 1997 CONSUMER ELECTRONICS, VOLUME 43, ISSUE 4, PAGE(S) 1331, ISSN 0098-3063	☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	12940747
	Filing Date	2010-11-05
	First Named Inventor	C. Earl Woolfork
	Art Unit	2614
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Megan Lyman/	Date (YYYY-MM-DD)	2011-03-03
Name/Print	Megan Lyman	Registration Number	57054

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Electronic Patent Application Fee Transmittal

Application Number:	12940747
Filing Date:	05-Nov-2010
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Filer:	Megan Elizabeth Lyman
Attorney Docket Number:	1028.5

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	9582401
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	03-MAR-2011
Filing Date:	05-NOV-2010
Time Stamp:	17:26:38
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	4122
Deposit Account	504576
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	NPL Documents	IshiguroReference.pdf	2444668 808cd8407a12c3daa5ec1bdb9c229f512f3dd49a	no	9
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Filed (SB/08)	IDSsub030311.pdf	766174 d38c6b0dd2335d20711bf2d0c897cc84100abd1a	no	4
Warnings:					
Information:					
3	Fee Worksheet (PTO-875)	fee-info.pdf	29918 29b090cddad5c966eb833cee3414663f27faa1d2	no	2
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New International Application Filed with the USPTO as a Receiving Office
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7. (New) A wireless digital audio headphone for receipt of a unique user code and a digital audio representation signal in a packet format, the unique user code configured to spread the said signal spectrum and further configured for independent communication operation, said wireless digital audio headphone comprising:

a digital audio receiver, capable of mobile operation, configured for direct digital wireless communication with a mobile digital audio transmitter, wherein said mobile digital audio transmitter is operatively coupled to a portable audio player;

a direct conversion module configured to capture the packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode the applied reduced intersymbol interference coding of said audio representation signal; and

a digital–to–analog converter generating an audio output of said digital audio representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence being recognized; said audio output being virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

8. (New) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and an original audio signal representation in the form of packets, the unique user code configured to spread the said signal spectrum and further configured for independent communication operation, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, wherein said mobile digital audio transmitter is operatively coupled to a portable audio player, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode applied reduced intersymbol interference coding of said original audio signal representation ; and

a digital-to-analog converter generating an audio output of said original audio signal representation;

and a module adapted to reproduce said generated audio output, in response to the unique user code being recognized; said audio output being virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

9. (New) A wireless digital audio transmitter operatively coupled to a portable audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver and capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent code division multiple access (CDMA) communication operation.

10. (New) A portable wireless digital audio system for digital transmission of an original audio signal representation from a portable audio player to a portable digital audio headphone receiver, said portable wireless digital audio system comprising:

a digital audio transmitter operatively coupled to said portable audio player and transmitting a unique user code bit sequence with said original audio signal representation in packet format, wherein said digital audio transmitter operatively coupled to said audio player is capable of mobile operation, said digital audio transmitter comprising:

a encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent CDMA communication operation;

said digital audio transmitter configured for direct digital wireless communication with said portable digital audio headphone receiver, said portable digital audio headphone receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code bit sequence;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from said portable audio source and reproduced virtually free from interference.

11. (New) A portable wireless digital audio system for digital transmission of an original audio signal representation from a portable audio player to a digital audio receiver, said portable wireless digital audio system comprising:

a digital audio transmitter operatively coupled to said audio player and transmitting a unique user code with said original audio signal representation in packet format, wherein said digital audio transmitter coupled to said audio player is capable of being moved in any direction during operation, said digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation;

said digital audio receiver capable of being moved in any direction during operation and in direct wireless communication with said digital audio transmitter, said digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode the applied reduced inter-symbol interference coding of said original audio signal representation;

a digital-to-analog converter generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from said audio source virtually free from interference.

12. (New) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be communicable with a mobile digital audio transmitter, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent code division multiple access communication operation;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio player virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

Electronic Patent Application Fee Transmittal

Application Number:	12940747
Filing Date:	05-Nov-2010
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Filer:	Megan Elizabeth Lyman
Attorney Docket Number:	1028.5

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Independent claims in excess of 3	2201	6	110	660
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**660**

Electronic Acknowledgement Receipt

EFS ID:	9861131
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	12-APR-2011
Filing Date:	05-NOV-2010
Time Stamp:	14:21:29
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$660
RAM confirmation Number	708
Deposit Account	
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Preliminary Amendment	PrelimAmendmentClaims2.pdf	54557 605b12953a42319d1e304c9e7bfd411b0e268738	no	5
Warnings:					
Information:					
2	Fee Worksheet (PTO-875)	fee-info.pdf	30188 dbe91c480171bb807f4b4cae2efc5050463350ab	no	2
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New Applications Under 35 U.S.C. 111
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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	12940747
	Filing Date	2010-11-05
	First Named Inventor	C. Earl Woolfork
	Art Unit	2614
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

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Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	12940747
	Filing Date	2010-11-05
	First Named Inventor	C. Earl Woolfork
	Art Unit	2614
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

	1	Author: Weizhong, Chen Title: Motorola's Bluetooth Solution to Interference Rejection and Coexistence with 802.11 Date: December 2001 Application Note AN2211/D Rev. 0 PAGE(S) 1 - 8,	☐

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	2614
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Megan Lyman/	Date (YYYY-MM-DD)	2011-04-14
Name/Print	Megan Lyman	Registration Number	57054

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	9877749
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	14-APR-2011
Filing Date:	05-NOV-2010
Time Stamp:	11:12:21
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Filed (SB/08)	IDS041311.pdf	611762 9f32671e8bd4451fccb0f3c01541d39959afd5d4	no	4

Warnings:

Information:

A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.

2	NPL Documents	MotorolaApplicationforIDS041411.pdf	2411722 185614ff8526876934e46016de343183949686e8	no	12

Warnings:

Information:

Total Files Size (in bytes):	3023484

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/940,747	11/05/2010	C. Earl Woolfork	1028.5	8175

68533 7590 05/05/2011

MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

EXAMINER	
FLANDERS, ANDREW C	
ART UNIT	**PAPER NUMBER**
2614	

NOTIFICATION DATE	DELIVERY MODE
05/05/2011	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

MELYMAN@LYMANPATENTS.COM

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No.	Applicant(s)	
	12/940,747	WOOLFORK, C. EARL	
	Examiner	Art Unit	
	ANDREW C. FLANDERS	2614	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _12 April 2011_.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-12_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1-12_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _05 November 2010_ is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1 – 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Altstatt (U.S. Patent 5,771,441) in view of Li (U.S. Patent 6,781,977) and in further view of Lindemann (U.S. Patent Application Publication 2004/0223622).

Regarding **Claim 1**, Altstatt discloses:

A wireless audio headphone (Fig. 1) comprising:

a portable audio headphone receiver (20) configured to receive an original audio signal (communication from 14 to 41) said portable digital audio headphone receiver comprising:

Altstatt fails to explicitly disclose:

the system as a digital system,

the receiver configured to receive a unique user code bit sequence and a original audio signal representation in the form of packets,

a direct conversion module configured to capture said packets embedded in the received spread spectrum signal;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode reduced intersymbol interference coding of original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized.

However, digital CDMA transmissions of audio sources to headphones in devices was notoriously well known in the art. For Example, Li teaches a system providing CDMA communication of digital audio to headphone devices; col. 3 lines 20 – 33.

Replacing the FM transmitter/receiver implementation of Alstatt to use the digital CDMA communication discloses:

the system as a digital system (i.e. digital audio; col. 2 lines 48 – 51); also A/D conversion; col. 3 line 7);

the receiver configured to receive a unique user code bit sequence (inherent in CDMA communication; see attached definition of CDMA) and a original audio signal representation in the form of packets, (packet form met by the G.729 encoding implementation, see col. 4 lines 25 - 33),

a direct conversion module configured to capture said packets embedded in the received spread spectrum signal (201 and 202 to prepare for despreading);

a digital demodulator configured for independent CDMA communication operation (202);

a decoder operative to decode coding of original audio signal representation (206);

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation (D/A portion of 204, signals are input to 204 as digital and then output as analog to post processor-205); and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized (portion 202 of receiving unit 200 that matches the inherent code in CDMA to initiate de-spreading, i.e. each channel in CDMA corresponds to a different random sequence, this sequence must be received and recognized by receiving unit 200 in order for the device to operate).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Alstatt. Li clearly teaches the device for use in portable implementations such as music and headphone audio reproductions. Li also teaches the outputs/inputs as standard audio jacks. Furthermore, doing so would be simple substitution of one known element (i.e. digital CDMA transmitter/receiver) for another (i.e. analog FM transmitter) to obtain predictable results (i.e. Alstatt w/ a digital transmitter). Additionally, Li discloses a number of advantages of using digital communication in col. 6.

The combination of Altstatt in view of Li fails to explicitly disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation.

However, reducing intersymbol interference in audio coding for CDMA transmission is notoriously well known in the art.

Lindemann discloses a device that transmits digital audio between a stereo system and a speaker using CDMA. Lindemann also includes that the transmission stream is created using a Seed-Solomon encoding and interleaver and a corresponding decoder in the decoder; Figs. 6 and 8.

Applying these teachings to the encoding of the combination discloses:

disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation (Fig. 8 element 802 which is a Reed Solomon decoder and Interleaver; it is known in the art to configure Reed Solomon decoding/interleaving to reduce ISI as is shown by Roberts 6,418,558. Reducing ISI is a desirable feature to any digital transmission).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the reed Solomon encoder/decoder in the combinations channel encoding. Doing so would have been nothing more than applying a known technique to a known device ready for improvement to yield predictable results as:

1) the prior art contained a base device in the combination's wireless CDMA headphone set that, when including intersymbol interference reduction, can be seen as in improvement;

2) the prior art contained a known technique (i.e. Reed Solomon encoding/decoding to reduce ISI) in a comparable device in Lindemann (i.e. wireless audio transmission); And

3) applying the teachings of Lindemann to the combination of Altstatt in view of Li would have been predictable as both operate on wireless CDMA communications of audio.

Regarding **Claim 2**, Altstatt discloses:

A wireless audio headphone for receipt of an audio music representation signal (Fig. 1), said wireless digital audio headphone comprising:

a audio receiver, capable of mobile operation, configured for direct wireless communication with a mobile audio transmitter (20 of Fig. 1).

Altstatt fails to explicitly disclose:

the system as a digital system,

the headphone for receipt of a unique user code and a digital audio music representation signal in the form of a packet;

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

a decoder operative to decode the applied reduced intersymbol interference coding of said audio music representation signal; and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence is being recognized.

However, digital CDMA transmissions of audio sources to headphones in devices was notoriously well known in the art. For Example, Li teaches a system providing CDMA communication of digital audio to headphone devices; col. 3 lines 20 – 33.

Replacing the FM transmitter/receiver implementation of Alstatt to use the digital CDMA communication discloses:

the system as a digital system (i.e. digital audio; col. 2 lines 48 – 51); also A/D conversion; col. 3 line 7);

the headphone for receipt of a unique user code (inherent in CDMA communication; see attached definition of CDMA) and a digital audio music representation signal in the form of a packet (packet form met by the G.729 encoding implementation, see col. 4 lines 25 – 33; also see the discussion of sending the entire signal using frames; col 3 lines 9 – 11);

a direct conversion module configured to capture packets embedded in the received spread spectrum signal (201 and 202 to prepare for despreading), the captured packets corresponding to the unique user code (frames as shown above receiving the specific random sequence to the particular channel; see definition of CDMA);

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation (202);

a decoder operative to decode the coding of said audio music representation signal (204); and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal (D/A portion of 204, signals are input to 204 as digital and then output as analog to post processor-205); and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized (portion 202 of receiving unit 200 that matches the inherent code in CDMA to initiate de-spreading, i.e. each channel in CDMA corresponds to a different random sequence, this sequence must be received and recognized by receiving unit 200 in order for the device to operate).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Alstatt. Li clearly teaches the device for use in portable implementations such as music and headphone audio reproductions. Li also teaches the outputs/inputs as standard audio jacks. Furthermore, doing so would be simple substitution of one known element (i.e. digital CDMA transmitter/receiver) for another (i.e. analog FM transmitter) to obtain predictable results (i.e. Alstatt w/ a digital transmitter). Additionally, Li discloses a number of advantages of using digital communication in col. 6.

The combination of Altstatt in view of Li fails to explicitly disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation.

However, reducing intersymbol interference in audio coding for CDMA transmission is notoriously well known in the art.

Lindemann discloses a device that transmits digital audio between a stereo system and a speaker using CDMA. Lindemann also includes that the transmission stream is created using a Seed-Solomon encoding and interleaver and a corresponding decoder in the decoder; Figs. 6 and 8.

Applying these teachings to the encoding of the combination discloses:

disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation (Fig. 8 element 802 which is a Reed Solomon decoder and Interleaver; it is known in the art to configure Reed Solomon decoding/interleaving to reduce ISI as is shown by Roberts 6,418,558. Reducing ISI is a desirable feature to any digital transmission).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the reed Solomon encoder/decoder in the combinations channel encoding. Doing so would have been nothing more than applying a known technique to a known device ready for improvement to yield predictable results as:

1) the prior art contained a base device in the combination's wireless CDMA headphone set that, when including intersymbol interference reduction, can be seen as in improvement;

2) the prior art contained a known technique (i.e. Reed Solomon encoding/decoding to reduce ISI) in a comparable device in Lindemann (i.e. wireless audio transmission); And

3) applying the teachings of Lindemann to the combination of Altstatt in view of Li would have been predictable as both operate on wireless CDMA communications of audio.

Regarding **Claim 5**, claim 5 is rejected under the same grounds as stated above. Additionally, the combination fails to disclose the module as a differential phase shift keying (DPSK) module. However, DPSK modulation is notoriously well known to be used in CDMA communication. It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the DPSK modulation to the CDMA implementation of the combination. One would have been motivated to do so to apply a known technique (i.e. DPSK) to a known device (CDMA transmitter) to yield predictable results (i.e. DPSK in CDMA, Li is silent as to the type of modulation used and it would have been provided predictable results to use any number of known and obvious techniques).

Claims 3, 4 and 6 – 12 are rejected under the same grounds stated above as well as the corresponding transmitter disclosed in Fig. 1 that corresponds the each of the modules disclosed in the receiver disclosed in fIg.1 as applied to the receiver claims above.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 1 – 12 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 - 13 of U.S. Patent No. 7,865,258. Although the conflicting claims are not identical, they are not patentably distinct from each other because:

Claims from the '258 patent anticipate claims from the instant application except for the packet format. However, the packet format of transmission in CDMA is extremely well known and obvious in view of the prior art. See Li above.

Claims 1 - 12 rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 - 20 of U.S. Patent No. 7,684,885. Although the conflicting claims are not identical, they are not patentably distinct from each other because:

Claims from the '885 patent anticipate claims from the instant application except for the packet format. However, the packet format of transmission in CDMA is extremely well known and obvious in view of the prior art. See Li above.

Claims 1 – 12 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 - 19 of U.S. Patent No. 7,412,294. Although the conflicting claims are not identical, they are not patentably distinct from each other because:

Claims from the '294 patent anticipate claims from the instant application except for the packet format. However, the packet format of transmission in CDMA is extremely well known and obvious in view of the prior art. See Li above.

This is a continuation of applicant's earlier Application No. 12/570,343. All claims are drawn to the same invention claimed in the earlier application and could have been finally rejected on the grounds and art of record in the next Office action if they had been entered in the earlier application. Accordingly, **THIS ACTION IS MADE FINAL** even though it is a first action in this case. See MPEP § 706.07(b). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no, however, event will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ANDREW C. FLANDERS whose telephone number is (571)272-7516. The examiner can normally be reached on M-F 8:30 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Curtis Kuntz can be reached on (571) 272-7499. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Andrew C Flanders/
Primary Examiner, Art Unit 2614

Notice of References Cited

Notice of References Cited	Application/Control No. 12/940,747	Applicant(s)/Patent Under Reexamination WOOLFORK, C. EARL	
	Examiner ANDREW C. FLANDERS	Art Unit 2614	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2004/0223622	11-2004	Lindemann et al.	381/079
*	B	US-5,771,441	06-1998	Altstatt, John E.	455/66.1
*	C	US-6,781,977	08-2004	Li, Yingtao	370/335
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	**Application/Control No.** 12940747	**Applicant(s)/Patent Under Reexamination** WOOLFORK, C. EARL
	Examiner ANDREW C FLANDERS	**Art Unit** 2614

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	05/02/2011								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								

Search Notes	Application/Control No. 12940747	Applicant(s)/Patent Under Reexamination WOOLFORK, C. EARL
	Examiner ANDREW C FLANDERS	**Art Unit** 2614

SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES

Search Notes	Date	Examiner
see history attached	5/2/11	acf
reviewed and repeated search history (including class search) of parent application 12/570,343	5/2/11	acf
edan, east and palm inventor search for double patenting	5/2/11	acf

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

	/ANDREW C FLANDERS/ Primary Examiner.Art Unit 2614

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CONFIRMATION NO. 8175

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/940,747	11/05/2010 **RULE**	700	2614	1028.5

APPLICANTS
C. Earl Woolfork, Pasadena, CA;

** **CONTINUING DATA** *************************
This application is a CON of 12/570,343 09/30/2009 PAT 7,865,258
which is a CON of 10/648,012 08/26/2003 PAT 7,412,294 *
which is a CON of 10/027,391 12/21/2001 ABN *
(*)Data provided by applicant is not consistent with PTO records.

** **FOREIGN APPLICATIONS** *************************

** **IF REQUIRED, FOREIGN FILING LICENSE GRANTED** ** ** SMALL ENTITY **
11/17/2010

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /ANDREW C FLANDERS/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CA	3	6	6

ADDRESS
MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613
UNITED STATES

TITLE
Wireless Digital Audio Music System

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
1452	No.____________ to charge/credit DEPOSIT ACCOUNT No.____________ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other ________________ ☐ Credit

BIB (Rev. 05/07).

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L6	3	(("7412294") or ("7865258") or ("7684885")).PN.	US-PGPUB; USPAT	OR	OFF	2011/05/02 14:06
S1	9	FHSS with unique with user	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:30
S2	6	S1 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:45
S3	0	FHSS with unique adj hop	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:46
S4	0	FHSS with each adj user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:46
S5	0	FHSS with individual adj user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:47
S6	0	(FHSS or "frequency hopping spread spectrum") with individual adj user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:47
S7	0	(FHSS or "frequency hopping spread spectrum") near user same unique	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:47
S8	9	(FHSS or "frequency hopping spread spectrum") with user same unique	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:48
S9	17	(FHSS or "frequency hopping spread spectrum") same unique same user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:48
S10	6	S9 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:48
S11	9	(FHSS or "frequency hopping spread spectrum") same multiple adj user!	US-PGPUB; USPAT	OR	OFF	2006/05/03 10:32

S12	91	(FHSS or "frequency hopping spread spectrum") same (pn or "hopping code")	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:50
S13	13	(FHSS or "frequency hopping spread spectrum") with ("hopping code")	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:50
S14	3	S13 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:51
S15	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2006/05/03 11:46
S16	1	("6342844").PN.	US-PGPUB; USPAT	OR	OFF	2006/05/03 11:46
S17	1	("5771441").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:55
S18	10725	"rechargeable battery" and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:55
S19	376	"rechargeable battery".ti. and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:55
S20	17	("rechargeable battery" and portable).ti. and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S21	3623043	("rechargeable battery" and portable) with mah andd @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S22	0	("rechargeable battery" and portable) with mah and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S23	3623041	("rechargeable battery" and portable) with ma-h andd @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S24	3623041	("rechargeable battery" and portable) with "ma-h" andd @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S25	0	("rechargeable battery" and portable) with "ma-h" and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S26	640693	("rechargeable battery" and portable) with milliamp hours and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57

S27	18	("rechargeable battery" and portable) and "milliamp hours" and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/31 12:17
S28	29	"5491839"	US-PGPUB; USPAT	OR	OFF	2006/08/30 12:56
S29	1	("5491839").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/30 12:56
S30	1	("5771441").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/30 12:56
S31	1	("6,107,147").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/31 12:17
S32	0	(10/648012).APP.	US-PGPUB; USPAT	OR	OFF	2006/09/25 09:26
S33	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2006/09/25 09:50
S34	422	(455/564.1,412,413).CCLS.	US-PGPUB; USPAT	OR	OFF	2006/09/25 09:50
S35	5294	(375/219,295-297,346,348).CCLS.	US-PGPUB; USPAT	OR	OFF	2006/09/25 10:02
S36	1	("20040223622").PN.	US-PGPUB; USPAT	OR	OFF	2006/09/25 10:04
S37	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2006/09/25 10:05
S38	1	("7,050,419").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:32
S39	1	("20010025358").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:37
S40	2618	(375/341,140,147).CCLS.	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:37
S41	1807	S40 and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:38

S42	8	("2001/0025358").URPN.	USPAT	OR	OFF	2007/03/20 09:51
S43	0	("2002/0025009").URPN.	USPAT	OR	OFF	2007/03/20 09:59
S44	0	("2002/0025009").URPN.	USPAT	OR	OFF	2007/03/20 10:01
S45	12	("20020159543" | "5434623" | "5867532" | "5973642" | "6243423" | "6327314" | "6339612" | "6459728" | "6477210" | "6480554" | "6654429" | "6671338").PN. OR ("7099413").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:08
S46	74	"band pass" and demodulator and interleaver and "viterbi decoder"	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:08
S47	59	S46 and @ad<"20011220"	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:08
S48	17	("4278978" | "4635063" | "5175558" | "5493307").PN. OR ("6130643").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:15
S49	1	("5175558").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 10:16
S50	13	("4651155" | "4931977").PN. OR ("5175558").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:34
S51	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 11:40
S52	7186	(375/295,146,130,340,316,148).CCLS.	US-PGPUB; USPAT	OR	OFF	2007/03/20 11:41
S53	4473	S52 and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2007/03/20 11:41
S54	1	("20040223622").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:11
S55	5	"reed solomon" with "intersymbol interference"	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:13

S56	30	"reed solomon" same "intersymbol interference"	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:13
S57	21	S56 and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:27
S58	1	("20030045235").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:37
S59	1	("5790595").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:37
S60	2435	((375/262,265,341) or (714/794,795)).CCLS.	US-PGPUB; USPAT	OR	OFF	2007/03/24 09:15
S62	56	"375".clas. and "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2007/03/26 11:04
S64	1	("4970637").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 13:46
S65	755	(audio sound music voice) same (a/d "analog to digital") same (lpf "low pass")	US-PGPUB; USPAT	OR	OFF	2007/03/28 13:46
S66	282	(audio sound music voice) with (a/d "analog to digital") with ((lpf "low pass") and "digital")	US-PGPUB; USPAT	OR	OFF	2007/03/28 13:47
S67	227	(audio sound music voice) with (a/d "analog to digital") with ((lpf "low pass") and "digital") and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:33
S68	34712	"band pass filter" bpf with "direct conversion receiver"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:33
S69	35	("band pass filter" bpf) with "direct conversion receiver"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:33
S70	8	S69 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:55
S71	1	("20030045235").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:16
S72	1	("20040223622").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:20

S73	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S74	364	"64-ary"	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S75	74	"64-ary" near modulat$4	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S76	46	S75 and @ad<"20011120"	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S77	2	(("4970637") or ("5790595")).PN.	US-PGPUB; USPAT	OR	OFF	2007/07/16 09:58
S78	3	(("4970637") or ("5790595") or ("20040223622")).PN.	US-PGPUB; USPAT	OR	OFF	2007/07/16 09:58
S79	3	("2004/0223622").URPN.	USPAT	OR	OFF	2007/07/16 11:25
S80	1	("5771441").PN.	US-PGPUB; USPAT	OR	OFF	2007/07/16 11:25
S81	60	("2236946" | "2828413" | "2840694" | "3080785" | "3085460" | "3087117" | "3296916" | "3579211" | "3743751" | "3781451" | "3825666" | "3863157" | "3901118" | "3906160" | "4004228" | "4229826" | "4335930" | "4344184" | "4369521" | "4430757" | "4453269" | "4464792" | "4471493" | "4612688" | "4647135" | "4721926" | "4794622" | "4845751" | "4899388" | "4988957" | "5025704" | "5214568").PN. OR ("5771441").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/16 11:26
S82	2	S81 and cdma	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/16 11:26
S83	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2008/05/20 11:41

S84	1	("20020072816").PN.	US-PGPUB; USPAT	OR	OFF	2008/05/20 14:24
S85	22	"fuzzy logic" and modulat$5 and filter and (dpsk "phase shift key")	US-PGPUB; USPAT	OR	OFF	2008/06/06 09:20
S86	0	"455".clas. and "375".clas. and S85	US-PGPUB; USPAT	OR	OFF	2008/06/06 09:21
S87	1	"10100351"	US-PGPUB; USPAT	OR	OFF	2008/06/06 11:49
S88	1	("6,678,892").PN.	US-PGPUB; USPAT	OR	OFF	2008/06/06 12:38
S89	3	("20030021429" | "20030076346" | "6867820").PN.	US-PGPUB; USPAT	OR	OFF	2008/06/06 12:42
S90	13	("4589134" | "4626892" | "5042070" | "5541638" | "5581621" | "5631850" | "5775939" | "6100936" | "6195438").PN. OR ("6867820").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/06 12:43
S91	2	"10648012"	US-PGPUB; USPAT	OR	OFF	2009/02/14 10:23
S92	1	"12144729"	US-PGPUB; USPAT	OR	OFF	2009/02/14 10:31
S93	1	("5790595").PN.	US-PGPUB; USPAT	OR	OFF	2009/02/14 12:36
S94	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2009/02/14 12:37
S95	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2009/05/26 07:51
S96	1680	portable and music and CDMA and transmitter and receiver	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:35
S97	527	portable and music and CDMA and transmitter and receiver and private	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:35

S98	57	portable and music and CDMA and transmitter and receiver and private and "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:35
S99	0	S98 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:36
S100	41	S97 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:36
S101	1	("6678692").PN.	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:39
S102	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:39
S103	25	("5555466" | "5771441" | "6058288" | "6243645" | "6266815" | "6300880" | "6317039").PN. OR ("6678892").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:39
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S106	4453	"fuzzy logic" and @ad<"20011221"	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:48
S107	659	S106 and transmitter	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:48

S108	591	S106 and portable	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:48
S109	4	S106 and portable adj player	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:49
S110	0	"fuzzy logic" with reciever	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:50
S111	49	"fuzzy logic" with receiver	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:50
S112	27	S111 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:50
S113	192	"fuzzy logic" same receiver	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:51
S114	72	S113 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:52
S115	71	("4019141" | "4229829" | "5264795" | "5404577" | "5437057" | "5568516" | "5694467" | "5771438" | "5771441" | "5867223" | "5978689" | "6006115").PN. OR ("6424820").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/02 11:27
S116	34	S115 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:28
S117	31	bluetooth with (headphone headset earphone "head phone" "head set" "ear phone") with cdma	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:32
S118	2	S117 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:32
S119	32	wireless with (headphone headset earphone "head phone" "head set" "ear phone") with cdma	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:33
S120	3	S119 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:33

S121	57	(headphone headset earphone "head phone" "head set" "ear phone") with cdma	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:34
S122	10	S121 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:34
S123	0	WO0056093	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:36
S124	0	WO0056093	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2009/09/02 11:37
S125	0	WO/0056093	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2009/09/02 11:37
S126	2	(("5781542") or ("5799005")).PN.	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:42
S127	1	("6199076").PN.	US-PGPUB; USPAT	OR	OFF	2009/09/02 13:51
S128	0	woolfork-earl.in.	US-PGPUB; USPAT	OR	OFF	2009/11/23 11:44
S129	3	woolfork-c-$.in.	US-PGPUB; USPAT	OR	OFF	2009/11/23 11:44
S139	1	("7412294").PN.	US-PGPUB; USPAT	OR	OFF	2010/01/11 12:21
S140	1	("7412294").PN.	US-PGPUB; USPAT	OR	OFF	2010/06/01 09:29
S141	3	"12144729"	US-PGPUB; USPAT	OR	OFF	2010/06/01 09:34

S142	843	cdma and "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S143	66	S142 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S144	14	cdma same "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S145	5	S144 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S146	11	code same wireless same "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:49
S147	2	S146 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:49
S148	2704	(700/94).CCLS.	US-PGPUB; USPAT	OR	OFF	2010/10/21 12:51

EAST Search History (Interference)

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S130	0	woolfork-earl.in.	USPAT; UPAD	OR	OFF	2009/11/23 11:44
S131	1	woolfork-c-$.in.	USPAT; UPAD	OR	OFF	2009/11/23 11:44
S132	195	(700/94).CCLS.	UPAD	OR	OFF	2009/11/23 11:59
S133	225	((700/94) or (455/3.06)).CCLS.	UPAD	OR	OFF	2010/01/11 11:18

5/2/2011 2:12:53 PM
C:\Documents and Settings\aflanders\My Documents\EAST\Workspaces\12940747.wsp

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	12940747
	Filing Date	2010-11-05
	First Named Inventor	C. Earl Woolfork
	Art Unit	2614
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

U.S.PATENTS

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6728585		2004-04-27	Neoh	
	2	7409064		2008-08-05	Watanuki	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	12940747
	Filing Date	2010-11-05
	First Named Inventor	C. Earl Woolfork
	Art Unit	2614
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Authors: ISHIGURO, TAKAHASHI, YOSHIDA, MIYAJIMA Title: Single-Chip Transceiver LSI For Spread Spectrum Communication With Smart Synchronization Technique Date: November 1997 CONSUMER ELECTRONICS, VOLUME 43, ISSUE 4, PAGE(S) 1331, ISSN 0098-3063	☐

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EXAMINER SIGNATURE

Examiner Signature	/Andrew Flanders/	Date Considered	05/02/2011

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	12940747
Filing Date	2010-11-05
First Named Inventor	C. Earl Woolfork
Art Unit	2614
Examiner Name	Andrew Flanders
Attorney Docket Number	1028.5

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	12940747
	Filing Date	2010-11-05
	First Named Inventor	C. Earl Woolfork
	Art Unit	2614
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

	1	Author: Weizhong, Chen Title: Motorola's Bluetooth Solution to Interference Rejection and Coexistence with 802.11 Date: December 2001 Application Note AN2211/D Rev. 0 PAGE(S) 1 - 8,	☐

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature	/Andrew Flanders/	Date Considered	05/02/2011

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/940,747	11/05/2010	C. Earl Woolfork	1028.5	8175

68533 7590 06/15/2011

MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

EXAMINER	
FLANDERS, ANDREW C	
ART UNIT	**PAPER NUMBER**
2614	

NOTIFICATION DATE	DELIVERY MODE
06/15/2011	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

MELYMAN@LYMANPATENTS.COM

Interview Summary	Application No. 12/940,747	Applicant(s) WOOLFORK, C. EARL	
	Examiner Andrew C. Flanders	Art Unit 2614	

All participants (applicant, applicant's representative, PTO personnel):

(1) Andrew C. Flanders.

(2) Megan Lyman.

(3) C. Earl Woolfork.

(4)_____.

Date of Interview: 07 June 2011.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☒ No.
If Yes, brief description: _____.

Claim(s) discussed: 1-12.

Identification of prior art discussed: Alstat (US 5,771,441), Li (US 6,781,977) and Lindemann (U.S. 2004/0223622).

Agreement with respect to the claims f)☐ was reached. g)☐ was not reached. h)☒ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: Discussed differences between the invention and the prior art. Applicant alleges the ISI correction in his invention differs from that of the prior art. Examiner generally agrees, however, the claim presentation does not meet the level of detail Examiner believes is necessary. Also discussed the differences in the Alstatt Li combination Applicant believes that a single transmitter system such as Li cannot be combined to a multiple transmitter system. Examienr disagrees and points to the analog system of Alstatt that includes multiple transmistter/reciever at 1:1 and submits digital transmission would logically follow. Also discussed the Direct Converiosn receiver. Examienr pointed out that while not exactly a DCR, the prior art meets these limiations with there modules cited, i.e. the directly receive and convert the data. Examiner also noted this wouldn't' be a good avenue to peruse because DCR's are notriously well known and would be obvious to substitute.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN A NON-EXTENDABLE PERIOD OF THE LONGER OF ONE MONTH OR THIRTY DAYS FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

/Andrew C Flanders/
Primary Examiner, Art Unit 2614

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

TERMINAL DISCLAIMER TO OBVIATE A PROVISIONAL DOUBLE PATENTING REJECTION OVER A PENDING "REFERENCE" APPLICATION	Docket Number (Optional) 1028.5

In re Application of: C. Earl Woolfork

Application No.: 12/940,747

Filed: 11/05/2010

For: Wireless Digital Audio System

The owner*, C. Earl Woolfork, of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending **reference** Application Number 12/940,747, filed on 11/05/2010, as such term is defined in 35 U.S.C. 154 and 173, and as the term of any patent granted on said **reference** application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending **reference** application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the **reference** application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 U.S.C. 154 and 173 of any patent granted on said **reference** application, "as the term of any patent granted on said **reference** application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending **reference** application," in the event that: any such patent: granted on the pending **reference** application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

Check either box 1 or 2 below, if appropriate.

1. ☐ For submissions on behalf of a business/organization (e.g., corporation, partnership, university, government agency, etc.), the undersigned is empowered to act on behalf of the business/organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. ☑ The undersigned is an attorney or agent of record. Reg. No. 57054

/Megan Lyman/ — Signature

06/20/2011 — Date

Megan E. Lyman — Typed or printed name

919 341 4023 — Telephone Number

☑ Terminal disclaimer fee under 37 CFR 1.20(d) is included.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this statement. See MPEP § 324.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	12940747
Filing Date:	05-Nov-2010
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Filer:	Megan Elizabeth Lyman
Attorney Docket Number:	1028.5

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Statutory or terminal disclaimer	2814	1	70	70
		Total in USD ($)		**70**

Electronic Acknowledgement Receipt

EFS ID:	10352152
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	21-JUN-2011
Filing Date:	05-NOV-2010
Time Stamp:	15:04:44
Application Type:	Utility under 35 USC 111(a)

Payment information:

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RAM confirmation Number	1565
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1	Applicant Arguments/Remarks Made in an Amendment	SubmittedResponse.pdf	190915 2563e6b224223a9b459393d053153f0703a4fc73	no	15
Warnings:					
Information:					
2	Amendment After Final	SubmittedClaimsAmended.pdf	70286 486b80b2929ae99f6dc54ee4c1b439e1c06872ff	no	8
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Information:					
3	Applicant Arguments/Remarks Made in an Amendment	ExhibitsforFRJResponse.pdf	14638063 dc72ef6f59396f3c9e9d5a61de9a067a69feaa13	no	43
Warnings:					
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4	Specification	SubmitedSpecAmended.pdf	67983 fec4ce48d41381f8dad928e121a70b289b5edd45	no	7
Warnings:					
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5	Terminal Disclaimer Filed	TerminalDisclaimerForm.pdf	207374 8a44994bedcc6a674f59a25258a5093fd36fee7f	no	2
Warnings:					
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6	Fee Worksheet (SB06)	fee-info.pdf	29680 2528ba2ed614b406d8e23a5030f2730335e8ffb5	no	2
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

RESPONSE TO THE FINAL REJECTION DATED 05/05/11

THE EXAMINER INTERIVEW OF JUNE 7, 2011

The Applicant would like to thank Examiner Flanders for his courtesy and attention in participating in the telephonic interview on June 7, 2011 at 10 am. The applicant has reviewed the Examiner's interview summary of June 15, 2011. As is recited in that summary, a detailed discussion regarding the particular issue of a mobile transmitter and receiver in the present invention differs substantially in problem and solution to the prior art. The Examiner agreed that the ISI problem is very different and requires a novel solution as is presented in the present invention. The Applicant maintains that the claim language properly details this solution (see Claims 2, 4, 6, 7, and 12 "a digital audio receiver, capable of mobile operation," "mobile digital audio transmitter"; Claims 3, 5, 9, and 11 "is capable of being moved in any direction during operation"; Claim 8 "wherein said mobile digital audio receiver," "mobile digital audio transmitter"; and Claim 10 "is capable of mobile operation"). The Applicant maintains that the centralized and not portable systems of Li, and analog systems of Altstatt cannot suggest remedies to the host of issues confronted by one of ordinary skill in creating a wireless digital system that can operate while the single transmitter and receiver are mobile and in an environment with other transmissions. The applicant also maintains that the presence of the DCR is novel and a patentable element of the present invention. The Applicant again wishes to show his appreciation for the Examiner's time and thought extended during the interview.

RESPONSE TO REJECTION OF CLAIMS 1 - 12 UNDER 35 U.S.C. 103

A finding of obviousness requires that "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertain." 35 U.S.C. §103(a). In *KSR Int'l Co. v. Teleflex, Inc.*, 127 S. Ct. 1727, 82 USPQ2d 1385 (2007), the Supreme Court stated that the following factors set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966) control an obviousness inquiry: (1) the scope and content of the prior art; (2) the differences between the prior art and the claimed invention; (3) the level of ordinary skill in the art; and (4) objective evidence of nonboviousness. *KSR,* 127 S. Ct. at 1734, 82 USPQ2d at 1388 (quoting *Graham*, 383 U.S. at 17-18, 14 USPQ at 467).

The *KSR* Court affirmed that it is "important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does . . . because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." *KSR,* 127 S. Ct. at 1741, 82 USPQ2d at 1396. Once the *Graham* factors have been addressed, the Examiner may apply the TSM test, asking whether (l) a teaching, suggestion or motivation exists in the prior art to combine the references cited, and (2) one skilled in the art would have a reasonable expectation of success. *See* USPTO Guidelines at 57534.

Further, in order to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka,* 490 F.2d 981, 180 USPQ 580 (CCPA 1974). Additionally, in considering a prior art reference, the reference must be considered in its entirety, *i.e.,* as a whole, including portions that would lead away from the claimed invention. *WL. Gore & Associates, Inc.* v. *Garlock. Inc., 721* F.2d 1540,220 USPQ 303 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984). A prior art reference is only appropriate where the "invention as a whole would be obvious to a person of ordinary skill in the field." In re Kumar, 418 F.3d 1361, 76 USPQ2d 1048, 1053 (Fed. Cir. 2005). Moreover, it is improper to combine references where the references teach away from their combination. *In re Grasselli,* 713 F.2d 731,743,218 USPQ 769, 779 (Fed. Cir. 1983). Indeed, "an applicant may rebut a prima facie case of obviousness by showing that the prior art teaches away from the claimed invention *in any material respect."* *In re Peterson*, 315 F.3d 1325, 1331 (Fed. Cir. 2003) (Emphasis added). In making an obviousness rejection, Examiners must provide evidence and clear argument as to how the prior art suggests the invention. *Sud-Chemie v. Multisorb Techs.*, 554 F. 3d 1001 (Fed. Cir. 2009).

Claims 1-12 Rejected as Unpatentable over Altstatt in View of Li and in Further View of Lindemann

Summary

The applicant is aware that the prior art is taken as a whole, as is cited above, in the rejections posed. It is this very fact that the applicant urges the examiner to review this invention. As is outlined in detail below, the prior art in combination do not teach or suggest the present invention and provide no motivation for one of ordinary skill to combine and solve the novel problems posed by a mobile system working with a single mobile transmitter and a single mobile receiver in a space containing other transmissions in the digital spectrum. The present invention was first presented to the Patent Office in 2001 and must be evaluated at that time point, well before wireless audio transmission was commonplace in our current digital society. Three patents have been issued towards the present invention, each directed towards different novel aspects of transmitting digital audio with high fidelity and without interference. It is the applicant's position the static systems of Lindemann, centralized and not portable systems of Li, and analog systems of Altstatt cannot suggest remedies to the host of issues confronted by one of ordinary skill in creating a wireless digital system that can operate while the single transmitter and receiver are mobile and in an environment with other transmissions. The overarching deficiencies in each prior art cannot be remedied by the presence of the prior art as a whole. These deficiencies in the prior art make it implausible to combine them in 2001 to teach, suggest, or provide motivation to one of ordinary skill to produce the present invention. Below three major areas discussed in the Final Rejection are addressed: ISI, CDMA, and the DCR. It is expected that after a review of these three issues and how the prior art fail to address the solutions fashioned by the present invention, the rejections will be removed and the application placed into allowance.

Amendments to the Claims

Claims 3, 4, 5, 6, and 12 have been amended to state that the "wireless digital receiver" is *directly* communicable with the "digital audio transmitter." The omission of the word "directly" in the originally submitted claims was in error. The insertion of this word does not change the scope of the claim and should be allowed at this time in prosecution. Claims 10 and 11 have also been amended to change "audio source" as is written in the original claims to "audio player." Again this amendment corrects the original language and does not change the scope of the claims. The Applicant respectfully requests that the amendments be entered at this time.

The Intersymbol Interference Problem

In order to clearly demonstrate that the prior art combination does not teach or suggest the present invention, a description of the problem of Intersymbol interference ("ISI") is provided. ISI distorts the audio signal content, causing a major obstacle to the transmission of high data rate audio from an in-motion transmitter to an in-motion receiver. Referring to the underlined sections of the Exhibit IV text "Adaptive Filter Theory," Second Edition, by Simon Haykin, ISI "is caused by dispersion in the transmit filter, the transmission medium, and the receive filter . . . we usually find that intersymbol interference is the chief determining factor in the design of high-data rate transmission systems . . . intersymbol interference, if left unchecked, can result in erroneous decisions when the sampled signal at the channel output is compared with some preassigned threshold by means of a decision device." The problem of ISI is very different in static and mobile systems.

Within the present invention, both the digital audio transmitter and digital audio receiver may be in motion (see Claims 1 - 12), thus, the relative position and velocity of both the transmitter and receiver (both in-motion transmitter and in-motion receiver present spatial and temporal variations) will be constantly changing (e.g., a person running with the wireless digital audio system). Because ISI results when the in-motion digital audio transmitter attempts to communicate high symbol rate audio to the in-motion digital audio receiver, ISI must be suppressed. The present invention solves the ISI problem by maintaining fidelity of the high data rate audio signal while the in-motion transmitter is in communication with the in-motion receiver. The ISI mitigation of the present invention is performed by, among other things, the claimed encoder ("a encoder operative to encode said original audio signal representation to reduce intersymbol interference") and decoder ("a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation")

(Claims 1 - 12). This solution is the result of a novel inventive step in producing the present invention.

On page 5 of the Final Rejection (FRJ) mailed 05/05/2011, it is stated: "The combination of Altstatt in view of Li fails to explicitly disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation." Thus, the rejection of the claim language "a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation" relies upon Lindemann. *It is important to note that Lindemann never discusses ISI.* Failure to identify the problem of ISI clearly demonstrates that this prior art, neither alone nor in combination can even suggest a solution to the present invention. *Furthermore, Roberts (6,418,558), which is also cited in this rejection, does not disclose the reduction of ISI in a mobile transmitter and mobile receiver system.* Roberts cannot teach or suggest how the unique problem of ISI in a mobile system can be attenuated. One of ordinary skill would have no motivation to look to these prior art to solve the ISI problem in a mobile system as has been accomplished by the present invention.

The FRJ relies upon the hypothetical scenario that Lindemann teaches reduction of ISI within a mobile transmitter/mobile receiver system (page 5 of the FRJ states: "Lindemann also includes that the transmission stream is created using a Reed-Solomon encoding and interleaver and a corresponding decoder in the decoder. Applying these teachings to the encoding of the combination discloses: . . . reduced intersymbol interference coding"). Reed-Solomon encoding and interleaving may be designed to address burst errors, but Lindemann does not teach Reed-Solomon encoding and interleaving for the purpose of reducing ISI in a mobile transmitter/mobile receiver system. Lindemann is silent about both mobility and ISI.

In fact, paragraph 0050 of Lindemann 2004/0223622, states: "The interleaver function performed by the Reed Solomon Encoder and Interleaver with Frame Marker Insertion 407 protects against *burst errors* by scrambling adjacent bits across multiple Reed Solomon encoding blocks. This error protection system is a called a concatenated encoder with interleaving." (Emphasis added). To be clear, "Reed-Solomon (RS) are nonbinary codes which are capable of correcting errors which appear in bursts and are commonly used in concatenated coding systems" (reference underlined section of Exhibit

V text "Wireless Communications Principles & Practice" by T. S. Rappaport). Bursts are the result of an additional unintended transmission source (also known as a jammer because it may unintentionally jam communications) as described in underlined section of Exhibit VI text "Introduction to Spread Spectrum Communications" by R.L. Peterson, R.E. Ziemer and D.E. Borth: "Jamming strategies which concentrate jamming resources on some fraction of the transmitted symbols using either pulsed or partial band techniques cause demodulator output errors to occur in bursts."

To clarify, "FIGURE 10-1. Covert communications process" and underlined section of Exhibit VII text "Introduction to Spread Spectrum Communications" by R.L. Peterson, R.E. Ziemer, and D.E. Borth states: "In any communications operation, there may be several ingredients or "players," as illustrated in Figure 10-1. First, there are the intended communicators, which make use of the transmitter and receiver shown in the figure. Second, there may be unintentional sources or jammers." Consequently, "These jammers produce bursts of errors . . . . To counter this difficulty, an interleaver is placed between the encoder and the modulator and a de-interleaver is placed between the demodulator and the decoder" (reference underlined section of Exhibit VIII text "Introduction to Spread Spectrum Communications" by R.L. Peterson, R.E. Ziemer, and D.E. Borth).

Lindemann does not teach a method of "Reed Solomon encoding/decoding to reduce ISI" as stated on page 6 of the FRJ. The FRJ misinterprets ISI (defined previously above) as interference radiating from an outside transmission source (burst errors). Moreover, Roberts is silent about reducing ISI within a wireless mobile transmitter/mobile receiver system. The rejection relies on a nonenabled hypothetical scenario, because neither Lindemann nor Roberts suggest a method of reducing ISI in a wireless mobile transmitter/mobile receiver system. The combination of Altstatt, Li, Lindemann (with Roberts) fails to teach or suggest the claim language "a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation."

A further review of Roberts shows that there is not disclosure of Reed-Solomon/Interleaving to reduce ISI (see col. 5 lns. 62 – 67 and col. 6 lns. 1 – 3: "The clock signals for generating the carriers and the symbols representing the transmitted data may be locked to each other or generated from the same source, to reduce intersymbol interference significantly," "Another technique for reducing intersymbol interference is the transmission of each symbol with more than 360 degrees of phase in one cycle of its carrier, in order to allow some leeway in tracking the phase of a channel carrier in a receiving system." And see col. 45 lns. 9 – 14: "Again, a phase discontinuities exist at the ends of the total 405 degree phase degrees of this wave. In fact, this characteristic gives the excess-phase improvement an advantage over its primary function of providing a guard band for the symbol decoder, for reducing intersymbol interference," And see col. 46 lns. 10 – 19: "In the present system, however, it has been found that even very small frequency drifts between the 8 kHz symbol or flame clock and the frequencies of the tones upon which they ride can produce significant intersymbol interference and distortion at the receiving end. Such drifts tend to destroy the orthogonality of the channel signals produced by inverse FFT 140 in FIG. 21. The present system also, however, provides a simple, inexpensive way to overcome this problem. FIG. 51 shows a portion 4200 of the HDT clock/sync logic in CTSU 54, FIG. 3.")

In each of the above methods to reduce ISI presented by Roberts, none of them disclose the use of Reed-Solomon/Interleaving as a solution to suppress ISI. In fact, Roberts discloses Reed-Solomon for error detection/correction (as previously described above and see col. 6 lns. 5 – 12: "An embodiment is shown which handles both unencoded parity-type detection/correction and more multiple types of more powerful methods, such as Reed-Solomon encoding, in a transparent, real-time fashion, by packing the data words differently for each case. Moreover, the processor loading involved in these error-correction techniques can be spread out in time, so that not all channels need to be handled at the same time.") Page 5 of the FRJ incorrectly states "configure Reed Solomon decoding/interleaving to reduce ISI as is shown by Roberts 6,418,558," because Roberts does not disclose nor teach such a configuration.

It is clear that the degree of ISI becomes more severe in a mobile environment (i.e., a mobile transmitter communicating with a mobile receiver) given the following: a fading channel exhibits ISI in digital communications (reference underlined section of Exhibit IX text "Introduction to Spread Spectrum Communications" by R. Peterson, R. Ziemer, and D. Borth and referring to the underlined section of Exhibit X text "Spread

Spectrum Systems With Commercial Applications," Third Edition, by Robert C. Dixon, *"The rate at which fades occur is a function of the rate at which the signal propagation paths change. In fixed-position systems, the fading rate is determined by how fast the environment changes."*) Lindemann (who does not address ISI) teaches a fixed-position system (i.e., immobile digital transmitter and immobile digital speaker receiver) and Roberts is silent as to mobile systems. Given the fact that the rate at which fades occur (fading relative to ISI) is a function of the rate at which the signal propagation paths change, and that both the transmitter and receiver in the present invention are mobile, it should be clear that the propagation paths, or multipath in the present invention, create a type of ISI that was not considered in Roberts.

The teachings of Altstatt, Li, Lindemann and Roberts do not combine to obviate the present invention when taken as a whole. Referencing the underlined section of Exhibit XI text "Spread Spectrum Systems with Commercial Applications," Third Edition, by Robert C. Dixon: "One cannot say, however, that using a spread spectrum signal *(e.g., CDMA)* does away with all multipath effects." Emphasis added. One may consider Bluetooth as an example of the Altstatt, Li, and Lindemann teachings based on the hypothetical scenario presented in the FRJ on pages 4 and 5. ("It would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Alstatt. Li clearly teaches the device for use in portable implementations such as music and headphone audio reproductions." And on page 5 "reducing intersymbol interference for CDMA transmission is notoriously well known in the art.")

At the present time, Bluetooth is known "for use in portable implementations such as music and headphone audio reproductions" (Reference page 4 of the FRJ). As stated in the underlined section of Exhibit XII, Bluetooth Specification Version 1.0B, page 41 "Bluetooth is a short-range radio link intended to replace cable(s) connecting portable . . . electronic devices." (submitted to the USPTO on 08/04/2010 by way of the Information Disclosure Statement). The FRJ states that "reducing intersymbol interference for CDMA transmission is notoriously well known in the art," and the combination of

Altstatt, Li and Lindemann (including Roberts) should lend a reduced ISI solution (for a portable mobile wireless system) that is "obvious to one of ordinary skill in the art."

Respectfully, the following application note provides evidence this rejection is in error. The application note (submitted to the USPTO on 04/14/2011by way of the Information Disclosure Statement) is "Motorola's Bluetooth Solution to Interference Rejection and Coexistence with 802.11" and it states on page 1, section 2 (also see page 7, section 4) "The Bluetooth channel has unrecoverable Inter Symbol Interference (ISI)." A copy of this statement is conveniently located and underlined in Exhibit XIII. It is important to note that Motorola's application note was published in December of 2001, while the present invention was disclosed to Mr. Dennis Beech (the patent prosecution attorney at that time) in June of 2001 (Please see Exhibit XIV). The application note is, at least, evidence that reducing ISI within a system that contains a mobile transmitter and a mobile receiver is *not* "obvious to one of ordinary skill in the art" nor is it "notoriously well known in the art."

The ISI within Bluetooth, at that time, would not be in an "unrecoverable" state if the solution was "obvious to one of ordinary skill in the art" or "notoriously well known in the art." The Bluetooth specification referenced here (version 1.0B) was published in December of 1999 and it was not until December of 2001 when Motorola proposed a solution to reduce ISI in Bluetooth's system. Again it is important to note that the solution for reducing ISI in a wireless mobile digital audio transmitter/mobile digital audio receiver system was part of the present invention prior to the Motorola application note.

The claims should be in allowance on the presence of the encoder /decoder that function to reduce ISI that results when both the transmitter and receiver are in motion. These explanations remove the obviousness arguments for all remaining Claims 1- 12. Thus, for at least the reasons provided above, the prior art references are deficient in providing the present invention solution, and the remaining Claims should be in allowance.

Digital Wireless Communications and CDMA

The claims are also rejected as being obviousness by the digital wireless communication of Li could be replaced by the FM modulation communication taught in

Altstatt. Li is cited in the rejection for teaching a device for use in portable implementations. It is stated that doing so is the substitution of one known element (i.e., the digital CDMA transmitter/receiver) for another (i.e., analog FM transmitter) to obtain predictable results. The Applicant respectfully disagrees.

Altstatt does not disclose a direct one-to-one digital transmitter-to-headphone communication link, thus, Altstatt cannot realize the benefits of such a digital link as asserted (Examiner Office Action Mailed 08-09-2005, page 6: "However the system of Altstatt is an analog transmission system that, in operation, lacks the benefits of a digitally encoded and transmitted audio signal" and Office Action Mailed 05-17-2006, page 6 and Office Action Mailed 10-02-2006, page 10: "However, the system of Altstatt an analog transmission system that, operation lacks the benefits digitally encoded and transmitted audio signal."). Additionally, Li clearly discloses a cellular communication system (Li column 1 lines 57 – 63 "CDMA digital cellular communications system . . . ," column 6 lines 55 – 62 "IMT 2000 . . . IS95 . . . CDMA 2000). IMT 2000, IS95 and CDMA 2000 are all cellular (i.e., cell phone) standards and each requires the *centralized* control of a base station for operation. Li's centralized control base station system does not teach or suggest a direct one-to-one transmitter-to-headphone communication link.

Based on what is taught by Altstatt and Li, applying "the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Alstatt," as stated on page 4 of the Final Rejection (FRJ) mailed 05/05/2011, *requires* the centralized control of the cellular base station taught by Li (Li column 7 lines 9 – 17 "The exchange or the service-providing unit of the mobile net can store various multichannel sounds needed by users, e.g. a great amount of MP3 music data. On request of users, the exchange or the service-providing unit of the mobile net sends the suitable data to the wideband CDMA base station, by which the multichannel data, e.g. MP3 music data, is transmitted to the multichannel mobile equipment through the radio interface of the wideband CDMA). Li teaches the cellular base station approach for "bi-directional" sound communication and interference suppression (Li column 1 lines 57 – 63 "CDMA digital cellular communications system can, with large system capacity only restricted by interference … providing bi-directional … sound."). As a result, the Altstatt/Li combination stated in the FRJ requires the cellular base station to meet the interference mitigation claim language "virtually free from interference from device transmitted signals operating in the portable wireless digital audio system spectrum" as found in Claims 4, 6, 7 - 12.

Regarding Claim 1, page 5 of the FRJ poses that the Altstatt/Li combination obviates the invention by "Replacing the FM transmitter/receiver implementation of Alstatt to use the digital CDMA communication." This Altstatt/Li combination fails to obviate the invention based on at least the following. The following explanation is applicable not only to Claim 1, but to the other remaining Claims (2-12) that stand rejected under the Altstatt/Li combination (and in view of Lindemann).

The Altstatt/Li combination does not suggest a portable audio system that includes a mobile transmitter and mobile receiver with a distributed architecture to one of ordinary skill. To further support this position, the Examiner is referred to the underlined portion of Exhibit I (herein attached) "From WPANs to Personal Networks Technologies and Applications" where it is stated: "A wireless network can be distributed or centralized. Distributed networks are those where each device accesses the medium individually and transmits the data without any central control . . . . Centralized network architecture has one network element, which controls the communication of various devices." The claim language "configured for independent CDMA communication operation" (as seen in Claims 1 - 12) reflects the distributed architecture and is supported by the specification of 10/027,391 application in paragraph 0016: "This . . . (CDMA) may be used to provide each user independent operation." (as well as other portions of the specification).

The Direct Conversion Receiver

Within the present invention, the task of each receiver, among other things, is to mitigate interference in the vicinity in order to receive the correct transmission. Thus, the direct conversion receiver (DCR) disclosed in the present invention (see Claims 1 - 12) utilizes, among other things, "timing and synchronization to capture the correct bit sequence embedded in the received spread spectrum signal" (Parent Application 10/027,391 paragraph 0015). Furthermore, paragraph 0016 of the 10/027,391 application states: "Other code words from wireless digital audio systems 10 may appear as noise to a particular audio receiver 50. This may also be true for other device transmitted signals operating in the wireless digital audio system 10 spectrum." Moreover, Patent 7,412,294 column 3 lines 32-34 state: "The battery powered transmitter 20 sends the audio music information to the battery powered receiver 50 in digital packet format."

When packets are communicated over a wireless link it may be referred to as packet radio. The underlined section of the text "Wireless Communications Principles & Practice" has been provided for clarification (please see Exhibit II: "... called packet radio when used over a wireless link .... This benefit is valuable for the case of mobile services where the available bandwidth is limited. The packet radio approach supports intelligent protocols for data flow control and retransmission, which can provide highly reliable transfer in degraded channel conditions."). While other code words and/or other device transmitted signals are in the vicinity, they can create associated noise channel conditions at the receiver that may prevent the capture of the packet with the correct bit sequence. Based on the above disclosures, it is clear that both intended and unintended spread spectrum packet signals can appear at the receiver, but only the packet with the correct bit sequence is captured by the DCR in the present invention. Moreover, there exists several data delivery types (for clarification, please see section 16.2.1, of the book from Vijay Garg entitled Wireless Communications and Networking, (relative to the CDMA2000 cellular communication taught by Li) accessible on the following Google books website:
http://books.google.com/books?id=UE2wEc9NfB8C&pg=PA544&lpg=PA544&dq=cdma2000+isdn&source=bl&ots=pB26eq6oLc&sig=nzleT7D4Q_P-KFMduSkb9b5015s&hl=en&ei=lZw8TKzcHZL4swOg0uDaCg&sa=X&oi=book_result&ct=result&resnum=2&ved=0CBoQ6AEwAQ#v=onepage&q=cdma2000%20isdn&f=false).

That source states: "End user data-bearing services. Services that deliver any form of data on behalf of the mobile end user, including packet data (e.g., IP service), circuit switched data services (e.g., B-ISDN emulation services), and SMS. Packet data services conform to industry standard connection-oriented and connectionless packet data including IP-based protocols (e.g., transmission control protocol (TCP) and user data protocol (UDP) and OSI connectionless interworking protocol (CLIP)). Circuit-switched data services that emulate international standards-defined, connection-oriented services such as asynchronous (async) dial-up access, fax, V.120 rate-adapted ISDN, and B-ISDN services." Of these data delivery types available, the Altstatt/Li combination does not disclose or suggest a digital packet format for audio information coming from an audio player/source as is included in the claim language and does not obviate the invention. The G.729 is a "compression algorithm for voice", "high quality audio cannot be transported reliably with this codec" as stated in http://en.wikipedia.org/wiki/G.729. Paragraph 0018 of application 10/027,391 discloses high quality audio. The digital packet and audio player/source disclosure is seen in Claims 2 – 12 of the present invention.

Moreover, the DCR of the present invention (based on paragraphs 0015 and 0016 of the 10/027,391 application, as well as Patent 7,412,294 column 3 lines 32-34) accounts for, among other things, (1) relevant timing metrics to capture the packet with the correct bit sequence embedded in the received spread spectrum signal within a in-motion transmitter, in-motion receiver, distributed architecture and (2) relevant synchronization metrics to capture the packet with the correct bit sequence embedded in the received spread spectrum signal within a in-motion transmitter, in-motion receiver, distributed architecture. It should be noted that synchronization includes forms of acquisition and tracking (please reference underlined section of Exhibit III taken from "Digital Communications Techniques Signal Design and Detection"). As a result, timing and synchronization, to capture the intended signal components, has been described and broadly covers all types of timing and synchronization distributed architecture techniques to perform such a task.

Regarding Claims 1 – 12 of the present invention, the Altstatt/Li combination does not disclose a direct conversion receiver (DCR) as stated on pages 4 and 7 in the FRJ where Li's elements "(201)" and "(202)" are referenced. There is no teaching or suggestion that Li's items 201 and 202 ("wideband CDMA demodulator") constitute a DCR. The DCR disclosed in the present invention, among other things, performs direct down conversion from radio frequency (RF) to baseband (or very near baseband), thus, omitting intermediate frequency (IF) down conversion components that are often used. The invention utilizes the DCR for, among other things, down conversion from RF-to-baseband (or very near baseband), eliminating unnecessary IF components, which reduces the size and power consumption of the module. The Altstatt/Li combination does not teach a DCR nor does it suggest the use of a DCR within the invention. Because one of ordinary skill would not be motivated in any way by Alstatt and Li to create the present invention with any reasonable expectation of success, the obviousness rejection should be removed.

In addition, the use of the DCR in the invention, suppresses aliasing noise effects by use of the anti-aliasing filters (typically low pass filters or some version thereof) located within the DCR, thus, aiding to preserve the fidelity of the transmitted high quality audio signal. The Altstatt/Li combination does not teach or suggest a DCR, thus, cannot realize the benefits of the claim language "a direct conversion module configured to capture the packet with the correct bit sequence embedded in the received spread spectrum signal" (see Claims 1 - 12). Neither Li, Altstatt, nor Lindemann (Lindemann discloses in paragraph 0057 "In the RF receiver embodiment of FIG. 3, …, The RF Downconverter 302 modulates the RF signal, using a sinusoid generated by the RF VCO 310*, down to IF frequency*. The *IF signal is further down modulated* by the IF Demodulator 303. The output of the IF Demodulator is a complex signal consisting of I and Q--real, imaginary--running at the Chip Rate") alone or in any combination of the three teach, suggest, or disclose the DCR of the present invention. One of ordinary skill would not be motivated or anticipate any success by reading the cited prior art to create a system containing a DCR to solve reception problems solved in the present invention. Claims 1- 12 should be in allowance on the presence of the DCR alone.

These explanations remove the obviousness arguments for all remaining Claims 1- 12. Thus, for at least the reasons provided above, the prior art references are deficient in providing the present invention solution, and the remaining Claims should be in allowance.

Moreover, the applicant would like to state that any other arguments made by the Examiner and not explicitly addressed in this response are not agreed to by the applicant (e.g., the rejection to DPSK/CDMA for obviousness). Silence as to any arguments made by the examiner is not an assent to those arguments; the applicant respectfully asserts that all claims in their present condition are allowable and patentable.

Double Patenting Rejection

A terminal disclaimer is submitted herewith to remove the double patenting rejection.

Amendment to the Specification

The first paragraph of the specification has been amended to reflect the proper family history of this application. The changes make clear lineage of the application and are ministerial in nature. Language to be deleted is in strikethrough and language to be added is underlined. It is respectfully requested that this amendment be entered.

If there are any questions, concerns, or actions that can be taken to expedite the processing of this application, please do not hesitate to contact the applicant's representative.

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CLAIMS

I claim:

1. (Original) A wireless digital audio headphone comprising:

a portable digital audio headphone receiver configured to receive a unique user code bit sequence and a original audio signal representation in the form of packets, said portable digital audio headphone receiver comprising:

a direct conversion module configured to capture said packets embedded in the received spread spectrum signal;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode reduced intersymbol interference coding of original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized.

2. (Original) A wireless digital audio headphone for receipt of a unique user code and a digital audio music representation signal in the form of a packet, said wireless digital audio headphone comprising:

a digital audio receiver, capable of mobile operation, configured for direct digital wireless communication with a mobile digital audio transmitter;

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

a decoder operative to decode the applied reduced intersymbol interference coding of said audio music representation signal; and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence is being recognized.

3. (Currently Amended) A wireless digital audio transmitter operatively coupled to a portable audio source and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio source, and configured to be <u>directly</u> communicable with a mobile receiver, is capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a channel encoder to reduce transmission errors; and

a digital modulator module configured for independent code division multiple access (CDMA) communication operation.

4. (Currently Amended) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be <u>directly</u> communicable with a mobile digital audio transmitter, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio source virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

5. (Currently Amended) A wireless digital audio transmitter operatively coupled to a portable audio source and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio source, and configured to be directly communicable with a mobile receiver, is capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

an interleaver to reduce transmission errors; and

a digital modulator module configured for CDMA communication; independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation.

6. (Currently Amended) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent CDMA communication operation;

an de-interleaver generating a corresponding digital output;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio source virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

7. (Previously Presented) A wireless digital audio headphone for receipt of a unique user code and a digital audio representation signal in a packet format, the unique user code configured to spread the said signal spectrum and further configured for independent communication operation, said wireless digital audio headphone comprising:

a digital audio receiver, capable of mobile operation, configured for direct digital wireless communication with a mobile digital audio transmitter, wherein said mobile digital audio transmitter is operatively coupled to a portable audio player;

a direct conversion module configured to capture the packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode the applied reduced intersymbol interference coding of said audio representation signal; and

a digital–to–analog converter generating an audio output of said digital audio representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence being recognized; said audio output being virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

8. (Previously Presented) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and an original audio signal representation in the form of packets, the unique user code configured to spread the said signal spectrum and further configured for independent communication operation, the

wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, wherein said mobile digital audio transmitter is operatively coupled to a portable audio player, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode applied reduced intersymbol interference coding of said original audio signal representation ; and

a digital-to-analog converter generating an audio output of said original audio signal representation;

and a module adapted to reproduce said generated audio output, in response to the unique user code being recognized; said audio output being virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

9. (Previously Presented) A wireless digital audio transmitter operatively coupled to a portable audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver and capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent code division multiple access (CDMA) communication operation.

10. (Currently Amended) A portable wireless digital audio system for digital transmission of an original audio signal representation from a portable audio player to a portable digital audio headphone receiver, said portable wireless digital audio system comprising:

a digital audio transmitter operatively coupled to said portable audio player and transmitting a unique user code bit sequence with said original audio signal representation in packet format, wherein said digital audio transmitter operatively coupled to said audio player is capable of mobile operation, said digital audio transmitter comprising:

a encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent CDMA communication operation;

said digital audio transmitter configured for direct digital wireless communication with said portable digital audio headphone receiver, said portable digital audio headphone receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code bit sequence;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from said portable audio ~~source~~ player and reproduced virtually free from interference.

11. (Currently Amended) A portable wireless digital audio system for digital transmission of an original audio signal representation from a portable audio player to a digital audio receiver, said portable wireless digital audio system comprising:

a digital audio transmitter operatively coupled to said audio player and transmitting a unique user code with said original audio signal representation in packet format, wherein said digital audio transmitter coupled to said audio player is

capable of being moved in any direction during operation, said digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation;

said digital audio receiver capable of being moved in any direction during operation and in direct wireless communication with said digital audio transmitter, said digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode the applied reduced inter-symbol interference coding of said original audio signal representation;

a digital-to-analog converter generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from said audio ~~source~~ player virtually free from interference.

12. (Currently Amended) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said

wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent code division multiple access communication operation;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio player virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

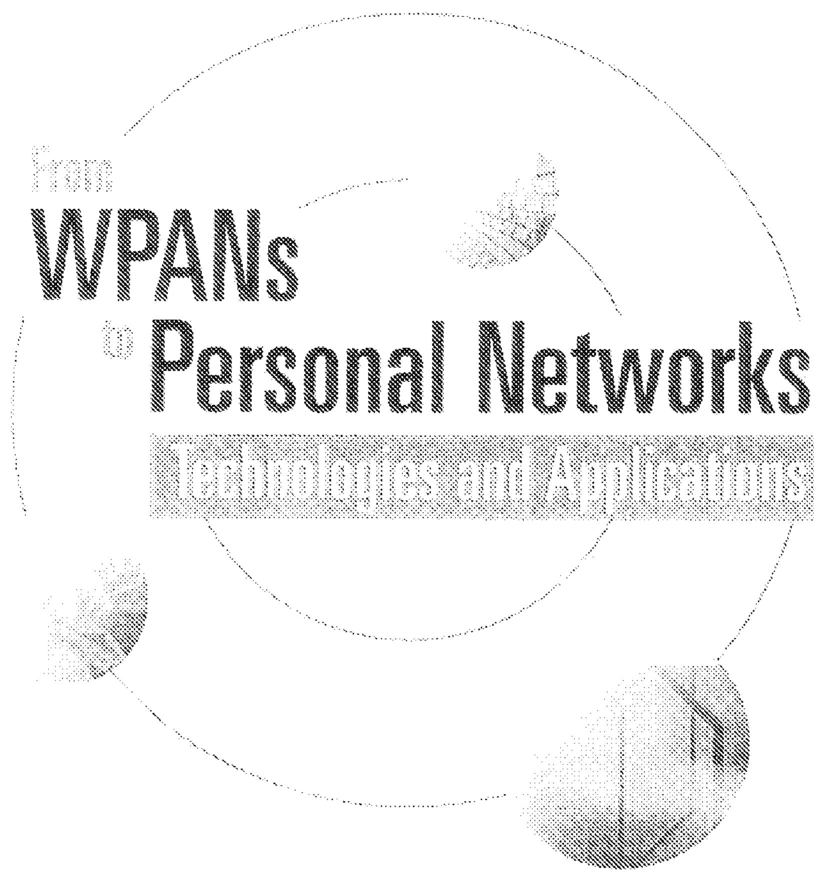
Exhibit I

universal personal communications

Ramjee Prasad
Luc Deneire

From WPANs to Personal Networks

Technologies and Applications



2.2 MAC in WLAN Standards

The MAC protocols form the basis of efficient use of a channel, be it wireline or wireless. When numerous users desire to transmit in a channel at the same time, conflicts occur, so there must be procedures on how the available channel capacity is allocated. These procedures constitute the MAC protocol rules each user has to follow in accessing the common channel [30]. The channel thus becomes a shared resource whose allocation is critical for proper functioning of the network. With the boom of WLANs, an efficient MAC has become a must.

Before designing an appropriate MAC protocol, one has to understand the wireless network under discussion [30–32]. The first thing that should be understood is the duplexing scheme used by a system and also the network architecture. A MAC protocol is dependent on these two issues.

Duplexing refers to mechanisms for wireless devices to send and receive. There are two duplexing methods, time based or frequency based. Sending and receiving data in the same frequency at different time periods is known as time division duplex (TDD), while sending and receiving data in same time and different frequency is known as frequency division duplex (FDD).

A wireless network can be distributed or centralized. Distributed networks are those where each device accesses the medium individually and transmits the data without any central control. Distributed network architecture requires the same frequency and thus makes use of TDD. IEEE 802.11 is an example of distributed network architecture. Centralized network architecture has one network element, which controls the communication of various devices. Such network architecture can make use of both TDD and FDD. HIPERLAN/2 is an example of centralized network architecture.

In the following sections the MAC protocols in IEEE 802.11 [33, 34] and HIPERLAN/2 [35, 36] are discussed. IEEE 802.11 is the most commonly used WLAN, and it is explained in more detail.

2.2.1 IEEE 802.11

Standardization of IEEE 802.11 was done to satisfy the needs of wireless data networking. CSMA/CA was the MAC protocol adopted by IEEE 802.11 [3, 10]. Wherein, the basic channel access method is random back-off CSMA with a MAC-level acknowledgment. A CSMA protocol requires the STA to listen before talk. In this protocol only one user can access the medium at a time while the system is mostly used for low data rate applications (Internet access, e-mail, and so forth). The IEEE 802.11 basic medium access behavior allows interoperability between compatible PHYs through the use of the CSMA/CA protocol and a random back-off time following a busy medium condition. In addition, all traffic uses immediate positive acknowledgment (ACK frame), where the sender

schedules a retransmission if no ACK
protocol is designed to reduce the col
accessing the medium at the point
occur. Collisions are most likely to
(i.e., just after busy medium conditio
have been waiting for the medium t
dom back-off arrangement is used t
IEEE 802.11 MAC also describes t
regular intervals (like 100 ms) to en
AP. The MAC also gives a set of ma
tively scan for other APs on any avail
stations may decide on the best-suite
special functional behavior for the fr
via request-to-send/clear-to-send (R
ordination (for time-bounded servic

The MAC sublayer is respons
protocol data unit (PDU) addressing
mentation and reassembly. The tra
tention mode exclusively, requiring
channel for each packet transmitted.
contention mode, known as the con
period (CFP). During the CFP, med
AP, thereby eliminating the need for
802.11 supports three different type
The management frames are used fo
the AP, timing and synchronization
Control frames are used for hand
edgments during the CP, and to e
mission of data during the CP and
acknowledgments during the C

Since the contention-free
contention mode of IEEE 802
coordination function (DCF
discussed in this chapter. T
MAC and not IEEE 802.1
tively, are presented.

2.2.1.1 Distributed Coo

The DCF is the fundam
transfer on a best effor
10], all stations must
network, and it either

Exhibit II

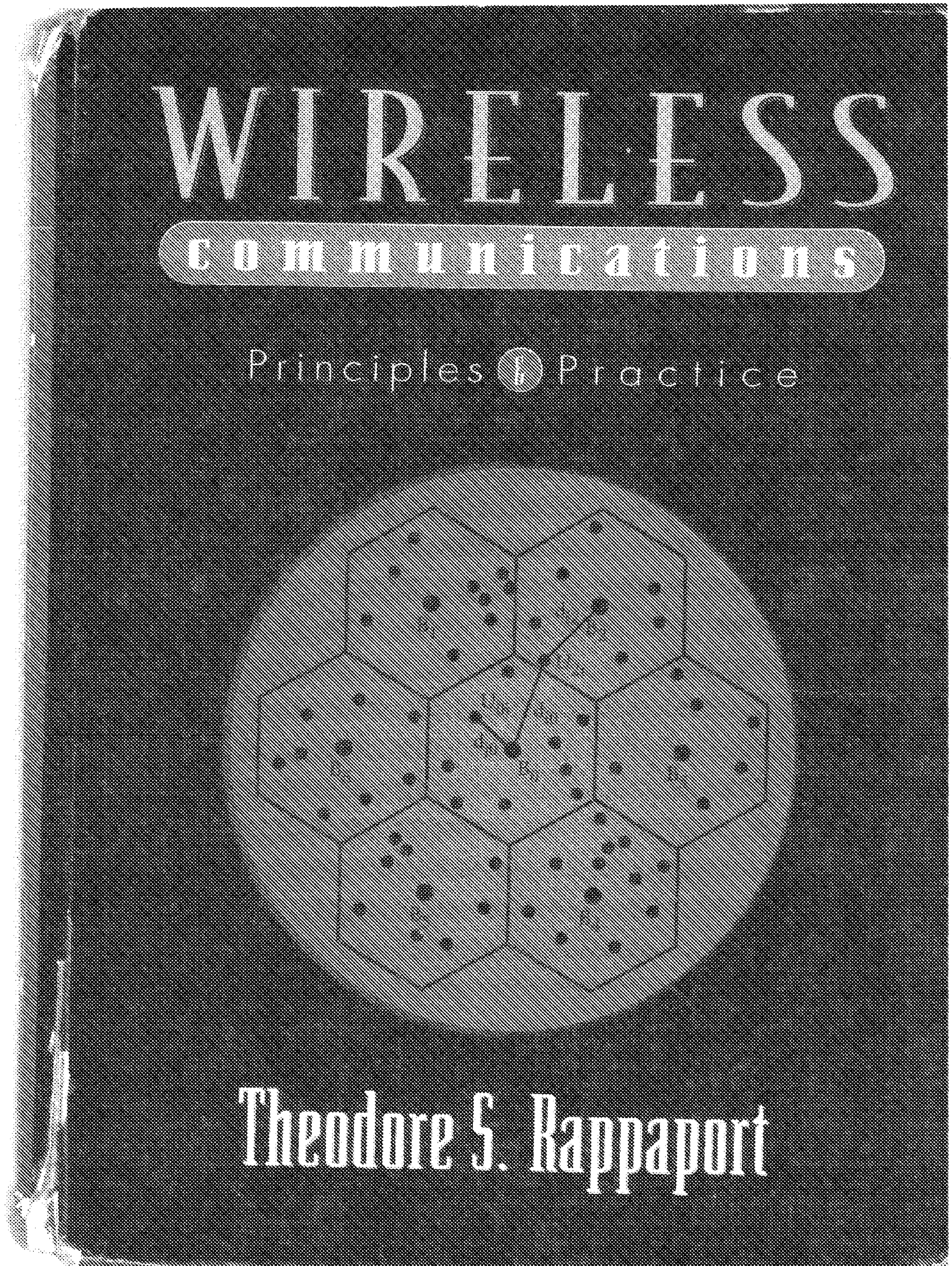

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Figure 9.7 illustrates the sequential format of a packet transmission. The packet consists of header information, the user data, and a trailer. The header specifies the beginning of a new packet and contains the source address, destination address, packet sequence number, and other routing and billing information. The user data contains information which is generally protected with error control coding. The trailer contains a cyclic redundancy checksum which is used for error detection at the receiver.

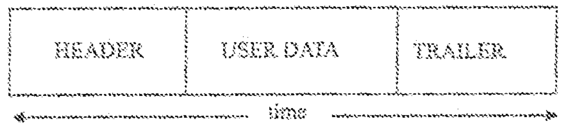


Figure 9.7
Packet data format.

Figure 9.8 shows the structure of a transmitted packet, which typically consists of five fields: the flag bits, the address field, the control field, the information field, and the frame check sequence field. The flag bits are specific (or reserved) bit sequences that indicate the beginning and end of each packet. The address field contains the source and the destination address for transmitting messages and for receiving acknowledgments. The control field defines functions such as transfer of acknowledgments, automatic repeat requests (ARQ), and packet sequencing. The information field contains the user data and may have variable length. The final field is the frame check sequence field or the CRC (Cyclic Redundancy Check) that is used for error detection.

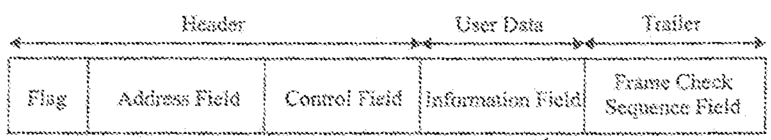


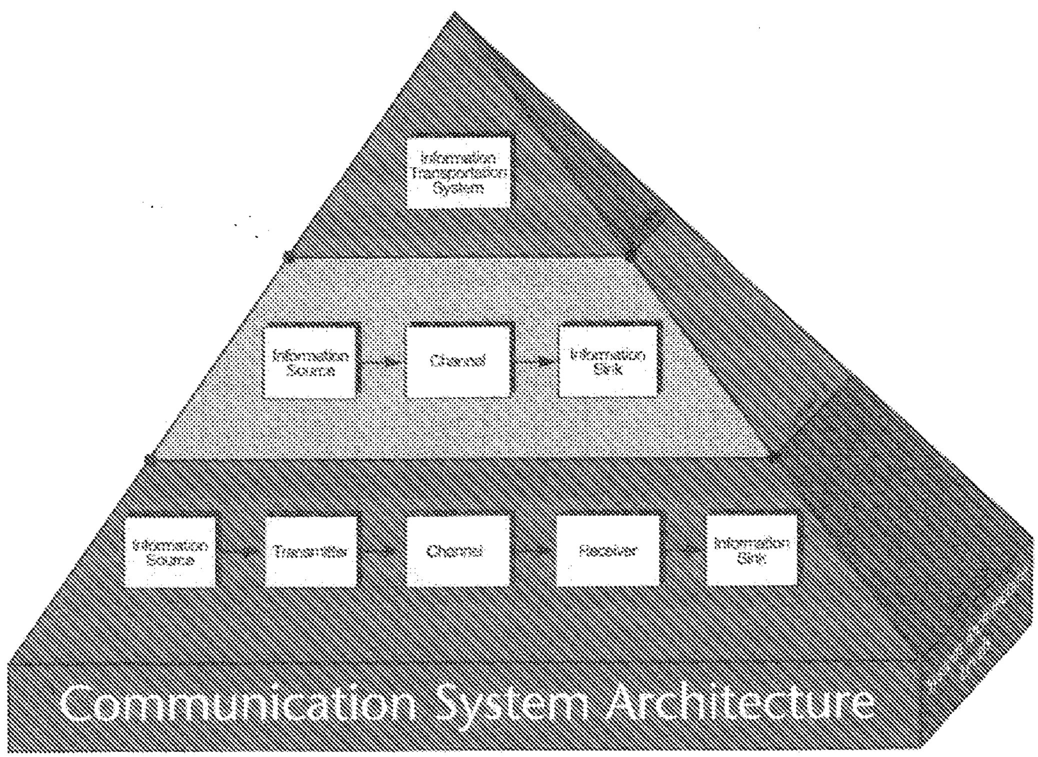
Figure 9.8
Fields in a typical packet of data.

In contrast to circuit switching, packet switching (also called packet radio when used over a wireless link) provides excellent channel efficiency for bursty data transmissions of short length. An advantage of packet-switched data is that the channel is utilized only when sending or receiving bursts of information. This benefit is valuable for the case of mobile services where the available bandwidth is limited. The packet radio approach supports intelligent protocols for data flow control and retransmission, which can provide highly reliable transfer in degraded channel conditions. X.25 is a widely used packet radio protocol that defines a data interface for packet switching [Ber92], [Tan81].

Exhibit III

DIGITAL COMMUNICATION TECHNIQUES

Signal Design and Detection



Marvin K. Simon ▪ Sami M. Hinedi ▪ William C. Lindsey

optimum receivers. The choice of the modulation scheme from the "simple" *binary phase shift keying* (BPSK) to the more "elaborate" *quadrature amplitude modulations* (QAM) is essential in trading channel bandwidth and achievable bit error rate for a given and fixed transmitted signal power. The *synchronization function* is fundamental in operating any communication link. At the receiving site, various timing and phase references are needed and are derived from the incoming noisy signal; these include carrier phase and frequency estimation, possibly subcarrier phase and frequency, and definitely symbol (bit) timing to recover the transmitted information bits. Synchronization precludes communication and includes these two functions: acquisition and tracking. Each of the carrier, subcarrier, and symbol acquisition processes consists of first frequency, then phase acquisition, and the total lock-up (or acquisition time) depends on the specific structures or algorithms employed. The transition from acquisition to tracking function is nonuniquely defined and is typically said to have occurred when the instantaneous phase error decreases and remains below a predetermined threshold. Automatic gain control (AGC) circuitry is essential in maintaining reasonable received power levels in the receiver and in providing some protection against "large" intentional or accidental interferences. Finally, signal reference generators at both the transmitter and receiver require some degree of time and frequency stability to maintain a fixed reference throughout the system.

This chapter introduces the reader to the architecture of a digital communication system and introduces the various terms and key parameters used throughout the book. Section 1.2 presents practical "telecommunication networks" and discusses future networks. The various elements and key functions of an end-to-end communication link are discussed in Section 1.3. The key performance parameters such as signal-to-noise ratios, bandwidth, and so on, are defined along with the various losses that need to be accounted for in a link budget analysis. The "information" capacity of a communication channel as defined by Shannon is discussed in Section 1.4 and in Chapter 11. Communication with subcarriers and data formatting of various signals is the topic of Section 1.5.

1.1 DIGITAL COMMUNICATION SYSTEM FUNCTIONAL ARCHITECTURE

For the most part, the functional architecture of a digital communication system [3] has evolved over the past 35 years; with few exceptions, the functional architecture matches the physical structure. This evolution has been driven by two major forces, viz., the development of communication and information theory (communication sciences) and the development of communications, computer, and information technology. In presenting the functional architecture of a digital communication system, the top-down approach will be used. This approach takes advantage of the hierarchical nature of any system, in particular, an *information transportation system* which transports information using a *digital communication system*. In addition, the top-down approach fits well with the presentation and development of the digital communication techniques and theory presented in the chapters that follow.

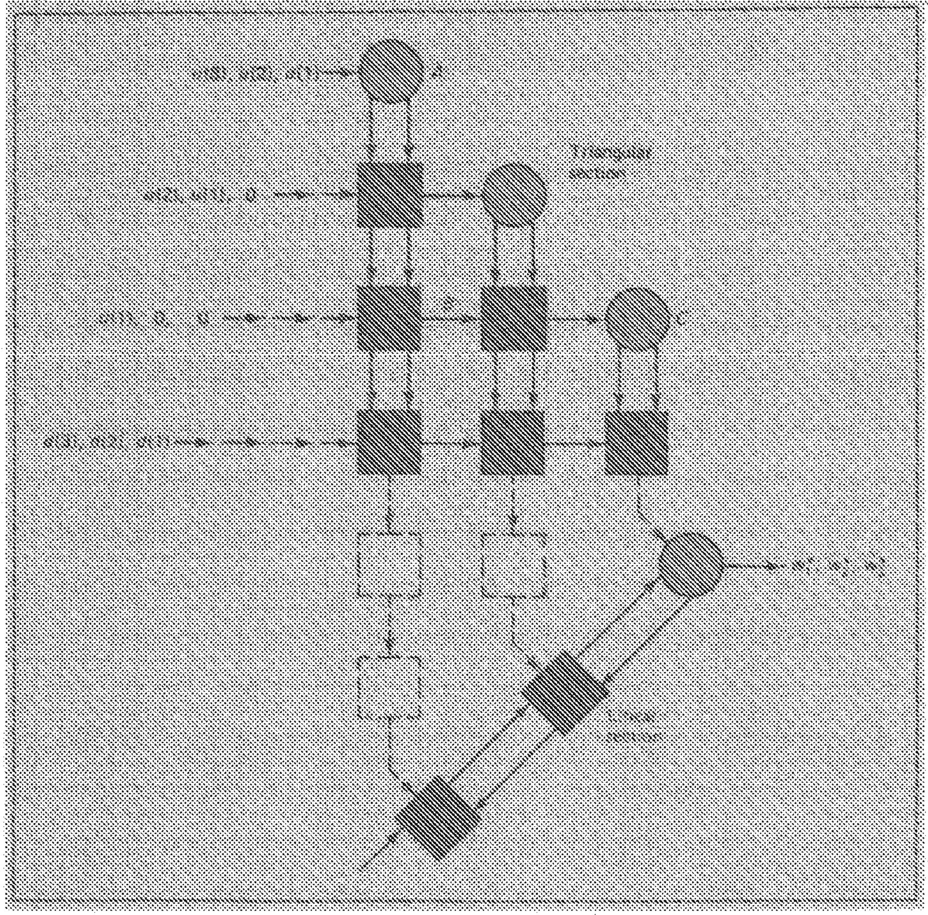
Our top-down approach begins with the simplest architectural level, *Level 0*: The *Conceptual Level*, and proceeds downward until the bottom level, viz., the *Physical Level*, is reached. Figure 1.1 demonstrates that the basic building blocks of an *Information Transportation System (ITS)* in level one of the hierarchy are: (1) an information source to be transported, (2) a communication channel or information pipe, and (3) an information user or a sink. In order to connect the information source to the channel, a *transducer* is needed. In level 2 of the hierarchy in Fig. 1.1, this transducer is identified as the *communication*

Exhibit IV

SECOND EDITION

ADAPTIVE FILTER THEORY

SIMON HAYKIN



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Thomas Kailath, Series Editor

2. A set of $(M + 1)$ unknowns, made up of the feedback coefficients $a_1, a_2, \ldots, a_M$ and the variance σ^2 of the white-noise process assumed to model w_n.

Given the seismogram $u_0(n)$, we may therefore uniquely determine the feedback coefficients $a_1, a_2, \ldots, a_M$ and the variance σ^2 by solving this system of equations.

From Eq. (1.39), we see that the impulse response of the deconvolution filter consists of the sequence $a_1, a_2, \ldots, a_M$. Accordingly, the convolution of this impulse response with $u_0(n)$ yields the desired estimate $\hat{w}_n$, as shown by (see Fig. 1.14)

$$\hat{w}_n = \sum_{k=0}^{M} a_k u_0(n-k) \tag{1.41}$$

where $a_0 = 1$. Equation (1.41) is a description of the deconvolution process. Note, however, the wave $d_0(n)$ generated by the source of seismic energy does not enter this description directly as in the idealized representation of Eq. (1.37). Rather, the physical nature of $d_0(n)$ influences the deconvolution process by modeling $d_0(n)$ as the impulse response of an all-pole feedback system.

An alternative procedure for constructing the deconvolution filter is to use an adaptive filtering algorithm, as illustrated in Fig. 1.15. In this application, the present value $u_0(n)$ of the seismic output serves the purpose of a desired response for the algorithm, and the past values $u_0(n-1), u_0(n-2), \ldots, u_0(n-M)$ are used as elements of the input vector. The prediction error controls the adaptation of the M tap weights of the transversal filter component of the algorithm. When the algorithm has converged, the tap weights of the transversal filter provide estimates of the feedback coefficients $a_1, a_2, \ldots, a_M$.

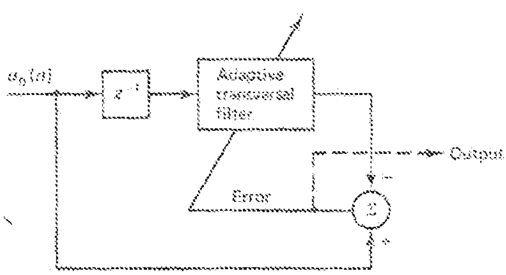


Figure 1.15 Adaptive filtering scheme for computing the impulse response of the deconvolution filter.

Adaptive Equalization

During the past three decades, a considerable effort has been devoted to the study of data-transmission systems that utilize the available channel bandwidth efficiently. The objective here is to design the system so as to accommodate the highest possible rate of data transmission, subject to a specified reliability that is usually measured in terms of the error rate or average probability of symbol error. The transmission of digital data through a linear communication channel is limited by two factors:

1. *Intersymbol interference* (ISI). This is caused by dispersion in the transmit filter, the transmission medium, and the receive filter.

2. *Additive thermal noise.* This is generated by the receiver at its front end.

For bandwidth-limited channels (e.g., voice-grade telephone channels), we usually find that intersymbol interference is the chief determining factor in the design of high-data-rate transmission systems.

Figure 1.16 shows the equivalent baseband model of a binary *pulse-amplitude modulation* (PAM) *system*. The signal applied to the input of the transmitter part of the system consists of a *binary data sequence* $\{b_k\}$, in which the binary symbol b_k consists of 1 or 0. This sequence is applied to a pulse generator, the output of which is filtered first in the transmitter, then by the medium, and finally in the receiver. Let $u(k)$ denote the sampled output of the receive filter in Fig. 1.16; the sampling is performed in synchronism with the pulse generator in the transmitter. This output is compared to a *threshold* by means of a *decision device*. If the threshold is exceeded, the receiver makes a decision in favor of symbol 1. Otherwise, it decides in favor of symbol 0.

Let a scaling factor a_k be defined by

$$a_k = \begin{cases} +1, & \text{if the input bit } b_k \text{ consists of symbol 1} \\ -1, & \text{if the input bit } b_k \text{ consists of symbol 0} \end{cases} \tag{1.42}$$

Then, in the absence of noise, we may express $u(k)$ as

$$\begin{aligned} u(k) &= \sum_n a_n p(k-n) \\ &= a_k p(0) + \sum_{\substack{n \\ n \neq k}} a_n p(k-n) \end{aligned} \tag{1.43}$$

where $p(n)$ is the sampled version of the impulse response of the cascade connection of the transmit filter, the transmission medium, and the receive filter. The first term on the right side of Eq. (1.43) defines the desired symbol, whereas the remaining series represents the intersymbol interference caused by the *channel* (i.e., the combination) of the transmit filter, the medium, and the receive filter). This intersymbol interference, if left unchecked, can result in erroneous decisions when the sampled signal at the channel output is compared with some preassigned threshold by means of a decision device.

To overcome the intersymbol interference problem, control of the time-sampled function $p(n)$ is required. In principle, if the characteristics of the transmission medium are known precisely, then it is virtually always possible to design a pair of transmit and receive filters that will make the effect of intersymbol interference

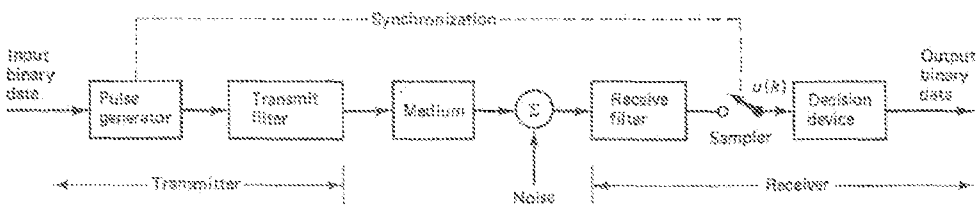
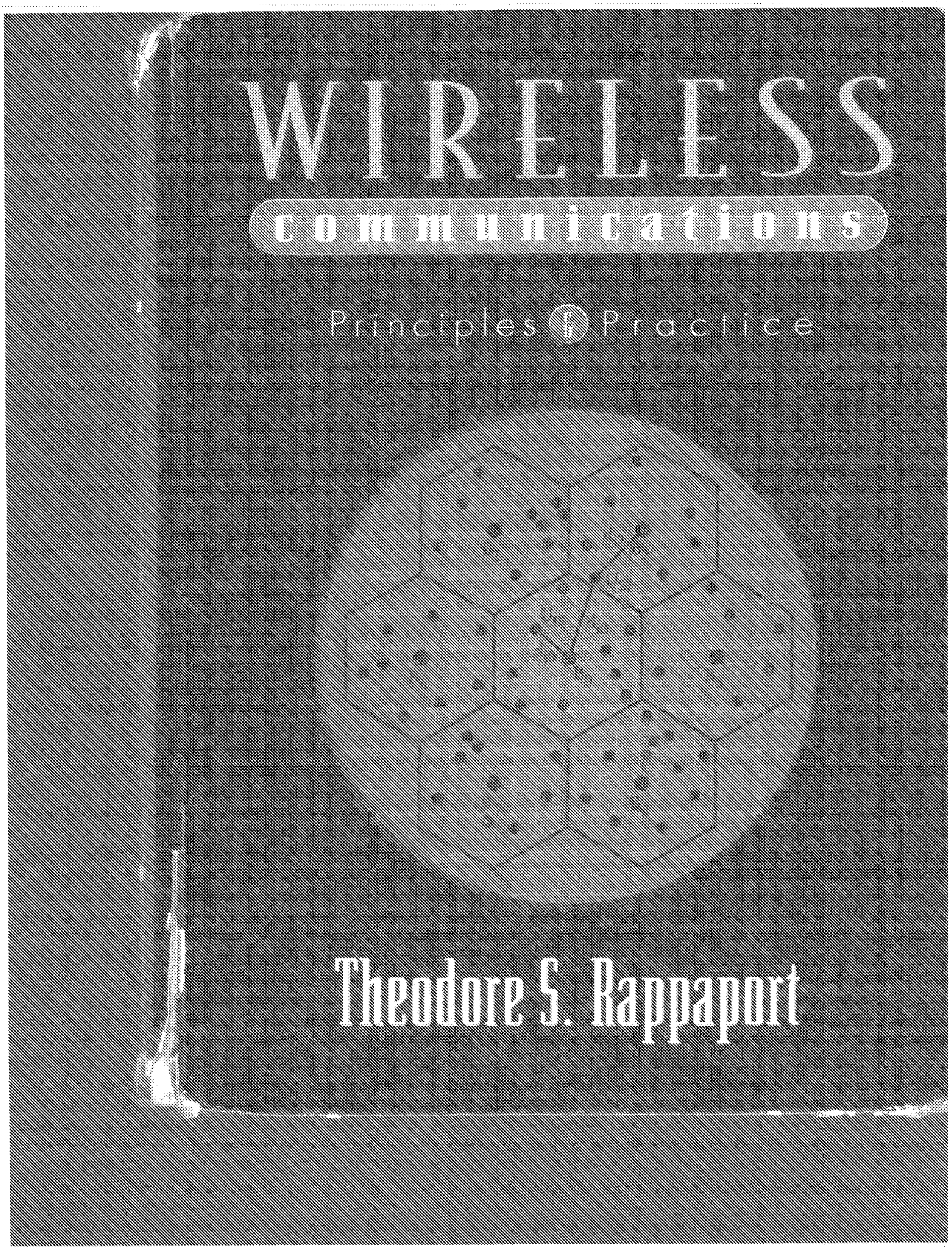


Figure 1.16 Block diagram of a baseband data transmission system (without equalization).

Exhibit V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lies within distance 3 of any codeword, thus making maximum likelihood decoding possible.

Cyclic Codes

Cyclic codes are a subset of the class of linear codes which satisfy the cyclic property as discussed before. As a result of this property, these codes possess a considerable amount of structure which can be exploited.

A cyclic code can be generated by using a generator polynomial $g(p)$ of degree $(n-k)$. The generator polynomial of an (n, k) cyclic code is a factor of p^n+1 and has the general form

$$g(p) = p^{n-k} + g_{n-k-1}p^{n-k-1} + \ldots + g_1 p + 1 \qquad (6.96)$$

A message polynomial $x(p)$ can also be defined as

$$x(p) = x_{k-1}p^{k-1} + \ldots + x_1 p + x_0 \qquad (6.97)$$

where $(x_{k-1}, \ldots, x_0)$ represents the k information bits. The resultant codeword $c(p)$ can be written as

$$c(p) = x(p)g(p) \qquad (6.98)$$

where $c(p)$ is a polynomial of degree less than n.

Encoding for a cyclic code is usually performed by a linear feedback shift register based on either the generator or parity polynomial.

BCH Codes

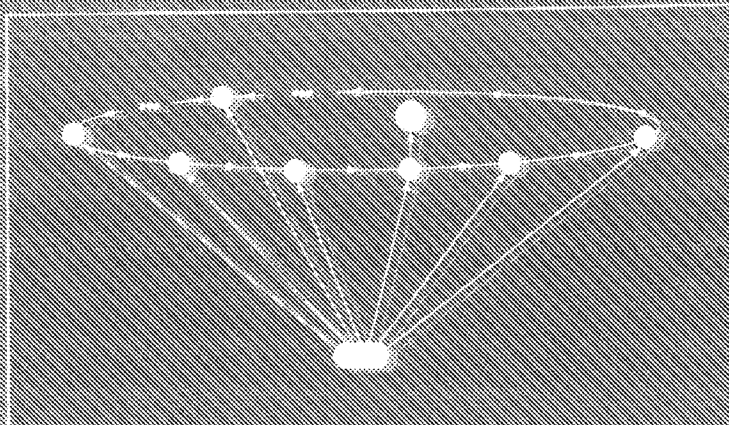
BCH cyclic codes are among the most important block codes since they exist for a wide range of rates, achieve significant coding gains, and can be implemented even at high speeds [Bos60]. The block length of the codes is $n = 2^m - 1$ for $m \geq 3$, and the number of errors that they can correct is bounded by $t < (2^m-1)/2$. The binary BCH codes can be generalized to create classes of nonbinary codes which use m bits per code symbol. The most important and common class of nonbinary BCH codes is the family of codes known as Reed-Solomon codes. The (63,47) Reed-Solomon code in U.S. *Cellular Digital Packet Data* (CDPD) uses $m = 6$ bits per code symbol.

Reed-Solomon Codes

Reed-Solomon (RS) are nonbinary codes which are capable of correcting errors which appear in bursts and are commonly used in concatenated coding systems [Ree60]. The block length of these codes is $n = 2^m - 1$. These can be extended to 2^m or 2^m+1. The number of parity symbols that must be used to correct e errors is $n-k = 2e$. The minimum distance $d_{min} = 2e+1$. RS codes achieve the largest possible d_{min} of any linear code.

Exhibit VI

INTRODUCTION *to* SPREAD SPECTRUM COMMUNICATIONS



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CHAPTER 7

Performance of Spread-Spectrum Systems with Forward Error Correction

7-1 Introduction

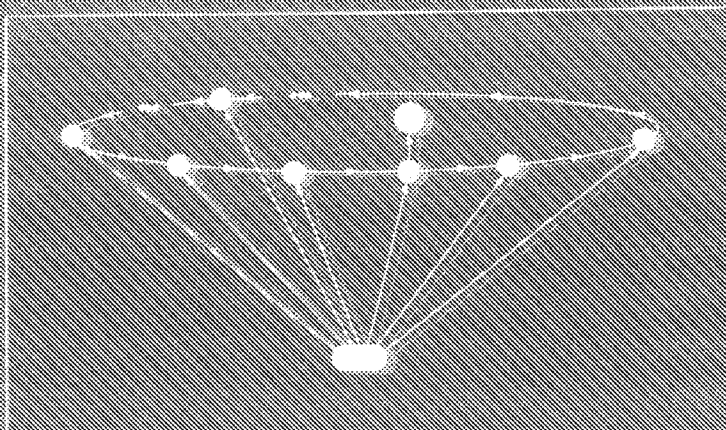
Spectrum spreading by itself produces large communication system performance improvements by effectively spreading the jammer power over the full spread communications bandwidth while simultaneously enabling communications performance to be affected only by the interference in approximately the data bandwidth. The resultant performance was analyzed in Chapter 6. Even with spectrum spreading, worst-case pulse or partial-band jamming was highly effective in degrading communications performance. The effect of worst-case jamming can be mitigated using one or more of the powerful forward error correction (FEC) techniques which have been developed following Shannon's pioneering work. Error correction coding is an extremely complex topic to which entire books are dedicated. In this book a small number of the most basic concepts of FEC are discussed to give the student a preliminary idea of the power of these techniques.

Jamming strategies which concentrate jamming resources on some fraction of the transmitted symbols using either pulsed or partial band techniques cause demodulator output errors to occur in bursts. Because the FEC techniques to be discussed perform best when channel errors are independent from one signaling interval to the next, interleaving is assumed for all FEC schemes. The purpose of the interleaver is to rearrange the order in which coder output symbols are transmitted so that bursts of transmission errors will not appear as bursts at the decoder input because they are reordered by the de-interleaving operation in the receiver. The system model for the coded spread-spectrum system was illustrated in Figure 6-1 and discussed in Section 6-2. This model includes the interleaver and deinterleaver within the discrete memoryless channel (DMC). It is the interleaver/de-interleaver that makes the channel approximately memoryless.

The performance of the FEC schemes in this chapter is calculated as a function of the DMC transition probabilities $p(y_j | x_i, z_i)$ accounting for jammer-state information z_i. These transition probabilities are calculated using the basic techniques discussed in Chapter 6. These techniques must be extended, however, to include instances where the DMC input and output alphabets are not the same. Additional information can be given to the decoder by permitting the DMC input and output alphabets to be different. For example, in addition to outputting a binary 1 or 0, the

Exhibit VII

INTRODUCTION to SPREAD SPECTRUM COMMUNICATIONS



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CHAPTER 10

Low-Probability-of-Intercept Methods

10-1 Introduction

In previous chapters the generation and reception of spread-spectrum signals was discussed. The reception process was assumed to be cooperative—that is, the receiver knew the essential properties of the transmitted signal to allow the implementation of an optimized receiver in the sense of minimum probability of error in AWGN and jamming. What about unintended receivers? Is it possible for an interceptor to detect the presence of a spread-spectrum signal and, if detected, to extract certain signal parameters? The answer to both of these questions is "Yes, to some degree." Methods that unintended interceptors may use to detect the presence of spread-spectrum signals and to extract certain signal parameters, mainly code chip rate, are explored in this chapter. After discussing the nature of the covert communications problem, the subject of energy detection of unknown signals is discussed. This was first explored in Chapter 5 in relation to acquisition of the spectrum spreading code in the receiver of a cooperative system. After reviewing energy detection, the optimum receiver for detection of a direct-sequence spread-spectrum signal is discussed. Certain more practical approximations to the optimum receiver are hypothesized and their performances analyzed. Next, the optimum detector for frequency-hop spread-spectrum signals is discussed and its performance relative to energy detection shown. A simplified approximation to the optimum frequency-hop spread-spectrum signal detector is examined next. Finally, the extraction of spread-spectrum signal parameters is discussed and the design of spread-spectrum signals to minimize the extraction of these parameters is examined. In addition to several papers that will be referenced in the sequel, a number of books have been published in the past few years that deal with the subject of spread-spectrum signal detection and parameter extraction [1–3].

10-2 Nature of Covert Communications

In any communications operation, there may be several ingredients or "players," as illustrated in Figure 10-1. First, there are the intended communicators, which make use of the transmitter and receiver shown in the figure. Second, there may be unin-

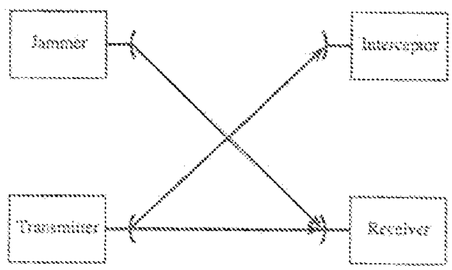


FIGURE 10-1. Covert communications process.

tentional sources or jammers. Third, there may be an eavesdropper illustrated by the intercept receiver in Figure 10-1.

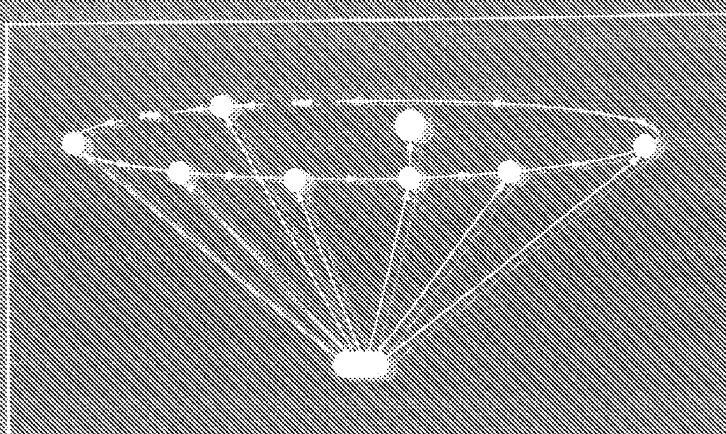
As a possible example that could happen in ordinary life, consider a conversation with a friend on a cordless telephone. The jammer could be a radio or television set playing in the background. The intercept receiver could be a snoopy neighbor with a scanning receiver, available in most electronics stores.

In situations as depicted in Figure 10-1, it is desirable for the intended communicators (hereafter referred to as the *communicators* or the *communications link*) to use minimum transmit power and the highest-sensitivity receiver possible to minimize the possibility of intercept. On the other hand, to minimize the effects of jamming, the communications should use the greatest transmit power at their disposal and the least sensitive receiver that will still allow the communication to take place. These are clearly conflicting conditions. In addition, there may be several variables present and options available in any communications game, such as propagation conditions, antenna gains, modulation types, employment of special signal processors, and so on. This discussion can be put on a more quantitative basis in terms of a measure of communications quality, or *quality factor* [4], which is the ratio of the intercept range to the range in which the communicators can communicate. The performance of the communications link is determined by the desired bit error performance, which implies a certain required E_b/N_0 depending on modulation type, background conditions, and processing at the receiver as reviewed in Chapter 1. As will be shown later, the interceptor is characterized by its probabilities of detection and false alarm. The desired probability of false alarm determines the threshold to be used for detection in the intercept receiver; to achieve a certain desired probability of detection, the intercept receiver uses this threshold to determine its required received signal-to-noise ratio. If this ratio cannot be achieved under the assumed conditions, other processing methods, geometries, or receiver implementations (e.g., a higher-gain antenna or a lower-noise front-end amplifier) must be explored. This illustrates to some degree the many trade-offs to be explored in the covert communications problem and the desire on the part of the interceptor to extract information from the transmission process.

A term that is used in an almost offhand fashion in discussions relating to uncooperative detection of spread-spectrum signals is *LPI* (low probability of intercept) *signal*. It is useful to define this term before beginning the consideration of intercept

Exhibit VIII

INTRODUCTION to SPREAD SPECTRUM COMMUNICATIONS



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provided that $E_b/N_J > \gamma$, where β and γ are given in Table 7-5 for various values of M and L. Bit error probability calculated using (7-76) is plotted in Figure 7-24 for $M = 2$ and $L = 10$. The bit error probability for BFSK in additive white Gaussian noise has also been plotted in Figure 7-24. Observe that the repeat code with soft-decision decoding and jammer-state information has nearly eliminated the advantage that the jammer gained through the use of partial-band techniques. At a bit error rate of 10^{-5}, this simple coding strategy has reduced the required signal power by approximately 30 dB relative to the power needed for binary FSK without coding in worst-case partial-band jamming. Using this technique, the required E_b/N_J is only 2.5 dB more than the E_b/N_J needed for the wideband barrage noise jammer (AWGN). Finally, note that this coding strategy has replaced the inverse-linear relationship between bit error rate and E_b/N_J, which was achieved by the optimum partial-band jammer, by an exponential relationship characteristic of MFSK performance in wideband stationary noise.

It has been noted by Viterbi [29] and Simon et al. [24, Chap. 2] that for FH/MFSK repeat coding using soft-decision decoding with optimum partial-band jamming and with known jammer state, there is an optimum L that is a function of E_b/N_J and the number of MFSK tones per symbol. Levitt [31] demonstrates that there is also an optimum L value for multitone jamming. Thus the jammer and the communicator both optimize their system, making the other's task as difficult as possible. This joint optimization game is discussed in detail in Ref. 24.

7-5 Interleaving

Most forward error correction codes perform well only when the channel errors are completely independent from one signaling interval to the next. All the bounds on bit error probability discussed in Sections 7-2 through 7-4 were based on the assumption that the channel is memoryless. The worst-case jammers analyzed in Chapter 6 are the pulsed noise or pulsed tone jammers for direct-sequence systems or the partial band noise or tone jammers for frequency-hop systems. These jammers produce bursts of errors and therefore the channel is not memoryless. To counter this difficulty, an interleaver is placed between the encoder and the modulator and a de-interleaver is placed between the demodulator and the decoder.

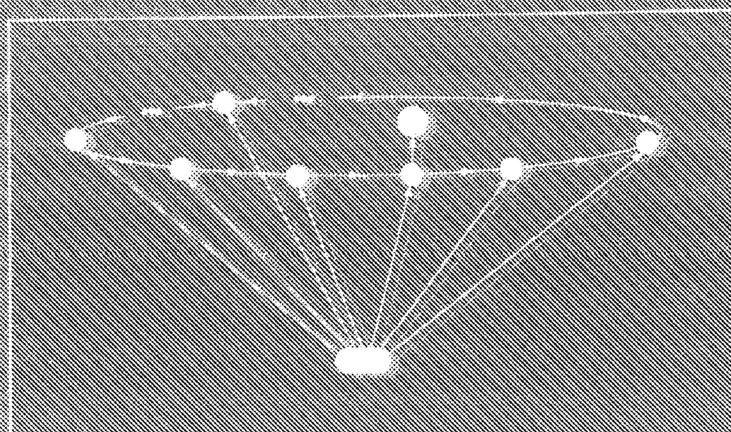
USPTO Exhibit VIII

One of two types of interleaving commonly used is called *block interleaving*. A block interleaver uses four N-row by B-column random access memories to randomize errors. Two of these memories are in the transmitter and the others are in the receiver. The transmitter reads encoder output symbols into a memory by columns until it is full. Then the memory is read out to the modulator by rows. While one memory is filling the other is being emptied, so two memories are needed. In the receiver, the inverse operation is effected by reading the demodulator output into a memory by rows and reading the decoder input from the memory by columns.

This operation is illustrated in Figure 7-25 for a $N = 10$, $B = 10$ interleaver. The encoder output symbols are numbered consecutively 1 through 100. These symbols are transmitted over the channel by rows. Thus the order of transmission for the first 20 symbols is 1, 11, 21, 31, 41, 51, 61, 71, 81, 91, 2, 12, 22, 32, 42, 52, 62, 72, 82,

Exhibit IX

INTRODUCTION to SPREAD SPECTRUM COMMUNICATIONS



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space communication channels, it is an overly simplified model for a number of radio channels, including high-frequency (HF) long-distance communications achieved via the ionosphere, microwave communications beyond the horizon achieved via the use of tropospheric scatter, and communications to a mobile platform. In the latter three channels, the received signal has been shown experimentally to undergo a process known as fading. A fading channel may exhibit such properties as selective frequency response, intersymbol interference in digital communications, spreading of signals in the frequency domain, time-varying amplitude response, or any combination of these attributes. A comprehensive model for a fading channel is given in this section.

In addition to the three examples of fading channels given above, there exist several other types of channels that exhibit fading. These include very-high-frequency (VHF) communication channels between an aircraft and a synchronous satellite relay [1]; artificially created communications channels temporarily created in an interesting experiment known as the West Ford Project† [2]; line-of-sight microwave communication links, which occasionally undergo severe fading due to the formation of tropospheric inversion layers, permitting multiple transmission paths between the transmitting and receiving antennas [3]; and communication at millimeter to optical wavelengths in line-of-sight paths through the nonionized atmosphere [4]. Further examples of the effects of fading over HF channels may be found in the text by Goodman [5]; details of fading over mobile VHF and UHF radio channels are given in Sections 8-3 and 8-4.

Fading encountered over either a mobile radio channel or an HF ionospheric channel, for example, has been verified experimentally to be of two types: short-duration rapid fading over time spans of less than 1 s and long-duration slow fading over time spans from 1 s to 1 h or longer. The statistics of the two fading processes are different; hence these two types of fading must be accounted for in the channel model.

The origin of the fading mechanism for most of the fading channels mentioned above may be traced to the scattering of an electromagnetic wave by a random medium. To see how this leads to fading, consider the following: Let a single continuous sine wave be scattered by a random medium. The scattered components may be resolved into in-phase and quadrature components. The instantaneous amplitudes of the two types of components may be shown to be uncorrelated. Using the central limit theorem, as the number of in-phase and quadrature components becomes large, the sum of the in-phase component approaches a Gaussian random variable. Similarly, the quadrature components add to form an identically distributed Gaussian random process. Hence the in-phase and quadrature random processes collectively form a zero-mean complex Gaussian random process [6]. If the random medium is a single surface and is time-invariant, the received signal, after scattering,

† In the West Ford Project, 20 kg of 2-cm-long copper dipoles were injected into a 3600-km-high orbit around the earth, and trans-horizon communications were conducted at 8 GHz using the orbiting dipole belt as a scattering mechanism. Fading effects due to the scattering were predicted prior to the experiment and were confirmed experimentally during the course of the experiment. Because of the shape of the scatterers, this project was also known as the "Needles" project. The *Proceedings of the IEEE* dedicated the May 1964 issue to a discussion of this project.

Exhibit X

SPREAD SPECTRUM SYSTEMS WITH COMMERCIAL APPLICATIONS

THIRD EDITION

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fading at the same time. Separation between the two antennas is not critical, but should be greater than a wavelength at the operating frequency.

Frequency Hopping

From figures (Figure 11.4 through 11.5) showing fading of direct sequence signals, it is obvious that one can expect frequency hopping signals to experience the loss of band sectors as well. When a frequency hopping system experiences the loss of part of its operating band, however, it is the same as having an interferor cause the information to be lost. It has no way to protect that information except to transmit the information redundantly at more than one frequency.

To accomplish the necessary transmission redundancy, frequency hopping systems use error correction coding and where possible, hop at a rate faster than the fading rate. In this way, one can expect to send a symbol representing the information at more than one frequency, and if the hop rate is faster than the fading rate, at least one symbol representing every bit of information is always sent at a nonfaded frequency.

Fading Rate

The rate at which fades occur is a function of the rate at which the signal propagation paths change. In fixed-position systems, the fading rate is determined by how fast the environment changes. This could be determined by factors as slow as atmospheric disturbances or as fast as aircraft flying between them. Figure 11.7 illustrates the multipath configuration that produces multipath reception of television signals with an aircraft as a multipath source.

The rate of fading due to a vehicular multipath source, or moving transmitter or receiver is

$$\frac{\text{Velocity of vehicle (Feet/second)}}{\text{Wavelength (Feet)}} = \text{Fades per second.}$$

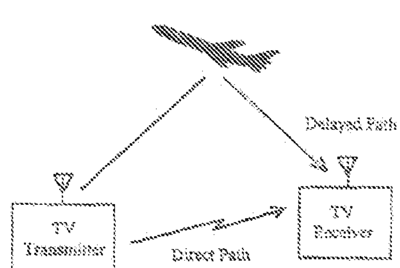

Figure 11.7 Typical multipath configuration near airports.

Exhibit XI

SPREAD SPECTRUM SYSTEMS WITH COMMERCIAL APPLICATIONS

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Compared to an FSK system that employs precorrelation demodulation, even the worst jamming margin shown is at least 8.1 dB better. (The FSK system requires a minimum input S/N of 6 dB just to work. In practice, higher input S/N in is needed.)

Finally, please note that jamming margin always exists whether it is negative or positive. Typical jamming margins are

AM receiver	-10 dB or more
FM/FSK receiver	-6 dB or more
FH receiver	$\leq 10 \log (0.15\ M)$
DS receiver	$\leq 10 \log \frac{BW}{Rdata} - \frac{S}{N}$ out

The spread spectrum receiver (either FH or DS) will *always* provide more jamming margin than AM, FM, or FSK receivers (even though the FSK receiver may try to masquerade as a spread spectrum receiver). Also, the actual performance will vary, depending on the specific type of interference (noise, other similar signals, etc.) and the specific S/N ratio required.

The point is, there is always jamming margin. Even though it may be squandered by poor system design or by overspecifying bit error rate, it is *always* present.

11.5 MULTIPATH REJECTION AND SPREAD SPECTRUM SIGNALS

Both direct-sequence and frequency hopping systems have the ability to operate in the presence of multipath signals to some degree. One cannot say, however, that using a spread spectrum signal does away with all multipath effects. In fact, some spread spectrum systems are degraded more by multipath than their narrower-band counterparts, in the same situations.

Direct Sequence

A typical 902–928-MHz direct sequence signal is shown in Figure 11.4. This particular signal has a main lobe null-to-null bandwidth of 26 MHz, sidelobes that are 20 dB down, and approximately $(\sin x/x)^2$ power distribution. The signal is shown without the effects of multipath, as the receiver would see it under undisturbed conditions.

Figures 11.5 and 11.6 show the same signal as it appears to the receiver under relatively mild multipath conditions. (Much greater distortion of the signal by multipath is very common.) In Figure 11.5, there is only one signal dropout, or fade, within the signal band,. The depth of the fade is at least 30

Exhibit XII

1 GENERAL DESCRIPTION

Bluetooth is a short-range radio link intended to replace the cable(s) connecting portable and/or fixed electronic devices. Key features are robustness, low complexity, low power, and low cost.

Bluetooth operates in the unlicensed ISM band at 2.4 GHz. A frequency hop transceiver is applied to combat interference and fading. A shaped, binary FM modulation is applied to minimize transceiver complexity. The symbol rate is 1 Ms/s. A slotted channel is applied with a nominal slot length of 625 µs. For full duplex transmission, a Time-Division Duplex (TDD) scheme is used. On the channel, information is exchanged through packets. Each packet is transmitted on a different hop frequency. A packet nominally covers a single slot, but can be extended to cover up to five slots.

The Bluetooth protocol uses a combination of circuit and packet switching. Slots can be reserved for synchronous packets. Bluetooth can support an asynchronous data channel, up to three simultaneous synchronous voice channels, or a channel which simultaneously supports asynchronous data and synchronous voice. Each voice channel supports a 64 kb/s synchronous (voice) channel in each direction. The asynchronous channel can support maximal 723.2 kb/s asymmetric (and still up to 57.6 kb/s in the return direction), or 433.9 kb/s symmetric.

The Bluetooth system consists of a radio unit (see Radio Specification), a link control unit, and a support unit for link management and host terminal interface functions, see Figure 1.1 on page 41. The current document describes the specifications of the Bluetooth link controller, which carries out the baseband protocols and other low-level link routines. Link layer messages for link set-up and control are defined in the Link Manager Protocol on page 165.

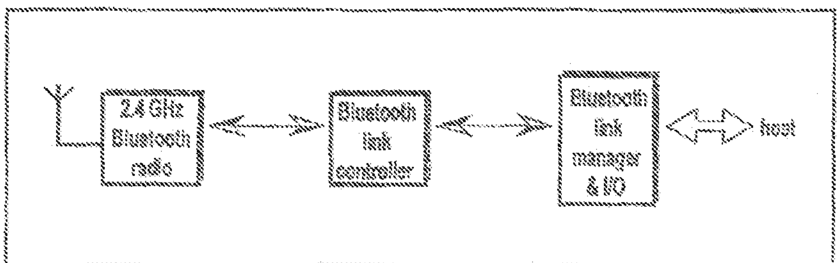

Figure 1.1: Different functional blocks in the Bluetooth system

The Bluetooth system provides a point-to-point connection (only two Bluetooth units involved), or a point-to-multipoint connection, see Figure 1.2 on page 42. In the point-to-multipoint connection, the channel is shared among several Bluetooth units. Two or more units sharing the same channel form a ***piconet***. One Bluetooth unit acts as the master of the piconet, whereas the other unit(s)

Exhibit XIII

1 Introduction

Bluetooth™ is a low-cost and low-power short-range radio link that operates in the worldwide 2.4 GHz unlicensed ISM band. It may be used as a cable replacement technology or as an advanced personal wireless local area network. Because of the unrestricted access to the ISM band, Bluetooth devices are exposed to a high level of interference from unknown proprietary products, such as microwave ovens, cordless phones, and so on. Interference is also possible from WLAN products, such as 802.11, which coexist with Bluetooth products.

A frequency-hopping scheme is used to overcome interference and fading. Bluetooth uses Gaussian Frequency Shift Keying (GFSK) modulation on each hop with a 1 Mbit/s raw data rate. This frequency hopping technology helps mitigate interference to some extent. However, due to the fact that Bluetooth channels are spread over the entire ISM band and have a narrow channel spacing, interference from adjacent Bluetooth channels also presents a problem.

Motorola believes that the solution to interference rejection can be achieved via high-performance signal detection algorithms. High-performance signal detection not only increases Bluetooth's ability to survive in an interference environment, it also reduces interference to 802.11 by reducing the need for re-transmissions. This in turn not only enhances the user's experience, it also reduces the battery drain of the device. However, Motorola's interference rejection performance does not come at the price of extensive processing that would increase power consumption and silicon cost. Instead, it relies on its unique, powerful, and efficient algorithms.

2 Motorola's Bluetooth Solution

The Motorola Bluetooth solution is a two-chip solution as shown in Figure 1, where the baseband portion provides high-performance detection.

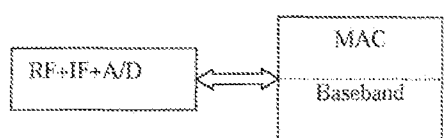

Figure 1. Motorola's Two-Chip Bluetooth Solution

The high-performance signal detection in baseband includes joint detection of the access code, timing, and carrier frequency. The maximum likelihood sequence estimation (MLSE) is used for symbol recovery and carrier tracking. The joint detection uses the 64 bits of the entire sync word to estimate the carrier digitally, instead of the 4 bits of the preamble in the conventional analog approach. Thus, the joint detection significantly improves the carrier estimation in the presence of interference, thereby enhancing the message recovery performance. The Bluetooth channel has unrecoverable Inter Symbol Interference (ISI) due to its GFSK modulation and narrow channel spacing. Conventional slicing detection is optimal only

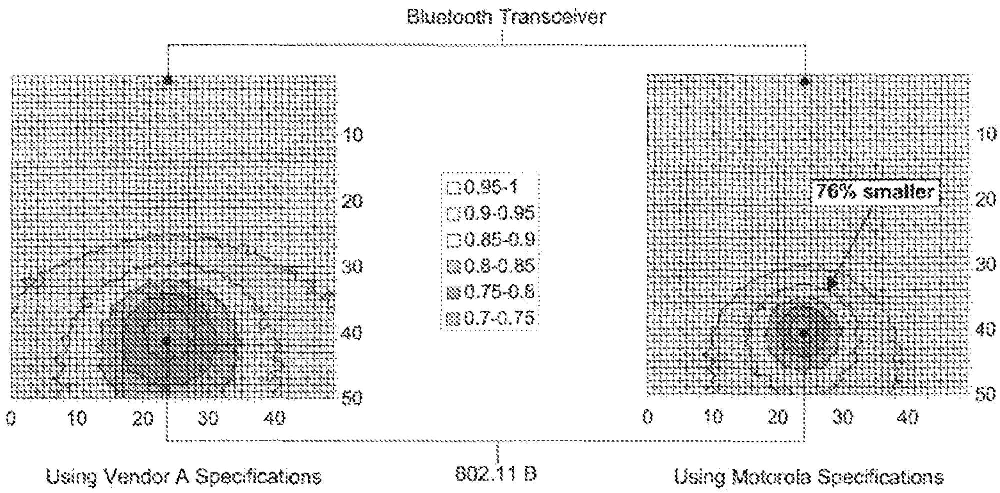

Figure 11. Coverage Map Showing Bluetooth Performance in the Presence of an 802.11 Interferer

Figure 11 shows how the interference rejection numbers in Table 1 impact the link performance of Bluetooth devices under 802.11 interference. The two graphs show Bluetooth packet reliability at various locations using Vendor A and Motorola devices respectively under identical 802.11 interference. It is shown that the Motorola solution provides a significant improvement in reception quality (76% smaller coverage hole). This improvement reveals itself in the form of increased throughput (for data applications) and better voice quality (for audio applications). Meanwhile, the improved Bluetooth performance also reduces the re-transmission for Bluetooth devices, thus further reducing interference to 802.11 devices.

4 Summary

The Motorola Bluetooth solution delivers to the Bluetooth market not only low-cost and low-power devices but also the best interference rejection performance as well.

Motorola has been involved with Bluetooth development since its beginning. Motorola is aware of the challenging issues of interference rejection and coexistence with 802.11. The engineers at Motorola put a heavy emphasis on interference rejection performance into the design of its platform solution.

The joint detection for access code, timing, and carrier provides high reliability and low false-alarm rate for the access code detection. It also provides robust carrier and timing synchronization in the presence of interference. The MLSE symbol recovery with carrier tracking is an optimal solution to message recovery in a Bluetooth channel environment that has unrecoverable ISI. In addition, MLSE symbol recovery also allows using exceptionally narrow selectivity that gives the Motorola solution additional interference rejection.

These sophisticated detection algorithms extend the battery life since they reduce the need for re-transmission. The sensitivity gain can be directly translated into better user experiences including coverage expansion, capacity increase, and quality of service. The reduced re-transmission can also improve the condition of coexistence with 802.11.

Exhibit XIV

9/7/01
DWB
[illegible]

NONDISCLOSURE AGREEMENT

WHEREAS Tina, Geraldine & Earl Woolfork known as the Inventor has developed a new and unique menstrual protective device and wireless music device and has conducted tests and other activities to evaluate and demonstrate his idea and is desirous of seeking help, ~~evaluation~~, assistance, ~~investment or procurement~~ in obtaining a ~~pa~~ U.S. Patent therefor; and

WHEREAS Dennis W. Beech, Attorney ~~Interested Party~~, is desirous of ~~helping, evaluating,~~ assisting, ~~investing or procuring said development by inventor~~ in obtaining such patent;

~~Interested Party~~ Attorney agrees:

(1) To use the idea and materials including those ideas and products derived from the use of the idea, derived in whole or in part from it solely for ~~Interested Party's evaluation purposes~~ obtaining a patent;

(2) ~~Not to use the idea and derivative materials for commercial purposes including any information or data obtained from Interested Party's independent tests or evaluations without first obtaining a license from Inventor~~;

(3) Not to transfer the idea or materials derived in whole or part from it, ~~including any information or data obtained from Interested Party's independent tests or evaluations~~, to any third party, including public or private entities, without first receiving Inventor's written consent to do so and to refer any party making a request for a sample of the idea to Inventor;

(4) ~~To require, where such consent is granted, your transferees to agree not to use the idea or derivative materials including any information or data obtained from~~

Interested Party's independent tests or evaluations for commercial purposes without first obtaining a license from Inventor;

(5) To provide Inventor with a pre-print of any abstract, manuscript, brochure, or investment description which describes Interested Party's work with the idea prior to submission of the abstract, manuscript, brochure, or investment description;

(6) To comply with all laws and regulations, including current Government guidelines, and to assume sole responsibility for any claims or liabilities which may arise as a result of Interested Party's use of the idea.

This agreement shall be interpreted in accordance with the laws of the State of California.

The parties agree that the ideas and materials that are the subject of this agreement are of a unique and proprietary nature and that improper disclosure would result in irreparable damage. As a result of the unique and proprietary nature, the parties agree that injunctive relief is appropriate. Such injunctive relief shall be in addition to any other remedy at law or equity.

This writing sets forth the entire Agreement between the parties hereto and supersedes any previous oral or written agreement. This Agreement may be amended only by written agreement between parties.

Should an action be necessary to enforce this agreement, the prevailing party shall be entitled to attorneys fees.

Dated: 6/24/01 ______________________ Inventor

Dated: 6/24/01 ______________________ Interested Party Attorney

WIRELESS DIGITAL AUDIO MUSIC SYSTEM

This continuation application claims the benefit of U.S. Patent Application No. 12/570,343, which was a continuation application ~~claimed~~ claiming the benefit of U.S. Patent Application Serial No. 12/144,729 filed July 12, 2008, now U.S. Patent No. 7,684,885, which was a continuation ~~which claimed~~ claiming benefit of U.S. Patent Application Serial No. 10/648,012 filed August 26, 2003, now U.S. Patent No. 7,412,294, which was a continuation-in-part ~~claimed~~ claiming benefit from U.S. Patent Application Serial No. 10/027,391, filed December 21, 2001, for "Wireless Digital Audio System," published under US 2003/0118196 A1 on June 26, 2003, now abandoned, ~~both of which are incorporated herein in their entirety by reference~~ the disclosures of which are incorporated herein in their entireties by reference.

BACKGROUND OF THE INVENTION

[0001] This invention relates to audio player devices and more particularly to systems that include headphone listening devices. The new audio system uses an existing headphone jack (i.e., this is the standard analog headphone jack that connects to wired headphones) of a music audio player (i.e., portable CD player, portable cassette player, portable A.M./F.M. radio, laptop/desktop computer, portable MP3 player, and the like) to connect a battery powered transmitter for wireless transmission of a signal to a set of battery powered receiving headphones.

[0002] Use of audio headphones with audio player devices such as portable CD players, portable cassette players, portable A.M./F.M. radios, laptop/desktop computers, portable MP3 players and the like have been in use for many years. These systems incorporate an audio source having an analog headphone jack to which headphones may be connected by wire.

[0003] There are also known wireless headphones that may receive A.M. and F.M. radio transmissions. However, they do not allow use of a simple plug in (i.e., plug in to the existing analog audio headphone jack) battery powered transmitter for connection to any music audio player device jack, such as the above mentioned music audio player devices, for coded wireless transmission and reception by headphones of audio music for private listening without interference where multiple users occupying the same space are operating wireless transmission devices. Existing audio systems make use of electrical wire connections between the audio source and the headphones to accomplish private listening to multiple users.

[0004] There is a need for a battery powered simple connection system for existing music audio player devices (i.e., the previously mentioned music devices), to allow coded digital wireless transmission (using a battery powered transmitter) to a headphone receiver (using a battery powered receiver headphones) that accomplishes private listening to multiple users occupying the same space without the use of wires.

SUMMARY OF THE INVENTION

[0005] The present invention is generally directed to a wireless digital audio system for coded digital transmission of an audio signal from any audio player with an analog headphone jack to a receiver headphone located away from the audio player. Fuzzy logic technology may be utilized by the system to enhance bit detection. A battery-powered digital transmitter may include a headphone plug in communication with any suitable music audio source. For reception, a battery-powered headphone receiver may use embedded fuzzy logic to enhance user code bit detection. Fuzzy logic detection may be used to enhance user code bit detection during decoding of the transmitted audio signal. The wireless digital audio music system provides private listening without interference from other users or wireless devices and without the use of conventional cable connections.

[0006] These and other features, aspects and advantages of the present invention will become better understood with reference to the following drawings, description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Some aspects of the present invention are generally shown by way of reference to the accompanying drawings in which:

Figure 1 schematically illustrates a wireless digital audio system in accordance with the present invention;

Figure 2 is a block diagram of an audio transmitter portion of the wireless digital audio system of Fig. 1.;

Figure 3 is a block diagram of an audio receiver portion of the wireless digital audio system of Fig. 1; and

Figure 4 is an exemplary graph showing the utilization of an embedded fuzzy logic coding algorithm according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0008] The following detailed description is the best currently contemplated modes for carrying out the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention.

[0009] Referring to Figures 1 through 3, a wireless digital audio music system 10 may include a battery powered transmitter 20 connected to a portable music audio player or music audio source 80. The battery powered wireless digital audio music transmitter 20 utilizes an analog to digital converter or ADC 32 and may be connected to the music audio source 80 analog headphone jack 82 using a headphone plug 22. The battery powered transmitter 20 may have a transmitting antenna 24 that may be omni-directional for transmitting a spread spectrum modulated signal to a receiving antenna 52 of a battery powered headphone receiver 50. The battery powered receiver 50 may have headphone speakers 75 in headphones 55 for listening to the spread spectrum demodulated and decoded communication signal. In the headphone receiver 50, fuzzy logic detection may be used to optimize reception of the received user code. The transmitter 20 may digitize the audio signal using ADC 32. The digitized signal may be processed downstream by an encoder 36. After digital conversion, the digital signal may be processed by a digital low pass filter. To reduce the effects of channel noise, the battery powered transmitter 20 may use a channel encoder 38. A modulator 42 modulates the digital signal to be transmitted. For further noise immunity, a spread spectrum DPSK (differential phase shift key) transmitter or module 48, is utilized. The battery powered transmitter 20 may contain a code generator 44 that may be used to create a unique user code. The unique user code generated is specifically associated with one wireless digital audio system user, and it is the only code recognized by the battery powered headphone receiver 50 operated by a particular user. The radio frequency (RF) spectrum utilized (as taken from the Industrial, Scientific and Medical (ISM) band) may be approximately 2.4 GHz. The power radiated by the transmitter adheres to the ISM standard.

[0010] Particularly, the received spread spectrum signal may be communicated to a 2.4 GHz direct conversion receiver or module 56. Referring to Figures 1 through 4, the spread spectrum modulated signal from transmit antenna 24 may be received by receiving antenna 52 and then processed by spread spectrum direct conversion receiver or module 56 with a receiver code generator 60 that contains the same transmitted unique code, in the battery powered receiver 50 headphones. The transmitted signal from antenna 24 may be received by receiving antenna 52 and communicated to a wideband bandpass filter (BPF). The battery powered receiver 50 may utilize embedded fuzzy logic 61 (as graphically depicted in Figures 1, 4) to optimize the bit detection of the received user code. The down converted output signal of direct conversion receiver or module 56 may be summed by receiver summing element 58 with a receiver code generator 60 signal. The receiver code generator 60 may contain the same unique wireless transmission of a signal code word that was transmitted by audio transmitter 20 specific to a particular user. Other code words from wireless digital audio systems 10 may appear as noise to audio receiver 50. This may also be true for other device transmitted wireless signals operating in the wireless digital audio spectrum of digital audio system 10. This code division multiple access (CDMA) may be used to provide each user independent audible enjoyment. The resulting summed digital signal from receiving summary element 58 and direct conversion receiver or module 56 may be processed by a 64-Ary demodulator 62 to demodulate the signal elements modulated in the audio transmitter 20. A block de-interleaver 64 may then decode the bits of the digital signal encoded in the block interleaver 40. Following such, a Viterbi decoder 66 may be used to decode the bits encoded by the channel encoder 38 in audio transmitter 20. A source decoder 68 may further decode the coding applied by encoder 36.

[0011] Each receiver headphone 50 user may be able to listen (privately) to high fidelity audio music, using any of the audio devices listed previously, without the use of wires, and without interference from any other receiver headphone 50 user, even when operated within a shared space. The fuzzy logic detection technique 61 used in the receiver 50 could provide greater user separation through optimizing code division in the headphone receiver.

[0012] The battery powered transmitter 20 sends the audio music information to the battery powered receiver 50 in digital packet format. These packets may flow to create a digital bit stream rate less than or equal to 1.0 Mbps.

[0013] The user code bits in each packet may be received and detected by a fuzzy logic detection sub-system 61 (as an option) embedded in the headphone receiver 50 to optimize audio receiver performance. For each consecutive packet received, the fuzzy logic detection sub-system 61 may compute a conditional density with respect to the context and fuzziness of the user code vector, i.e., the received code bits in each packet. Fuzziness may describe the ambiguity of the high (1)/low (0 or -1) event in the received user code within the packet. The fuzzy logic detection sub-system 61 may measure the degree to which a high/low bit occurs in the user code vector, which produces a low probability of bit error in the presence of noise. The fuzzy logic detection sub-system 61 may use a set of if-then rules to map the user code bit inputs to validation outputs. These rules may be developed as if-then statements.

[0014] Fuzzy logic detection sub-system 61 in battery-powered headphone receiver 50 utilizes the if-then fuzzy set to map the received user code bits into two values: a low (0 or -1) and a high (1). Thus, as the user code bits are received, the "if" rules map the signal bit energy to the fuzzy set low value to some degree and to the fuzzy set high value to some degree. Figure 4 graphically shows that x-value -1 equals the maximum low bit energy representation and x-value 1 equals the maximum high bit energy representation. Due to additive noise, the user code bit energy may have some membership to a low and high as represented in Figure 4. The if-part fuzzy set may determine if each bit in the user code, for every received packet, has a greater membership to a high bit representation or a low bit representation. The more a user code bit energy fits into the high or low representation, the closer its subsethood, i.e., a measure of the membership degree to which a set may be a subset of another set, may be to one.

[0015] The if-then rule parts that make up the fuzzy logic detection sub-system 61 must be followed by a defuzzifying operation. This operation reduces the aforementioned fuzzy set to a bit energy representation (i.e., -1 or 1) that is received by the transmitted packet. Fuzzy logic detection sub-system 61 may be used in battery-powered headphone receiver 50 to enhance overall system performance.

[0016] The next step may process the digital signal to return the signal to analog or base band format for use in powering speaker(s) 75. A digital-to-analog converter 70 (DAC) may be used to transform the digital signal to an analog audio signal. An analog low pass filter 72 may be used to filter the analog audio music signal to pass a signal in the approximate 20 Hz to 20 kHz frequency range and filter other frequencies. The analog audio music signal may then be processed by a power amplifier 74 that may be optimized for powering headphone speakers 75 to provide a high quality, low distortion audio music for audible enjoyment by a user wearing headphones 55. A person skilled in the art would appreciate that some of the embodiments described hereinabove are merely illustrative of the general principles of the present invention. Other modifications or variations may be employed that are within the scope of the invention. Thus, by way of example, but not of limitation, alternative configurations may be utilized in accordance with the teachings herein. Accordingly, the drawings and description are illustrative and not meant to be a limitation thereof.

[0017] Moreover, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Thus, it is intended that the invention cover all embodiments and variations thereof as long as such embodiments and variations come within the scope of the appended claims and their equivalents.

ABSTRACT

[0018] A wireless digital audio system includes a portable audio source with a digital audio transmitter operatively coupled thereto and an audio receiver operatively coupled to a headphone set. The audio receiver is configured for digital wireless communication with the audio transmitter. The digital audio receiver utilizes fuzzy logic to optimize digital signal processing. Each of the digital audio transmitter and receiver is configured for code division multiple access (CDMA) communication. The wireless digital audio system allows private audio enjoyment without interference from other users of independent wireless digital transmitters and receivers sharing the same space.

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12/940,747	11/05/2010	C. Earl Woolfork	1028.5	8175

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EXAMINER	
FLANDERS, ANDREW C	
ART UNIT	**PAPER NUMBER**
2614	

NOTIFICATION DATE	DELIVERY MODE
07/27/2011	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

MELYMAN@LYMANPATENTS.COM

Advisory Action Before the Filing of an Appeal Brief	**Application No.** *12/940,747*	**Applicant(s)** WOOLFORK, C. EARL
	Examiner Andrew C. Flanders	**Art Unit** 2614

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 21 June 2011 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

1. ☒ The reply was filed after a final rejection, but prior to or on the same day as filing a Notice of Appeal. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. The reply must be filed within one of the following time periods:
   a) ☒ The period for reply expires *3* months from the mailing date of the final rejection.
   b) ☐ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   Examiner Note: If box 1 is checked, check either box (a) or (b). ONLY CHECK BOX (b) WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on ______. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☒ The proposed amendment(s) filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   (a) ☒ They raise new issues that would require further consideration and/or search (see NOTE below);
   (b) ☐ They raise the issue of new matter (see NOTE below);
   (c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   (d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: *Claims 3 - 6, 10 and 12 now require the reciver to be directly communicable with a mobile digital audio transmitter. Previous they were only communicable, no direct requirement was present. The previous interpreation allowed for intermetient steps during communication while the new limitations preclude this interpretation and thus are a change in scope.*. (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): ______.
6. ☐ Newly proposed or amended claim(s) ______ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☒ For purposes of appeal, the proposed amendment(s): a) ☒ will not be entered, or b) ☐ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.
   The status of the claim(s) is (or will be) as follows:
   Claim(s) allowed: ______.
   Claim(s) objected to: ______.
   Claim(s) rejected: *1-12*.
   Claim(s) withdrawn from consideration: ______.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ The affidavit or other evidence filed after a final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
9. ☐ The affidavit or other evidence filed after the date of filing a Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing a good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
10. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

11. ☐ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: ______.
12. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). ______
13. ☐ Other: ______.

/Andrew C Flanders/
Primary Examiner, Art Unit 2614

PTO/SB/30EFS (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	12940747	Filing Date	2010-11-05	Docket Number (if applicable)	1028.5	Art Unit	2614
First Named Inventor	C. Earl Woolfork			Examiner Name	Andrew C. Flanders		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☒ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on ________
- ☐ Other ________

☒ Enclosed

- ☒ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other ________

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months ________
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other ________

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 504576

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

PTO/SB/30EFS (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Signature of Registered U.S. Patent Practitioner			
Signature	/Megan Lyman/	Date (YYYY-MM-DD)	2011-08-02
Name	Megan Lyman	Registration Number	57054

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

REQUEST FOR CONTINUED EXAM AND RESPONSE TO THE FINAL REJECTION DATED 05/05/11

THE EXAMINER INTERIVEW OF JUNE 7, 2011

The Applicant would like to thank Examiner Flanders for his courtesy and attention in participating in the telephonic interview on June 7, 2011 at 10 am. The applicant has reviewed the Examiner's interview summary of June 15, 2011. As is recited in that summary, a detailed discussion regarding the particular issue of a mobile transmitter and receiver in the present invention differs substantially in problem and solution to the prior art. The Examiner agreed that the ISI problem is very different and requires a novel solution as is presented in the present invention. The Applicant maintains that the claim language properly details this solution (see Claims 2, 4, 6, 7, and 12 "a digital audio receiver, capable of mobile operation," "mobile digital audio transmitter"; Claims 3, 5, 9, and 11 "is capable of being moved in any direction during operation"; Claim 8 "wherein said mobile digital audio receiver," "mobile digital audio transmitter"; and Claim 10 "is capable of mobile operation"). The Applicant maintains that the centralized and not portable systems of Li, and analog systems of Altstatt cannot suggest remedies to the host of issues confronted by one of ordinary skill in creating a wireless digital system that can operate while the single transmitter and receiver are mobile and in an environment with other transmissions. The applicant also maintains that the presence of the DCR is novel and a patentable element of the present invention. The Applicant again wishes to show his appreciation for the Examiner's time and thought extended during the interview.

ADDITION OF CLAIMS 13-18

The applicant has added additional Claims 13-18 that clearly state the problem of intersymbol interference and the decoder and encoder elements of the present invention that solve this problem. The ISI problem was discussed in the Examiner Interview, and the new claims seek to address the concerns of the Examiner, namely that the issue was not detailed. These new claims indicate that a mobile transmitter and receiver have ISI issues that require special coding to resolve. These new claims do not add new matter to the application and it is respectfully requested that they be entered and reviewed.

RESPONSE TO REJECTION OF CLAIMS 1 - 12 UNDER 35 U.S.C. 103

A finding of obviousness requires that "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertain." 35 U.S.C. §103(a). In *KSR Int'l Co. v. Teleflex, Inc.*, 127 S. Ct. 1727, 82 USPQ2d 1385 (2007), the Supreme Court stated that the following factors set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966) control an obviousness inquiry: (1) the scope and content of the prior art; (2) the differences between the prior art and the claimed invention; (3) the level of ordinary skill in the art; and (4) objective evidence of nonboviousness. *KSR*, 127 S. Ct. at 1734, 82 USPQ2d at 1388 (quoting *Graham*, 383 U.S. at 17-18, 14 USPQ at 467).

The *KSR* Court affirmed that it is "important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does . . . because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." *KSR,* 127 S. Ct. at 1741, 82 USPQ2d at 1396. Once the *Graham* factors have been addressed, the Examiner may apply the TSM test, asking whether (l) a teaching, suggestion or motivation exists in the prior art to combine the references cited, and (2) one skilled in the art would have a reasonable expectation of success. *See* USPTO Guidelines at 57534.

Further, in order to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka,* 490 F.2d 981, 180 USPQ 580 (CCPA 1974). Additionally, in considering a prior art reference, the reference must be considered in its entirety, *i.e.,* as a whole, including portions that would lead away from the claimed invention. *WL. Gore & Associates, Inc.* v. *Garlock. Inc., 721* F.2d 1540,220 USPQ 303 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984). A prior art reference is only appropriate where the "invention as a whole would be obvious to a person of ordinary skill in the field." In re Kumar, 418 F.3d 1361, 76 USPQ2d 1048, 1053 (Fed. Cir. 2005). Moreover, it is improper to combine references where the references teach away from their combination. *In re Grasselli,* 713 F.2d 731,743,218 USPQ 769, 779 (Fed. Cir. 1983). Indeed, "an applicant may rebut a prima facie case of obviousness by showing that the prior art teaches away from the claimed invention *in any material respect."* *In re Peterson*, 315 F.3d 1325, 1331 (Fed. Cir. 2003) (Emphasis added). In making an obviousness rejection, Examiners must provide evidence and clear argument as to how the prior art suggests the invention. *Sud-Chemie v. Multisorb Techs.*, 554 F. 3d 1001 (Fed. Cir. 2009).

Claims 1-12 Rejected as Unpatentable over Altstatt in View of Li and in Further View of Lindemann

Summary

The applicant is aware that the prior art is taken as a whole, as is cited above, in the rejections posed. It is this very fact that the applicant urges the examiner to review this invention. As is outlined in detail below, the prior art in combination do not teach or suggest the present invention and provide no motivation for one of ordinary skill to combine and solve the novel problems posed by a mobile system working with a single mobile transmitter and a single mobile receiver in a space containing other transmissions in the digital spectrum. The present invention was first presented to the Patent Office in 2001 and must be evaluated at that time point, well before wireless audio transmission was commonplace in our current digital society. Three patents have been issued towards the present invention, each directed towards different novel aspects of transmitting digital audio with high fidelity and without interference. It is the applicant's position the static systems of Lindemann, centralized and not portable systems of Li, and analog systems of Altstatt cannot suggest remedies to the host of issues confronted by one of ordinary skill in creating a wireless digital system that can operate while the single transmitter and receiver are mobile and in an environment with other transmissions. The overarching deficiencies in each prior art cannot be remedied by the presence of the prior art as a whole. These deficiencies in the prior art make it implausible to combine them in 2001 to teach, suggest, or provide motivation to one of ordinary skill to produce the present invention. Below three major areas discussed in the Final Rejection are addressed: ISI, CDMA, and the DCR. It is expected that after a review of these three issues and how the prior art fail to address the solutions fashioned by the present invention, the rejections will be removed and the application placed into allowance.

Amendments to the Claims

Claims 3, 4, 5, 6, and 12 have been amended to state that the "wireless digital receiver" is *directly* communicable with the "digital audio transmitter." The omission of the word "directly" in the originally submitted claims was in error. The insertion of this word does not change the scope of the claim and should be allowed at this time in prosecution. Claims 10 and 11 have also been amended to change "audio source" as is written in the original claims to "audio player." Again this amendment corrects the original language and does not change the scope of the claims. The Applicant respectfully requests that the amendments be entered at this time. New Claims 13-18 have been added and it is respectfully requested that they be entered for examination.

The Intersymbol Interference Problem

In order to clearly demonstrate that the prior art combination does not teach or suggest the present invention, a description of the problem of Intersymbol interference ("ISI") is provided. ISI distorts the audio signal content, causing a major obstacle to the transmission of high data rate audio from an in-motion transmitter to an in-motion receiver. Referring to the underlined sections of the Exhibit IV text "Adaptive Filter Theory," Second Edition, by Simon Haykin, ISI "is caused by dispersion in the transmit filter, the transmission medium, and the receive filter . . . we usually find that intersymbol interference is the chief determining factor in the design of high-data rate transmission systems . . . intersymbol interference, if left unchecked, can result in erroneous decisions when the sampled signal at the channel output is compared with some preassigned threshold by means of a decision device." The problem of ISI is very different in static and mobile systems.

Within the present invention, both the digital audio transmitter and digital audio receiver may be in motion (see Claims 1 - 12), thus, the relative position and velocity of both the transmitter and receiver (both in-motion transmitter and in-motion receiver present spatial and temporal variations) will be constantly changing (e.g., a person running with the wireless digital audio system). Because ISI results when the in-motion digital audio transmitter attempts to communicate high symbol rate audio to the in-motion digital audio receiver, ISI must be suppressed. The present invention solves the ISI problem by maintaining fidelity of the high data rate audio signal while the in-motion transmitter is in communication with the in-motion receiver. The ISI mitigation of the present invention is performed by, among other things, the claimed encoder ("a encoder operative to encode said original audio signal representation to reduce intersymbol interference") and decoder ("a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation") (Claims 1 - 12). This solution is the result of a novel inventive step in producing the present invention.

On page 5 of the Final Rejection (FRJ) mailed 05/05/2011, it is stated: "The combination of Altstatt in view of Li fails to explicitly disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation." Thus, the rejection of the claim language "a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation" relies upon Lindemann. *It is important to note that Lindemann never discusses ISI.* Failure to identify the problem of ISI clearly demonstrates that this prior art, neither alone nor in combination can even suggest a solution to the present invention. *Furthermore, Roberts (6,418,558), which is also cited in this rejection, does not disclose the reduction of ISI in a mobile transmitter and mobile receiver system.* Roberts cannot teach or suggest how the unique problem of ISI in a mobile system can be attenuated. One of ordinary skill would have no motivation to look to these prior art to solve the ISI problem in a mobile system as has been accomplished by the present invention.

The FRJ relies upon the hypothetical scenario that Lindemann teaches reduction of ISI within a mobile transmitter/mobile receiver system (page 5 of the FRJ states: "Lindemann also includes that the transmission stream is created using a Reed-Solomon encoding and interleaver and a corresponding decoder in the decoder. Applying these teachings to the encoding of the combination discloses: . . . reduced intersymbol interference coding"). Reed-Solomon encoding and interleaving may be designed to address burst errors, but Lindemann does not teach Reed-Solomon encoding and interleaving for the purpose of reducing ISI in a mobile transmitter/mobile receiver system. Lindemann is silent about both mobility and ISI.

In fact, paragraph 0050 of Lindemann 2004/0223622, states: "The interleaver function performed by the Reed Solomon Encoder and Interleaver with Frame Marker

Insertion 407 protects against *burst errors* by scrambling adjacent bits across multiple Reed Solomon encoding blocks. This error protection system is a called a concatenated encoder with interleaving." (Emphasis added). To be clear, "Reed-Solomon (RS) are nonbinary codes which are capable of correcting errors which appear in bursts and are commonly used in concatenated coding systems" (reference underlined section of Exhibit V text "Wireless Communications Principles & Practice" by T. S. Rappaport). Bursts are the result of an additional unintended transmission source (also known as a jammer because it may unintentionally jam communications) as described in underlined section of Exhibit VI text "Introduction to Spread Spectrum Communications" by R.L. Peterson, R.E. Ziemer and D.E. Borth: "Jamming strategies which concentrate jamming resources on some fraction of the transmitted symbols using either pulsed or partial band techniques cause demodulator output errors to occur in bursts."

To clarify, "FIGURE 10-1. Covert communications process" and underlined section of Exhibit VII text "Introduction to Spread Spectrum Communications" by R.L. Peterson, R.E. Ziemer, and D.E. Borth states: "In any communications operation, there may be several ingredients or "players," as illustrated in Figure 10-1. First, there are the intended communicators, which make use of the transmitter and receiver shown in the figure. Second, there may be unintentional sources or jammers." Consequently, "These jammers produce bursts of errors . . . . To counter this difficulty, an interleaver is placed between the encoder and the modulator and a de-interleaver is placed between the demodulator and the decoder" (reference underlined section of Exhibit VIII text "Introduction to Spread Spectrum Communications" by R.L. Peterson, R.E. Ziemer, and D.E. Borth).

Lindemann does not teach a method of "Reed Solomon encoding/decoding to reduce ISI" as stated on page 6 of the FRJ. The FRJ misinterprets ISI (defined previously above) as interference radiating from an outside transmission source (burst errors). Moreover, Roberts is silent about reducing ISI within a wireless mobile transmitter/mobile receiver system. The rejection relies on a nonenabled hypothetical scenario, because neither Lindemann nor Roberts suggest a method of reducing ISI in a wireless mobile transmitter/mobile receiver system. The combination of Altstatt, Li, Lindemann (with Roberts) fails to teach or suggest the claim language "a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation."

A further review of Roberts shows that there is not disclosure of Reed-Solomon/Interleaving to reduce ISI (see col. 5 lns. 62 – 67 and col. 6 lns. 1 – 3: "The clock signals for generating the carriers and the symbols representing the transmitted data may be locked to each other or generated from the same source, to reduce intersymbol interference significantly," "Another technique for reducing intersymbol interference is the transmission of each symbol with more than 360 degrees of phase in one cycle of its carrier, in order to allow some leeway in tracking the phase of a channel carrier in a receiving system." And see col. 45 lns. 9 – 14: "Again, a phase discontinuities exist at the ends of the total 405 degree phase degrees of this wave. In fact, this characteristic gives the excess-phase improvement an advantage over its primary function of providing a guard band for the symbol decoder, for reducing intersymbol interference," And see col. 46 lns. 10 – 19: "In the present system, however, it has been found that even very small frequency drifts between the 8 kHz symbol or flame clock and the frequencies of the tones upon which they ride can produce significant intersymbol interference and distortion at the receiving end. Such drifts tend to destroy the orthogonality of the channel signals produced by inverse FFT 140 in FIG. 21. The present system also, however, provides a simple, inexpensive way to overcome this problem. FIG. 51 shows a portion 4200 of the HDT clock/sync logic in CTSU 54, FIG. 3.")

In each of the above methods to reduce ISI presented by Roberts, none of them disclose the use of Reed-Solomon/Interleaving as a solution to suppress ISI. In fact, Roberts discloses Reed-Solomon for error detection/correction (as previously described above and see col. 6 lns. 5 – 12: "An embodiment is shown which handles both unencoded parity-type detection/correction and more multiple types of more powerful methods, such as Reed-Solomon encoding, in a transparent, real-time fashion, by packing the data words differently for each case. Moreover, the processor loading involved in these error-correction techniques can be spread out in time, so that not all channels need to be handled at the same time.") Page 5 of the FRJ incorrectly states "configure Reed Solomon decoding/interleaving to reduce ISI as is shown by Roberts 6,418,558," because Roberts does not disclose nor teach such a configuration.

It is clear that the degree of ISI becomes more severe in a mobile environment (i.e., a mobile transmitter communicating with a mobile receiver) given the following: a fading channel exhibits ISI in digital communications (reference underlined section of Exhibit IX text "Introduction to Spread Spectrum Communications" by R. Peterson, R. Ziemer, and D. Borth and referring to the underlined section of Exhibit X text "Spread Spectrum Systems With Commercial Applications," Third Edition, by Robert C. Dixon, *"The rate at which fades occur is a function of the rate at which the signal propagation paths change. In fixed-position systems, the fading rate is determined by how fast the environment changes."*) Lindemann (who does not address ISI) teaches a fixed-position system (i.e., immobile digital transmitter and immobile digital speaker receiver) and Roberts is silent as to mobile systems. Given the fact that the rate at which fades occur (fading relative to ISI) is a function of the rate at which the signal propagation paths change, and that both the transmitter and receiver in the present invention are mobile, it should be clear that the propagation paths, or multipath in the present invention, create a type of ISI that was not considered in Roberts.

The teachings of Altstatt, Li, Lindemann and Roberts do not combine to obviate the present invention when taken as a whole. Referencing the underlined section of Exhibit XI text "Spread Spectrum Systems with Commercial Applications," Third Edition, by Robert C. Dixon: "One cannot say, however, that using a spread spectrum signal *(e.g., CDMA)* does away with all multipath effects." Emphasis added. One may consider Bluetooth as an example of the Altstatt, Li, and Lindemann teachings based on the hypothetical scenario presented in the FRJ on pages 4 and 5. ("It would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Alstatt. Li clearly teaches the device for use in portable implementations such as music and headphone audio reproductions." And on page 5 "reducing intersymbol interference for CDMA transmission is notoriously well known in the art.")

At the present time, Bluetooth is known "for use in portable implementations such as music and headphone audio reproductions" (Reference page 4 of the FRJ). As stated in the underlined section of Exhibit XII, Bluetooth Specification Version 1.0B, page 41

"Bluetooth is a short-range radio link intended to replace cable(s) connecting portable . . . electronic devices." (submitted to the USPTO on 08/04/2010 by way of the Information Disclosure Statement). The FRJ states that "reducing intersymbol interference for CDMA transmission is notoriously well known in the art," and the combination of Altstatt, Li and Lindemann (including Roberts) should lend a reduced ISI solution (for a portable mobile wireless system) that is "obvious to one of ordinary skill in the art."

Respectfully, the following application note provides evidence this rejection is in error. The application note (submitted to the USPTO on 04/14/2011by way of the Information Disclosure Statement) is "Motorola's Bluetooth Solution to Interference Rejection and Coexistence with 802.11" and it states on page 1, section 2 (also see page 7, section 4) "The Bluetooth channel has unrecoverable Inter Symbol Interference (ISI)." A copy of this statement is conveniently located and underlined in Exhibit XIII. It is important to note that Motorola's application note was published in December of 2001, while the present invention was disclosed to Mr. Dennis Beech (the patent prosecution attorney at that time) in June of 2001 (Please see Exhibit XIV). The application note is, at least, evidence that reducing ISI within a system that contains a mobile transmitter and a mobile receiver is *not* "obvious to one of ordinary skill in the art" nor is it "notoriously well known in the art."

The ISI within Bluetooth, at that time, would not be in an "unrecoverable" state if the solution was "obvious to one of ordinary skill in the art" or "notoriously well known in the art." The Bluetooth specification referenced here (version 1.0B) was published in December of 1999 and it was not until December of 2001 when Motorola proposed a solution to reduce ISI in Bluetooth's system. Again it is important to note that the solution for reducing ISI in a wireless mobile digital audio transmitter/mobile digital audio receiver system was part of the present invention prior to the Motorola application note.

The claims should be in allowance on the presence of the encoder /decoder that function to reduce ISI that results when both the transmitter and receiver are in motion. These explanations remove the obviousness arguments for all remaining Claims 1- 12. Thus, for at least the reasons provided above, the prior art references are deficient in providing the present invention solution, and the remaining Claims should be in allowance.

Digital Wireless Communications and CDMA

The claims are also rejected as being obviousness by the digital wireless communication of Li could be replaced by the FM modulation communication taught in Altstatt. Li is cited in the rejection for teaching a device for use in portable implementations. It is stated that doing so is the substitution of one known element (i.e., the digital CDMA transmitter/receiver) for another (i.e., analog FM transmitter) to obtain predictable results. The Applicant respectfully disagrees.

Altstatt does not disclose a direct one-to-one digital transmitter-to-headphone communication link, thus, Altstatt cannot realize the benefits of such a digital link as asserted (Examiner Office Action Mailed 08-09-2005, page 6: "However the system of Altstatt is an analog transmission system that, in operation, lacks the benefits of a digitally encoded and transmitted audio signal" and Office Action Mailed 05-17-2006, page 6 and Office Action Mailed 10-02-2006, page 10: "However, the system of Altstatt an analog transmission system that, operation lacks the benefits digitally encoded and transmitted audio signal."). Additionally, Li clearly discloses a cellular communication system (Li column 1 lines 57 – 63 "CDMA digital cellular communications system . . . ," column 6 lines 55 – 62 "IMT 2000 . . . IS95 . . . CDMA 2000). IMT 2000, IS95 and CDMA 2000 are all cellular (i.e., cell phone) standards and each requires the *centralized* control of a base station for operation. Li's centralized control base station system does not teach or suggest a direct one-to-one transmitter-to-headphone communication link.

Based on what is taught by Altstatt and Li, applying "the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Alstatt," as stated on page 4 of the Final Rejection (FRJ) mailed 05/05/2011, *requires* the centralized control of the cellular base station taught by Li (Li column 7 lines 9 – 17 "The exchange or the service-providing unit of the mobile net can store various multichannel sounds needed by users, e.g. a great amount of MP3 music data. On request of users, the exchange or the service-providing unit of the mobile net sends the suitable data to the wideband CDMA base station, by which the multichannel data, e.g. MP3 music data, is transmitted to the multichannel mobile equipment through the radio interface of the wideband CDMA). Li teaches the cellular base station approach for "bi-directional" sound communication and interference suppression (Li column 1 lines 57 – 63 "CDMA digital cellular communications system can, with large system capacity only restricted by interference … providing bi-directional … sound."). As a result, the Altstatt/Li combination stated in the FRJ requires the cellular base station to meet the interference mitigation claim language "virtually free from interference from device transmitted signals operating in the portable wireless digital audio system spectrum" as found in Claims 4, 6, 7 - 12.

Regarding Claim 1, page 5 of the FRJ poses that the Altstatt/Li combination obviates the invention by "Replacing the FM transmitter/receiver implementation of Alstatt to use the digital CDMA communication." This Altstatt/Li combination fails to obviate the invention based on at least the following. The following explanation is applicable not only to Claim 1, but to the other remaining Claims (2-12) that stand rejected under the Altstatt/Li combination (and in view of Lindemann).

The Altstatt/Li combination does not suggest a portable audio system that includes a mobile transmitter and mobile receiver with a distributed architecture to one of ordinary skill. To further support this position, the Examiner is referred to the underlined portion of Exhibit I (herein attached) "From WPANs to Personal Networks Technologies and Applications" where it is stated: "A wireless network can be distributed or centralized. Distributed networks are those where each device accesses the medium individually and transmits the data without any central control . . . . Centralized network architecture has one network element, which controls the communication of various devices." The claim language "configured for independent CDMA communication operation" (as seen in Claims 1 - 12) reflects the distributed architecture and is supported by the specification of 10/027,391 application in paragraph 0016: "This . . . (CDMA) may be used to provide each user independent operation." (as well as other portions of the specification).

The Direct Conversion Receiver

Within the present invention, the task of each receiver, among other things, is to mitigate interference in the vicinity in order to receive the correct transmission. Thus, the direct conversion receiver (DCR) disclosed in the present invention (see Claims 1 - 12) utilizes, among other things, "timing and synchronization to capture the correct bit sequence embedded in the received spread spectrum signal" (Parent Application 10/027,391 paragraph 0015). Furthermore, paragraph 0016 of the 10/027,391 application states: "Other code words from wireless digital audio systems 10 may appear as noise to a particular audio receiver 50. This may also be true for other device transmitted signals operating in the wireless digital audio system 10 spectrum." Moreover, Patent 7,412,294 column 3 lines 32-34 state: "The battery powered transmitter 20 sends the audio music information to the battery powered receiver 50 in digital packet format."

When packets are communicated over a wireless link it may be referred to as packet radio. The underlined section of the text "Wireless Communications Principles & Practice" has been provided for clarification (please see Exhibit II: "... called packet radio when used over a wireless link . . . . This benefit is valuable for the case of mobile services where the available bandwidth is limited. The packet radio approach supports intelligent protocols for data flow control and retransmission, which can provide highly reliable transfer in degraded channel conditions."). While other code words and/or other device transmitted signals are in the vicinity, they can create associated noise channel conditions at the receiver that may prevent the capture of the packet with the correct bit sequence. Based on the above disclosures, it is clear that both intended and unintended spread spectrum packet signals can appear at the receiver, but only the packet with the correct bit sequence is captured by the DCR in the present invention. Moreover, there exists several data delivery types (for clarification, please see section 16.2.1, of the book from Vijay Garg entitled Wireless Communications and Networking, (relative to the CDMA2000 cellular communication taught by Li) accessible on the following Google books website:
http://books.google.com/books?id=UE2wEc9NfB8C&pg=PA544&lpg=PA544&dq=cdma2000+isdn&source=bl&ots=pB26eq6oLc&sig=nzleT7D4Q_P-KFMduSkb9b5015s&hl=en&ei=lZw8TKzcHZL4swOg0uDaCg&sa=X&oi=book_result&ct=result&resnum=2&ved=0CBoQ6AEwAQ#v=onepage&q=cdma2000%20isdn&f=false).

That source states: "End user data-bearing services. Services that deliver any form of data on behalf of the mobile end user, including packet data (e.g., IP service), circuit switched data services (e.g., B-ISDN emulation services), and SMS. Packet data services conform to industry standard connection-oriented and connectionless packet data including IP-based protocols (e.g., transmission control protocol (TCP) and user data protocol (UDP) and OSI connectionless interworking protocol (CLIP)). Circuit-switched data services that emulate international standards-defined, connection-oriented services such as asynchronous (async) dial-up access, fax, V.120 rate-adapted ISDN, and B-ISDN services." Of these data delivery types available, the Altstatt/Li combination does not disclose or suggest a digital packet format for audio information coming from an audio player/source as is included in the claim language and does not obviate the invention. The G.729 is a "compression algorithm for voice", "high quality audio cannot be transported reliably with this codec" as stated in http://en.wikipedia.org/wiki/G.729. Paragraph 0018 of application 10/027,391 discloses high quality audio. The digital packet and audio player/source disclosure is seen in Claims 2 – 12 of the present invention.

Moreover, the DCR of the present invention (based on paragraphs 0015 and 0016 of the 10/027,391 application, as well as Patent 7,412,294 column 3 lines 32-34) accounts for, among other things, (1) relevant timing metrics to capture the packet with the correct bit sequence embedded in the received spread spectrum signal within a in-motion transmitter, in-motion receiver, distributed architecture and (2) relevant synchronization metrics to capture the packet with the correct bit sequence embedded in the received spread spectrum signal within a in-motion transmitter, in-motion receiver, distributed architecture. It should be noted that synchronization includes forms of acquisition and tracking (please reference underlined section of Exhibit III taken from "Digital Communications Techniques Signal Design and Detection"). As a result, timing and synchronization, to capture the intended signal components, has been described and broadly covers all types of timing and synchronization distributed architecture techniques to perform such a task.

Regarding Claims 1 – 12 of the present invention, the Altstatt/Li combination does not disclose a direct conversion receiver (DCR) as stated on pages 4 and 7 in the FRJ where Li's elements "(201)" and "(202)" are referenced. There is no teaching or suggestion that Li's items 201 and 202 ("wideband CDMA demodulator") constitute a

DCR. The DCR disclosed in the present invention, among other things, performs direct down conversion from radio frequency (RF) to baseband (or very near baseband), thus, omitting intermediate frequency (IF) down conversion components that are often used. The invention utilizes the DCR for, among other things, down conversion from RF-to-baseband (or very near baseband), eliminating unnecessary IF components, which reduces the size and power consumption of the module. The Altstatt/Li combination does not teach a DCR nor does it suggest the use of a DCR within the invention. Because one of ordinary skill would not be motivated in any way by Alstatt and Li to create the present invention with any reasonable expectation of success, the obviousness rejection should be removed.

In addition, the use of the DCR in the invention, suppresses aliasing noise effects by use of the anti-aliasing filters (typically low pass filters or some version thereof) located within the DCR, thus, aiding to preserve the fidelity of the transmitted high quality audio signal. The Altstatt/Li combination does not teach or suggest a DCR, thus, cannot realize the benefits of the claim language "a direct conversion module configured to capture the packet with the correct bit sequence embedded in the received spread spectrum signal" (see Claims 1 - 12). Neither Li, Altstatt, nor Lindemann (Lindemann discloses in paragraph 0057 "In the RF receiver embodiment of FIG. 3, …, The RF Downconverter 302 modulates the RF signal, using a sinusoid generated by the RF VCO 310, *down to IF frequency*. The *IF signal is further down modulated* by the IF Demodulator 303. The output of the IF Demodulator is a complex signal consisting of I and Q--real, imaginary--running at the Chip Rate") alone or in any combination of the three teach, suggest, or disclose the DCR of the present invention. One of ordinary skill would not be motivated or anticipate any success by reading the cited prior art to create a system containing a DCR to solve reception problems solved in the present invention. Claims 1- 12 should be in allowance on the presence of the DCR alone.

These explanations remove the obviousness arguments for all remaining Claims 1- 12. Thus, for at least the reasons provided above, the prior art references are deficient in providing the present invention solution, and the remaining Claims should be in allowance.

Moreover, the applicant would like to state that any other arguments made by the Examiner and not explicitly addressed in this response are not agreed to by the applicant (e.g., the rejection to DPSK/CDMA for obviousness). Silence as to any arguments made by the examiner is not an assent to those arguments; the applicant respectfully asserts that all claims in their present condition are allowable and patentable.

Amendment to the Specification

The first paragraph of the specification has been amended to reflect the proper family history of this application. The changes make clear lineage of the application and are ministerial in nature. Language to be deleted is in strikethrough and language to be added is underlined. It is respectfully requested that this amendment be entered.

If there are any questions, concerns, or actions that can be taken to expedite the processing of this application, please do not hesitate to contact the applicant's representative.

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Respectfully Submitted,

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CLAIMS

I claim:

1. (Original) A wireless digital audio headphone comprising:

a portable digital audio headphone receiver configured to receive a unique user code bit sequence and a original audio signal representation in the form of packets, said portable digital audio headphone receiver comprising:

a direct conversion module configured to capture said packets embedded in the received spread spectrum signal;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode reduced intersymbol interference coding of original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized.

2. (Original) A wireless digital audio headphone for receipt of a unique user code and a digital audio music representation signal in the form of a packet, said wireless digital audio headphone comprising:

a digital audio receiver, capable of mobile operation, configured for direct digital wireless communication with a mobile digital audio transmitter;

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

a decoder operative to decode the applied reduced intersymbol interference coding of said audio music representation signal; and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence is being recognized.

3. (Currently Amended) A wireless digital audio transmitter operatively coupled to a portable audio source and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio source, and configured to be directly communicable with a mobile receiver, is capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a channel encoder to reduce transmission errors; and

a digital modulator module configured for independent code division multiple access (CDMA) communication operation.

4. (Currently Amended) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio source virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

5. (Currently Amended) A wireless digital audio transmitter operatively coupled to a portable audio source and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio source, and configured to be directly communicable with a mobile receiver, is capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

an interleaver to reduce transmission errors; and

a digital modulator module configured for CDMA communication; independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation.

6. (Currently Amended) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent CDMA communication operation;

an de-interleaver generating a corresponding digital output;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio source virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

7. (Previously Presented) A wireless digital audio headphone for receipt of a unique user code and a digital audio representation signal in a packet format, the unique user code configured to spread the said signal spectrum and further configured for independent communication operation, said wireless digital audio headphone comprising:

a digital audio receiver, capable of mobile operation, configured for direct digital wireless communication with a mobile digital audio transmitter, wherein said mobile digital audio transmitter is operatively coupled to a portable audio player;

a direct conversion module configured to capture the packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode the applied reduced intersymbol interference coding of said audio representation signal; and

a digital–to–analog converter generating an audio output of said digital audio representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence being recognized; said audio output being virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

8. (Previously Presented) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and an original audio signal representation in the form of packets, the unique user code configured to spread the said signal spectrum and further configured for independent communication operation, the

wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, wherein said mobile digital audio transmitter is operatively coupled to a portable audio player, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode applied reduced intersymbol interference coding of said original audio signal representation ; and

a digital-to-analog converter generating an audio output of said original audio signal representation;

and a module adapted to reproduce said generated audio output, in response to the unique user code being recognized; said audio output being virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

9. (Previously Presented) A wireless digital audio transmitter operatively coupled to a portable audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver and capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent code division multiple access (CDMA) communication operation.

10. (Currently Amended) A portable wireless digital audio system for digital transmission of an original audio signal representation from a portable audio player to a portable digital audio headphone receiver, said portable wireless digital audio system comprising:

a digital audio transmitter operatively coupled to said portable audio player and transmitting a unique user code bit sequence with said original audio signal representation in packet format, wherein said digital audio transmitter operatively coupled to said audio player is capable of mobile operation, said digital audio transmitter comprising:

a encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent CDMA communication operation;

said digital audio transmitter configured for direct digital wireless communication with said portable digital audio headphone receiver, said portable digital audio headphone receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code bit sequence;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from said portable audio ~~source~~ player and reproduced virtually free from interference.

11. (Currently Amended) A portable wireless digital audio system for digital transmission of an original audio signal representation from a portable audio player to a digital audio receiver, said portable wireless digital audio system comprising:

a digital audio transmitter operatively coupled to said audio player and transmitting a unique user code with said original audio signal representation in packet format, wherein said digital audio transmitter coupled to said audio player is

capable of being moved in any direction during operation, said digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation;

said digital audio receiver capable of being moved in any direction during operation and in direct wireless communication with said digital audio transmitter, said digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode the applied reduced inter-symbol interference coding of said original audio signal representation;

a digital-to-analog converter generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from said audio ~~source~~ <u>player</u> virtually free from interference.

12. (Currently Amended) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be <u>directly</u> communicable with a mobile digital audio transmitter, said

wireless digital audio receiver comprising:

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator configured for independent code division multiple access communication operation;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio player virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

13. (New) A wireless digital audio headphone for receipt of a unique user code and a digital audio music representation signal in the form of a packet, said wireless digital audio headphone comprising:

a mobile digital audio receiver configured for direct digital wireless communication with a mobile digital audio transmitter;

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

a decoder operative to receive and apply coding to reduce intersymbol interference of said audio representation signal respective to said headphone and said mobile digital audio transmitter; and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal; and a module adapted to reproduce said generated audio output.

14. (New) A mobile wireless digital audio receiver, configured to receive a unique user code and a original audio signal representation in the form of packets, said unique user code configured to spread the spectrum of said signal and further configured for independent communication operation, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said mobile wireless digital audio receiver comprising:

a decoder operative to receive and apply coding to reduce intersymbol interference of said audio representation signal respective to said mobile wireless digital audio receiver and said mobile digital audio transmitter;

a digital-to-analog converter generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output.

15. (New) A wireless digital audio transmitter operatively coupled to a portable audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver, is mobile, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference respective to mobile said digital audio transmitter coupled to said audio player and said mobile receiver; and

a digital modulator module configured for independent code division multiple access (CDMA) communication operation.

16. (New) A wireless digital audio transmitter operatively coupled to a audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver, is mobile, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference respective to mobile said digital audio transmitter coupled to said audio player and said mobile receiver; and

a digital modulator module configured for independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation;

17. (New) A wireless digital audio transmitter operatively coupled to a portable audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver, is mobile, the unique user code configured to spread the spectrum of said signal and further configured for independent communication operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference respective to mobile said digital audio transmitter coupled to said audio player and said mobile receiver.

18. (New) A wireless digital audio headphone for receipt of a unique user code and a digital audio representation signal in the form of a packet, said wireless digital audio headphone comprising:

a mobile digital audio receiver configured for direct digital wireless communication with a mobile digital audio transmitter;

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

a decoder operative to receive and apply coding to reduce intersymbol interference of said audio representation signal respective to said headphone and said mobile digital audio transmitter; and

a digital-to-analog converter generating an audio output of said digital audio representation signal; and a module adapted to reproduce said generated audio output.

WIRELESS DIGITAL AUDIO MUSIC SYSTEM

This continuation application claims the benefit of U.S. Patent Application No. 12/570,343, which was a continuation application ~~claimed~~ claiming the benefit of U.S. Patent Application Serial No. 12/144,729 filed July 12, 2008, now U.S. Patent No. 7,684,885, which was a continuation ~~which claimed~~ claiming benefit of U.S. Patent Application Serial No. 10/648,012 filed August 26, 2003, now U.S. Patent No. 7,412,294, which was a continuation-in-part ~~claimed~~ claiming benefit from U.S. Patent Application Serial No. 10/027,391, filed December 21, 2001, for "Wireless Digital Audio System," published under US 2003/0118196 A1 on June 26, 2003, now abandoned, ~~both of which are incorporated herein in their entirety by reference~~ the disclosures of which are incorporated herein in their entireties by reference.

BACKGROUND OF THE INVENTION

[0001] This invention relates to audio player devices and more particularly to systems that include headphone listening devices. The new audio system uses an existing headphone jack (i.e., this is the standard analog headphone jack that connects to wired headphones) of a music audio player (i.e., portable CD player, portable cassette player, portable A.M./F.M. radio, laptop/desktop computer, portable MP3 player, and the like) to connect a battery powered transmitter for wireless transmission of a signal to a set of battery powered receiving headphones.

[0002] Use of audio headphones with audio player devices such as portable CD players, portable cassette players, portable A.M./F.M. radios, laptop/desktop computers, portable MP3 players and the like have been in use for many years. These systems incorporate an audio source having an analog headphone jack to which headphones may be connected by wire.

[0003] There are also known wireless headphones that may receive A.M. and F.M. radio transmissions. However, they do not allow use of a simple plug in (i.e., plug in to the existing analog audio headphone jack) battery powered transmitter for connection to any music audio player device jack, such as the above mentioned music audio player devices, for coded wireless transmission and reception by headphones of audio music for private listening without interference where multiple users occupying the same space are operating wireless transmission devices. Existing audio systems make use of electrical wire connections between the audio source and the headphones to accomplish private listening to multiple users.

[0004] There is a need for a battery powered simple connection system for existing music audio player devices (i.e., the previously mentioned music devices), to allow coded digital wireless transmission (using a battery powered transmitter) to a headphone receiver (using a battery powered receiver headphones) that accomplishes private listening to multiple users occupying the same space without the use of wires.

SUMMARY OF THE INVENTION

[0005] The present invention is generally directed to a wireless digital audio system for coded digital transmission of an audio signal from any audio player with an analog headphone jack to a receiver headphone located away from the audio player. Fuzzy logic technology may be utilized by the system to enhance bit detection. A battery-powered digital transmitter may include a headphone plug in communication with any suitable music audio source. For reception, a battery-powered headphone receiver may use embedded fuzzy logic to enhance user code bit detection. Fuzzy logic detection may be used to enhance user code bit detection during decoding of the transmitted audio signal. The wireless digital audio music system provides private listening without interference from other users or wireless devices and without the use of conventional cable connections.

[0006] These and other features, aspects and advantages of the present invention will become better understood with reference to the following drawings, description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Some aspects of the present invention are generally shown by way of reference to the accompanying drawings in which:

Figure 1 schematically illustrates a wireless digital audio system in accordance with the present invention;

Figure 2 is a block diagram of an audio transmitter portion of the wireless digital audio system of Fig. 1.;

Figure 3 is a block diagram of an audio receiver portion of the wireless digital audio system of Fig. 1; and

Figure 4 is an exemplary graph showing the utilization of an embedded fuzzy logic coding algorithm according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0008] The following detailed description is the best currently contemplated modes for carrying out the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention.

[0009] Referring to Figures 1 through 3, a wireless digital audio music system 10 may include a battery powered transmitter 20 connected to a portable music audio player or music audio source 80. The battery powered wireless digital audio music transmitter 20 utilizes an analog to digital converter or ADC 32 and may be connected to the music audio source 80 analog headphone jack 82 using a headphone plug 22. The battery powered transmitter 20 may have a transmitting antenna 24 that may be omni-directional for transmitting a spread spectrum modulated signal to a receiving antenna 52 of a battery powered headphone receiver 50. The battery powered receiver 50 may have headphone speakers 75 in headphones 55 for listening to the spread spectrum demodulated and decoded communication signal. In the headphone receiver 50, fuzzy logic detection may be used to optimize reception of the received user code. The transmitter 20 may digitize the audio signal using ADC 32. The digitized signal may be processed downstream by an encoder 36. After digital conversion, the digital signal may be processed by a digital low pass filter. To reduce the effects of channel noise, the battery powered transmitter 20 may use a channel encoder 38. A modulator 42 modulates the digital signal to be transmitted. For further noise immunity, a spread spectrum DPSK (differential phase shift key) transmitter or module 48, is utilized. The battery powered transmitter 20 may contain a code generator 44 that may be used to create a unique user code. The unique user code generated is specifically associated with one wireless digital audio system user, and it is the only code recognized by the battery powered headphone receiver 50 operated by a particular user. The radio frequency (RF) spectrum utilized (as taken from the Industrial, Scientific and Medical (ISM) band) may be approximately 2.4 GHz. The power radiated by the transmitter adheres to the ISM standard.

[0010] Particularly, the received spread spectrum signal may be communicated to a 2.4 GHz direct conversion receiver or module 56. Referring to Figures 1 through 4, the spread spectrum modulated signal from transmit antenna 24 may be received by receiving antenna 52 and then processed by spread spectrum direct conversion receiver or module 56 with a receiver code generator 60 that contains the same transmitted unique code, in the battery powered receiver 50 headphones. The transmitted signal from antenna 24 may be received by receiving antenna 52 and communicated to a wideband bandpass filter (BPF). The battery powered receiver 50 may utilize embedded fuzzy logic 61 (as graphically depicted in Figures 1, 4) to optimize the bit detection of the received user code. The down converted output signal of direct conversion receiver or module 56 may be summed by receiver summing element 58 with a receiver code generator 60 signal. The receiver code generator 60 may contain the same unique wireless transmission of a signal code word that was transmitted by audio transmitter 20 specific to a particular user. Other code words from wireless digital audio systems 10 may appear as noise to audio receiver 50. This may also be true for other device transmitted wireless signals operating in the wireless digital audio spectrum of digital audio system 10. This code division multiple access (CDMA) may be used to provide each user independent audible enjoyment. The resulting summed digital signal from receiving summary element 58 and direct conversion receiver or module 56 may be processed by a 64-Ary demodulator 62 to demodulate the signal elements modulated in the audio transmitter 20. A block de-interleaver 64 may then decode the bits of the digital signal encoded in the block interleaver 40. Following such, a Viterbi decoder 66 may be used to decode the bits encoded by the channel encoder 38 in audio transmitter 20. A source decoder 68 may further decode the coding applied by encoder 36.

[0011] Each receiver headphone 50 user may be able to listen (privately) to high fidelity audio music, using any of the audio devices listed previously, without the use of wires, and without interference from any other receiver headphone 50 user, even when operated within a shared space. The fuzzy logic detection technique 61 used in the receiver 50 could provide greater user separation through optimizing code division in the headphone receiver.

[0012] The battery powered transmitter 20 sends the audio music information to the battery powered receiver 50 in digital packet format. These packets may flow to create a digital bit stream rate less than or equal to 1.0 Mbps.

[0013] The user code bits in each packet may be received and detected by a fuzzy logic detection sub-system 61 (as an option) embedded in the headphone receiver 50 to optimize audio receiver performance. For each consecutive packet received, the fuzzy logic detection sub-system 61 may compute a conditional density with respect to the context and fuzziness of the user code vector, i.e., the received code bits in each packet. Fuzziness may describe the ambiguity of the high (1)/low (0 or -1) event in the received user code within the packet. The fuzzy logic detection sub-system 61 may measure the degree to which a high/low bit occurs in the user code vector, which produces a low probability of bit error in the presence of noise. The fuzzy logic detection sub-system 61 may use a set of if-then rules to map the user code bit inputs to validation outputs. These rules may be developed as if-then statements.

[0014] Fuzzy logic detection sub-system 61 in battery-powered headphone receiver 50 utilizes the if-then fuzzy set to map the received user code bits into two values: a low (0 or -1) and a high (1). Thus, as the user code bits are received, the "if" rules map the signal bit energy to the fuzzy set low value to some degree and to the fuzzy set high value to some degree. Figure 4 graphically shows that x-value -1 equals the maximum low bit energy representation and x-value 1 equals the maximum high bit energy representation. Due to additive noise, the user code bit energy may have some membership to a low and high as represented in Figure 4. The if-part fuzzy set may determine if each bit in the user code, for every received packet, has a greater membership to a high bit representation or a low bit representation. The more a user code bit energy fits into the high or low representation, the closer its subsethood, i.e., a measure of the membership degree to which a set may be a subset of another set, may be to one.

[0015] The if-then rule parts that make up the fuzzy logic detection sub-system 61 must be followed by a defuzzifying operation. This operation reduces the aforementioned fuzzy set to a bit energy representation (i.e., -1 or 1) that is received by the transmitted packet. Fuzzy logic detection sub-system 61 may be used in battery-powered headphone receiver 50 to enhance overall system performance.

[0016] The next step may process the digital signal to return the signal to analog or base band format for use in powering speaker(s) 75. A digital-to-analog converter 70 (DAC) may be used to transform the digital signal to an analog audio signal. An analog low pass filter 72 may be used to filter the analog audio music signal to pass a signal in the approximate 20 Hz to 20 kHz frequency range and filter other frequencies. The analog audio music signal may then be processed by a power amplifier 74 that may be optimized for powering headphone speakers 75 to provide a high quality, low distortion audio music for audible enjoyment by a user wearing headphones 55. A person skilled in the art would appreciate that some of the embodiments described hereinabove are merely illustrative of the general principles of the present invention. Other modifications or variations may be employed that are within the scope of the invention. Thus, by way of example, but not of limitation, alternative configurations may be utilized in accordance with the teachings herein. Accordingly, the drawings and description are illustrative and not meant to be a limitation thereof.

[0017] Moreover, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Thus, it is intended that the invention cover all embodiments and variations thereof as long as such embodiments and variations come within the scope of the appended claims and their equivalents.

ABSTRACT

[0018] A wireless digital audio system includes a portable audio source with a digital audio transmitter operatively coupled thereto and an audio receiver operatively coupled to a headphone set. The audio receiver is configured for digital wireless communication with the audio transmitter. The digital audio receiver utilizes fuzzy logic to optimize digital signal processing. Each of the digital audio transmitter and receiver is configured for code division multiple access (CDMA) communication. The wireless digital audio system allows private audio enjoyment without interference from other users of independent wireless digital transmitters and receivers sharing the same space.

Electronic Patent Application Fee Transmittal

Application Number:	12940747
Filing Date:	05-Nov-2010
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Filer:	Megan Elizabeth Lyman
Attorney Docket Number:	1028.5

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Independent claims in excess of 3	2201	6	110	660
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	2801	1	405	405
	Total in USD ($)			**1065**

Electronic Acknowledgement Receipt

EFS ID:	10647814
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	02-AUG-2011
Filing Date:	05-NOV-2010
Time Stamp:	14:22:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1065
RAM confirmation Number	669
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Request for Continued Examination (RCE)	RCEform.pdf	797428 06e4ca492c1f04edbfde9404633969265e8496ab	no	3
Warnings:					
Information:					
2	Amendment Submitted/Entered with Filing of CPA/RCE	ResponseRCE.pdf	192100 2492c5033516568d75e274579ef0284b0d84fd7c	no	15
Warnings:					
Information:					
3	Amendment Submitted/Entered with Filing of CPA/RCE	ClaimsDraft080111.pdf	77717 821bfcc692ac0554c74e2fed525a887d244ea8c7	no	11
Warnings:					
Information:					
4	Amendment Submitted/Entered with Filing of CPA/RCE	SubmitedSpecRCE.pdf	72904 9b17915e899c7ac593dea6ba119302a0622d8a85	no	7
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	31979 a28259cbc5097084f0a5ca58fb80b12128a4dcaf	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1172128		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	
12/940,747	11/05/2010	☐ To be Mailed

APPLICATION AS FILED – PART I

SMALL ENTITY ☒ OR OTHER THAN SMALL ENTITY

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)		OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
			TOTAL			TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

SMALL ENTITY OR OTHER THAN SMALL ENTITY

AMENDMENT

08/02/2011	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 18	Minus	** 20	= 0	X $26 =	0	OR	X $ =	
Independent (37 CFR 1.16(h))	* 18	Minus	***12	= 6	X $110 =	660	OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE	**660**	OR	TOTAL ADD'L FEE	

AMENDMENT

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/MARTHA NEWMAN/

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination
	12/940,747	WOOLFORK, C. EARL

Document Code - DISQ	Internal Document – DO NOT MAIL

TERMINAL DISCLAIMER	☐ APPROVED	☒ DISAPPROVED
Date Filed : 06/21/11	**This patent is subject to a Terminal Disclaimer**	

Approved/Disapproved by:

Wrong case cited in Td it should be patents 7,865,258; 7684,885; 7,412,294.

Angie Walker

U.S. Patent and Trademark Office

PTO/SB/26 (08-11)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	Docket Number (Optional) 1028.5

In re Application of: C. Earl Woolfork

Application No.: 12/940,747

Filed: 11/05/2010

For: Wireless Digital Audio System

The owner*, C. Earl Woolfork, of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of **prior patent** No. 7,865,258 ** as the term of said **prior patent** is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

expires for failure to pay a maintenance fee;
is held unenforceable;
is found invalid by a court of competent jurisdiction;
is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. ☐ For submissions on behalf of a business/organization (e.g., corporation, partnership, university, government agency, etc.), the undersigned is empowered to act on behalf of the business/organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. ☑ The undersigned is an attorney or agent of record. Reg. No. 57054

** 7,684,885; and 7,412, 294 /Megan Lyman/ — 10/06/2011
Signature — Date

Megan Lyman
Typed or printed name

919 341-4023
Telephone Number

☐ Terminal disclaimer fee under 37 CFR 1.20(d) included.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner). Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	11113973
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	05-OCT-2011
Filing Date:	05-NOV-2010
Time Stamp:	11:44:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer Filed	TerminalDisclaimer1011.pdf	374321 8aaefc7c416043b505bedc4e14cad034d254c1a0	no	2

Warnings:

Information:

Total Files Size (in bytes):	374321

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination
	12/940,747	WOOLFORK, C. EARL

Document Code - DISQ	Internal Document – DO NOT MAIL

TERMINAL DISCLAIMER	☒ APPROVED	☐ DISAPPROVED
Date Filed : 10/5/11	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:

Janice Ford

U.S. Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/940,747	11/05/2010	C. Earl Woolfork	1028.5	8175

68533 7590 11/14/2011

MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

EXAMINER	
FLANDERS, ANDREW C	

ART UNIT	PAPER NUMBER
2614	

NOTIFICATION DATE	DELIVERY MODE
11/14/2011	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

MELYMAN@LYMANPATENTS.COM

Office Action Summary	Application No.	Applicant(s)	
	12/940,747	WOOLFORK, C. EARL	
	Examiner	**Art Unit**	
	Andrew C. Flanders	2614	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _02 August 2011_.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) _1-18_ is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) _1-18_ is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on _05 November 2010_ is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

12)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

Applicant's arguments filed 02 August 2011 have been fully considered but they are not persuasive.

Applicant states:

> "The present invention was first presented to the Patent Office in 2001 and must be evaluated at that time point, well before wireless audio transmission was commonplace in our current digital society."

Examiner respectfully disagrees that at this time, wireless digital audio transmission was not commonplace in society. Lavelle (U.S. 678,892) filed 27 October 2000 is one of many issued patents that teaches of wireless digital communication to a headset.

Regarding Applicant's allegations under the section titled "The Intersymbol Interference Problem" Applicant provides a lengthy discussion as to how Applicant's invention differs from the prior art in correction ISI. However, this lengthy discussion about how correction is made in motion, and is quite different form the prior art is irrelevant in light of the claim language. The claim only provides for a brief mention of ISI reduction, a very simple limitation. For example, Claim 2 includes "a decoder operative to decoded applied reduced intersymbol interference coding." This claim is a rather vague and broad application of ISI reduction. No where is there a limitation discussing the attempted reduction of an in-motion transmitter communicating a high symbol rate (or the other details provided under the discussion section). In fact, Applicant's specification is just as brief which is likely why this limitation is so vague and broad and the level of detail in the arguments much greater. The specification and Claims only provide a brief statement to reduction of intersymbol interference. There is no discussion present in the specification regarding the problem of ISI in static and mobile systems (as presented in the arguments) and any inferences drawn into the claims must be considered in light of this.

Applicant's arguments, while perhaps persuasive (though not necessarily agreed to by the Examiner), are irrelevant in light of what is actually claimed.

Applicant further alleges:

> It is important to note that Lindemann never discusses ISI. Failure to identify the problem of ISI clearly demonstrates that this prior art, neither alone nor in combination can even suggest a solution to the present invention. Furthermore, Roberts (6,418,558), which is also cited in this rejection, does not disclose the reduction of ISI in a mobile transmitter and mobile receiver system. Roberts cannot teach or suggest how the unique problem of ISI in a mobile system can be attenuated. One of ordinary skill would have no motivation to look to these prior art to solve the ISI problem in a mobile system as has been accomplished by the present invention.

Examiner respectfully disagrees. Roberts clearly shows that in a Reed-Solomon encoder/decoder, ISI is reduced (col. 5 lines 65 – 67 and col. 6 lines 1 – 13). The prior art need not solve the particular problems with reducing ISI as alleged by Applicant as they are not explicitly claimed nor disclosed in the specification.

Applicant further alleges:

> The FRJ relies upon the hypothetical scenario that Lindemann teaches reduction of ISI within a mobile transmitter/mobile receiver system (page 5 of the FRJ states: "Lindemann also includes that the transmission stream is created using a Reed-Solomon encoding and interleaver and a corresponding decoder in the decoder. Applying these teachings to the encoding of the combination discloses:.., reduced intersymbol interference coding"). Reed-Solomon encoding and interleaving may be designed to address burst errors, but Lindemann does not teach Reed-Solomon encoding and interleaving for the purpose of reducing ISI in a mobile transmitter/mobile receiver system. Lindemann is silent about both mobility and ISI.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Applicant attacks the Lindemann reference in this section ignoring its combination with the other pieces of prior art and thus ignoring its mobility and ISI.

Applicant further alleges:

> In fact, paragraph 0050 of Lindemann 2004/0223622, states: "The interleaver function performed by the Reed Solomon Encoder and Interleaver with Frame Marker Insertion 407 protects against burst errors by scrambling adjacent bits across multiple Reed Solomon encoding blocks. This error protection system is a called a concatenated encoder with interleaving." (Emphasis added). To be clear, "Reed-Solomon (RS) are nonbinary codes which are capable of correcting errors which appear in bursts and are commonly used in concatenated coding systems" (reference underlined section of Exhibit V text "Wireless Communications

> Principles & Practice" by T. S. Rappaport). Bursts are the result of an additional unintended transmission source (also known as a jammer because it may unintentionally jam communications) as described in underlined section of Exhibit VI text "Introduction to Spread Spectrum Communications" by R.L. Peterson, R.E. Ziemer and D.E. Borth: "Jamming strategies which concentrate jamming resources on some fraction of the transmitted symbols using either pulsed or partial band techniques cause demodulator output errors to occur in bursts."
>
> To clarify, "FIGURE 10-1. Covert communications process" and underlined section of Exhibit VII text "Introduction to Spread Spectrum Communications" by R.L. Peterson, R.E. Ziemer, and D.E. Borth states: "In any communications operation, there may be several ingredients or "players," as illustrated in Figure 10-1. First, there are the intended communicators, which make use of the transmitter and receiver shown in the figure. Second, there may be unintentional sources or jammers." Consequently, "These jammers produce bursts of errors .... To counter this difficulty, an interleaver is placed between the encoder and the modulator and a de-interleaver is placed between the demodulator and the decoder" (reference underlined section of Exhibit VIII text "Introduction to Spread Spectrum Communications" by R.L. Peterson, R.E. Ziemer, and D.E. Borth).

Again these problems alleged by Applicant are not present in the specification or claims. Only a vague and borad recitation of reducing ISI, which, Examiner submits is notoriously well known in the field of CDMA communication as shown by Roberts. The prior art need not solve the particular problems with reducing ISI as alleged by Applicant.

Applicant further alleges:

> Lindemann does not teach a method of"Reed Solomon encoding/decoding to reduce ISI" as stated on page 6 of the FRJ. The FRJ misinterprets ISI (defined previously above) as interference radiating from an outside transmission source (burst errors). Moreover, Roberts is silent about reducing ISI within a wireless mobile transmitter/mobile receiver system. The rejection relies on a nonenabled hypothetical scenario, because neither Lindemann nor Roberts suggest a method of

reducing ISI in a wireless mobile transmitter/mobile receiver system. The combination of Altstatt, Li, Lindemann (with Roberts) fails to teach or suggest the claim language "a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation."

A further review of Roberts shows that there is not disclosure of Reed- Solomon/Interleaving to reduce ISI (see col. 5 lns. 62 - 67 and col. 6 lns. 1 - 3: "The clock signals for generating the carriers and the symbols representing the transmitted data may be locked to each other or generated from the same source, to reduce intersymbol interference significantly," "Another technique for reducing intersymbol interference is the transmission of each symbol with more than 360 degrees of phase in one cycle of its carrier, in order to allow some leeway in tracking the phase of a channel carrier in a receiving system." And see col. 45 lns. 9 - 14: "Again, a phase discontinuities exist at the ends of the total 405 degree phase degrees of this wave. In fact, this characteristic gives the excess-phase improvement an advantage over its primary function of providing a guard band for the symbol decoder, for reducing intersymbol interference," And see col. 46 lns. 10 - 19: "In the present system, however, it has been found that even very small frequency drifts between the 8 kHz symbol or flame clock and the frequencies of the tones upon which they ride can produce significant intersymbol interference and distortion at the receiving end. Such drifts tend to destroy the orthogonality of the channel signals produced by inverse FFT 140 in FIG. 21. The present system also, however, provides a simple, inexpensive way to overcome this problem. FIG. 51 shows a portion 4200 of the HDT clock/sync logic in CTSU 54, FIG. 3.")

In each of the above methods to reduce ISI presented by Roberts, none of them disclose the use of Reed-Solomon/Interleaving as a solution to suppress ISI. In fact, Roberts discloses Reed-Solomon for error detection/correction (as previously described above and see col. 6 lns. 5 - 12: "An embodiment is shown which handles both unencoded parity-type detection/correction and more multiple types of more powerful methods, such as Reed-Solomon encoding, in a transparent, real-time fashion, by packing the data words differently for each case. Moreover, the processor loading involved in these error-correction techniques can be spread out in time, so that not all channels need to be handled at the same time.") Page 5 of the FRJ incorrectly states "configure Reed Solomon decoding/interleaving to reduce ISI as is shown by Roberts 6,418,558," because Roberts does not disclose nor teach such a configuration.

Examiner respectfully disagrees. Roberts states:

> Another technique **for reducing intersymbol interference** is the transmission of each symbol with more than 360.degree. of phase in one cycle of its carrier, in order to allow some leeway in tracking the phase of a channel carrier in a receiving modem. **Some applications** demand more or different error detection and correction capability than others. An embodiment is shown which handles both unencoded parity-type detection/correction and more multiple types of more powerful methods, **such as Reed-Solomon encoding**…"

It is clear that reducing ISI in Reed-Solomon encoding is desirable, and from this paragraph known. Thus applying it to Lindemann would follow logically.

Applicant further alleges:

> It is clear that the degree of ISI becomes more severe in a mobile environment (i.e., a mobile transmitter communicating with a mobile receiver) given the following: a fading channel exhibits ISI in digital communications (reference underlined section of Exhibit IX text "Introduction to Spread Spectrum Communications" by R. Peterson, R. Ziemer, and D. Borth and referring to the underlined section of Exhibit X text "Spread Spectrum Systems With Commercial Applications," Third Edition, by Robert C. Dixon, "The rate at which fades occur is a function of the rate at which the signal propagation paths change. Infixed-position systems, the fading rate is" determined by how fast the environment changes. ") Lindemann (who does not address ISI) teaches a fixed-position system (i.e., immobile digital transmitter and immobile digital speaker receiver) and Roberts is silent as to mobile systems. Given the fact that the rate at which fades occur (fading relative to ISI) is a function of the rate at which the signal propagation paths change, and that both the transmitter and receiver in the present invention are mobile, it should be clear that the propagation paths, or multipath in the present invention, create a type of ISI that was not considered in Roberts.
>
> The teachings ofAltstatt, Li, Lindemann and Roberts do not combine to obviate the present invention when taken as a whole. Referencing the underlined section of Exhibit XI text "Spread Spectrum Systems with Commercial Applications," Third Edition, by Robert C. Dixon: "One cannot say, however, that using a spread spectrum signal (e.g., CDMA) does away with all multipath effects." Emphasis added. One may consider Bluetooth as an example of the Altstatt, Li, and Lindemann teachings based on the hypothetical scenario presented in the FRJ on pages 4 and 5. ("It would have been obvious to one of ordinary skill in the

> art at the time the invention was made to apply the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Alstatt. Li clearly teaches the device for use in portable implementations such as music and headphone audio reproductions." And on page 5 "reducing intersymbol interference for CDMA transmission is notoriously well known in the art.")

Again these problems alleged by Applicant are not present in the specification or claims. Only a vague and borad recitation of reducing ISI, which, Examiner submits is notoriously well known in the field of CDMA communication as shown by Roberts. The prior art need not solve the particular problems with reducing ISI as alleged by Applicant.

Applicant further alleges:

> At the present time, Bluetooth is known "for use in portable implementations such as music and headphone audio reproductions" (Reference page 4 of the FRJ). As stated in the underlined section of Exhibit XII, Bluetooth Specification Version 1.0B, page 41 Bluetooth is a short-range radio link intended to replace cable(s) connecting portable... electronic devices." (submitted to the USPTO on 08/04/2010 by way of the Information Disclosure Statement). The FRJ states that "reducing intersymbol interference for CDMA transmission is notoriously well known in the art," and the combination of Altstatt, Li and Lindemann (including Roberts) should lend a reduced ISI solution (for a portable mobile wireless system) that is "obvious to one of ordinary skill in the art."
>
> Respectfully, the following application note provides evidence this rejection is in error. The application note (submitted to the USPTO on 04/14/201 lby way of the Information Disclosure Statement) is "Motorola's Bluetooth Solution to Interference Rejection and Coexistence with 802.11" and it states on page 1, section 2 (also see page 7, section 4) "The Bluetooth channel has unrecoverable Inter Symbol Interference (ISI)." A copy of this statement is conveniently located and underlined in Exhibit XIII. It is important to note that Motorola's application note was published in December of 2001, while the present invention was disclosed to Mr. Dennis Beech (the patent prosecution attorney at that time) in June of 2001 (Please see Exhibit XIV). The application note is, at least, evidence

> that reducing ISI within a system that contains a mobile transmitter and a mobile receiver is not "obvious to one of ordinary skill in the art" nor is it "notoriously well known in the art."
>
> The ISI within Bluetooth, at that time, would not be in an "unrecoverable" state if the solution was "obvious to one of ordinary skill in the art" or "notoriously well known in the art." The Bluetooth specification referenced here (version 1.0B) was published in December of 1999 and it was not until December of 2001 when Motorola proposed a solution to reduce ISI in Bluetooth's system. Again it is important to note that the solution for reducing ISI in a wireless mobile digital audio transmitter/mobile digital audio receiver system was part of the present invention prior to the Motorola application note.

Examiner respectfully disagrees. These arguments are irrelevant in light of the prior art used in the rejection of the claims. The references relied upon are not reliant upon bluetooth technology and thus, any argument as to why they should fail due to the shortcomings of Bluetooth, also should fail.

In response to the arguments under the section titled Digital Wireless Communications and CDMA, Examiner points to Lavelle (U.S> 6,678,892). Lavelle discloses the CDMA communication in a mobile transmitted/receiver configuration, and on a smaller scale. Thus, the Examiner submits that it is clear the teachings in Li can be applied on the same level as they are directed to CDMA communication as well (i.e. to Alstatt).

Applicant further states under the section titled The Direct Conversion Receiver:

> Based on the above disclosures, it is clear that both intended and unintended spread spectrum packet signals can appear at the receiver, but only the packet with the correct bit sequence is captured by the DCR in the present invention...

> Of these data delivery types available, the Altstatt/Li combination does not disclose or suggest a digital packet format for audio information coming from an audio player/source as is included in the claim language and does not obviate the invention.

Examiner submits this is exactly what the CDMA communication in the present combination does, i.e. listens to all, but receives only those meant for the proper devcie.

Applicant further alleges:

> The G.729 is a "compression algorithm for voice", "high quality audio cannot be transported reliably with this codec" as stated in http://en.wikipedia.org/wiki/G.729. Paragraph 0018 of application 10/027,391 discloses high quality audio. The digital packet and audio player/source disclosure is seen in Claims 2 - 12 of the present invention.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Applicant attacks the citation of G.729 which is present to show that packetized audio is present and ignores the nature of the combination to allow for high quality music transmission (i.e. Alstatt).

Applicant further alleges:

> Regarding Claims 1 - 12 of the present invention, the Altstatt/Li combination does not disclose a direct conversion receiver (DCR) as stated on pages 4 and 7 in the FRJ where Li's elements "(201)" and "(202)" are referenced. There is no teaching or suggestion that Li's items 201 and 202 ("wideband CDMA demodulator") constitute a DCR. The

> DCR disclosed in the present invention, among other things, performs direct down conversion from radio frequency (RF) to baseband (or very near baseband), thus, omitting intermediate frequency (IF) down conversion components that are often used. The invention utilizes the DCR for, among other things, down conversion from RF-to- baseband (or very near baseband), eliminating unnecessary IF components, which reduces the size and power consumption of the module. The Altstatt/Li combination does not teach a DCR nor does it suggest the use of a DCR within the invention. Because one of ordinary skill would not be motivated in any way by Alstatt and Li to create the present invention with any reasonable expectation of success, the obviousness rejection should be removed.
>
> In addition, the use of the DCR in the invention, suppresses aliasing noise effects by use of the anti-aliasing filters (typically low pass filters or some version thereof) located within the DCR, thus, aiding to preserve the fidelity of the transmitted high quality audio signal. The Altstatt/Li combination does not teach or suggest a DCR, thus, cannot realize the benefits of the claim language % direct conversion module configured to capture the packet with the correct bit sequence embedded in the received spread spectrum signal" (see Claims 1 - 12). Neither Li, Altstatt, nor Lindemann (Lindemann discloses in paragraph 0057 "In the RF receiver embodiment of FIG. 3, ..., The RF Downconverter 302 modulates the RF signal, using a sinusoid generated by the RF VCO 310, down to IF frequency. The IF signal is further down modulated by the IF Demodulator 303. The output of the IF Demodulator is a complex signal consisting of I and Q--real, imaginary--running at the Chip Rate") alone or in any combination of the three teach, suggest, or disclose the DCR of the present invention. One of ordinary skill would not be motivated or anticipate any success by reading the cited prior art to create a system containing a DCR to solve reception problems solved in the present invention. Claims 1- 12 should be in allowance on the presence of the DCR alone.

Examiner respectfully disagrees and submits that the cited portions of Li meet the DCR as claimed. The elements argued by Applicant are not presently claimed and thus are irrelevant (i.e. conversion from RF to baseband, thus omitting intermediate frequency down conversion components).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1 – 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Altstatt (U.S. Patent 5,771,441) in view of Li (U.S. Patent 6,781,977) and in further view of Lindemann (U.S. Patent Application Publication 2004/0223622).

Regarding **Claim 1**, Altstatt discloses:

A wireless audio headphone (Fig. 1) comprising:

a portable audio headphone receiver (20) configured to receive an original audio signal (communication from 14 to 41) said portable digital audio headphone receiver comprising:

Altstatt fails to explicitly disclose:

the system as a digital system,

the receiver configured to receive a unique user code bit sequence and a original audio signal representation in the form of packets,

a direct conversion module configured to capture said packets embedded in the received spread spectrum signal;

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode reduced intersymbol interference coding of original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized.

However, digital CDMA transmissions of audio sources to headphones in devices was notoriously well known in the art. For Example, Li teaches a system providing CDMA communication of digital audio to headphone devices; col. 3 lines 20 – 33.

Replacing the FM transmitter/receiver implementation of Alstatt to use the digital CDMA communication discloses:

the system as a digital system (i.e. digital audio; col. 2 lines 48 – 51); also A/D conversion; col. 3 line 7);

the receiver configured to receive a unique user code bit sequence (inherent in CDMA communication; see attached definition of CDMA) and a original audio signal representation in the form of packets, (packet form met by the G.729 encoding implementation, see col. 4 lines 25 - 33),

a direct conversion module configured to capture said packets embedded in the received spread spectrum signal (201 and 202 to prepare for despreading);

a digital demodulator configured for independent CDMA communication operation (202);

a decoder operative to decode coding of original audio signal representation (206);

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation (D/A portion of 204, signals are input to 204 as digital and then output as analog to post processor-205); and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized (portion 202 of receiving unit 200 that matches the inherent code in CDMA to initiate de-spreading, i.e. each channel in CDMA corresponds to a different random sequence, this sequence must be received and recognized by receiving unit 200 in order for the device to operate).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Alstatt. Li clearly teaches the device for use in portable implementations such as music and headphone audio reproductions. Li also teaches the outputs/inputs as standard audio jacks. Furthermore, doing so would be simple substitution of one known element (i.e. digital CDMA transmitter/receiver) for another (i.e. analog FM transmitter) to obtain predictable results (i.e. Alstatt w/ a digital transmitter). Additionally, Li discloses a number of advantages of using digital communication in col. 6.

The combination of Altstatt in view of Li fails to explicitly disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation.

However, reducing intersymbol interference in audio coding for CDMA transmission is notoriously well known in the art.

Lindemann discloses a device that transmits digital audio between a stereo system and a speaker using CDMA. Lindemann also includes that the transmission stream is created using a Reed-Solomon encoding and interleaver and a corresponding decoder in the decoder; Figs. 6 and 8.

Applying these teachings to the encoding of the combination discloses:

disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation (Fig. 8 element 802 which is a Reed Solomon decoder and Interleaver; it is known in the art to configure Reed Solomon decoding/interleaving to reduce ISI as is shown by Roberts 6,418,558. Reducing ISI is a desirable feature to any digital transmission).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the reed Solomon encoder/decoder in the combinations channel encoding. Doing so would have been nothing more than applying a known technique to a known device ready for improvement to yield predictable results as:

1) the prior art contained a base device in the combination's wireless CDMA headphone set that, when including intersymbol interference reduction, can be seen as in improvement;

2) the prior art contained a known technique (i.e. Reed Solomon encoding/decoding to reduce ISI) in a comparable device in Lindemann (i.e. wireless audio transmission); And

3) applying the teachings of Lindemann to the combination of Altstatt in view of Li would have been predictable as both operate on wireless CDMA communications of audio.

Regarding **Claim 2**, Altstatt discloses:

A wireless audio headphone for receipt of an audio music representation signal (Fig. 1), said wireless digital audio headphone comprising:

a audio receiver, capable of mobile operation, configured for direct wireless communication with a mobile audio transmitter (20 of Fig. 1).

Altstatt fails to explicitly disclose:

the system as a digital system,

the headphone for receipt of a unique user code and a digital audio music representation signal in the form of a packet;

a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

a decoder operative to decode the applied reduced intersymbol interference coding of said audio music representation signal; and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence is being recognized.

However, digital CDMA transmissions of audio sources to headphones in devices was notoriously well known in the art. For Example, Li teaches a system providing CDMA communication of digital audio to headphone devices; col. 3 lines 20 – 33.

Replacing the FM transmitter/receiver implementation of Alstatt to use the digital CDMA communication discloses:

the system as a digital system (i.e. digital audio; col. 2 lines 48 – 51); also A/D conversion; col. 3 line 7);

the headphone for receipt of a unique user code (inherent in CDMA communication; see attached definition of CDMA) and a digital audio music representation signal in the form of a packet (packet form met by the G.729 encoding implementation, see col. 4 lines 25 – 33; also see the discussion of sending the entire signal using frames; col 3 lines 9 – 11);

a direct conversion module configured to capture packets embedded in the received spread spectrum signal (201 and 202 to prepare for despreading), the captured packets corresponding to the unique user code (frames as shown above receiving the specific random sequence to the particular channel; see definition of CDMA);

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation (202);

a decoder operative to decode the coding of said audio music representation signal (204); and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal (D/A portion of 204, signals are input to 204 as digital and then output as analog to post processor-205); and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized (portion 202 of receiving unit 200 that matches the inherent code in CDMA to initiate de-spreading, i.e. each channel in CDMA corresponds to a different random sequence, this sequence must be received and recognized by receiving unit 200 in order for the device to operate).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Alstatt. Li clearly teaches the device for use in portable implementations such as music and headphone audio reproductions. Li also teaches the outputs/inputs as standard audio jacks. Furthermore, doing so would be simple substitution of one known element (i.e. digital CDMA transmitter/receiver) for another (i.e. analog FM transmitter) to obtain predictable results (i.e. Alstatt w/ a digital transmitter). Additionally, Li discloses a number of advantages of using digital communication in col. 6.

The combination of Altstatt in view of Li fails to explicitly disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation.

However, reducing intersymbol interference in audio coding for CDMA transmission is notoriously well known in the art.

Lindemann discloses a device that transmits digital audio between a stereo system and a speaker using CDMA. Lindemann also includes that the transmission stream is created using a Seed-Solomon encoding and interleaver and a corresponding decoder in the decoder; Figs. 6 and 8.

Applying these teachings to the encoding of the combination discloses:

disclose that the decoder is operative to decode reduced intersymbol interference coding of original audio signal representation (Fig. 8 element 802 which is a Reed Solomon decoder and Interleaver; it is known in the art to configure Reed Solomon decoding/interleaving to reduce ISI as is shown by Roberts 6,418,558. Reducing ISI is a desirable feature to any digital transmission).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the reed Solomon encoder/decoder in the combinations channel encoding. Doing so would have been nothing more than applying a known technique to a known device ready for improvement to yield predictable results as:

1) the prior art contained a base device in the combination's wireless CDMA headphone set that, when including intersymbol interference reduction, can be seen as in improvement;

2) the prior art contained a known technique (i.e. Reed Solomon encoding/decoding to reduce ISI) in a comparable device in Lindemann (i.e. wireless audio transmission); And

3) applying the teachings of Lindemann to the combination of Altstatt in view of Li would have been predictable as both operate on wireless CDMA communications of audio.

Regarding **Claim 5**, claim 5 is rejected under the same grounds as stated above. Additionally, the combination fails to disclose the module as a differential phase shift keying (DPSK) module. However, DPSK modulation is notoriously well known to be used in CDMA communication. It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the DPSK modulation to the CDMA implementation of the combination. One would have been motivated to do so to apply a known technique (i.e. DPSK) to a known device (CDMA transmitter) to yield predictable results (i.e. DPSK in CDMA, Li is silent as to the type of modulation used and it would have been provided predictable results to use any number of known and obvious techniques).

Claims 3, 4 and 6 – 18 are rejected under the same grounds stated above as well as the corresponding transmitter disclosed in Fig. 1 that corresponds the each of the modules disclosed in the receiver disclosed in fIg.1 as applied to the receiver claims above. Furhter, it is noted that the source is directly communicable with the mobile receiver as can be seen in Alstatt's communication between 14 and 24.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Andrew C. Flanders whose telephone number is (571)272-7516. The examiner can normally be reached on M-F 8:30 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Curtis Kuntz can be reached on (571) 272-7499. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Andrew C Flanders/
Primary Examiner, Art Unit 2614

Search Notes	Application/Control No. 12940747	Applicant(s)/Patent Under Reexamination WOOLFORK, C. EARL
	Examiner ANDREW C FLANDERS	**Art Unit** 2614

SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES

Search Notes	Date	Examiner
see history attached	5/2/11	acf
reviewed and repeated search history (including class search) of parent application 12/570,343	5/2/11	acf
edan, east and palm inventor search for double patenting	5/2/11	acf
updated	11/3/11	acf

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

	/ANDREW C FLANDERS/ Primary Examiner.Art Unit 2614

Index of Claims	Application/Control No. 12940747	Applicant(s)/Patent Under Reexamination WOOLFORK, C. EARL
	Examiner ANDREW C FLANDERS	Art Unit 2614

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE									
Final	Original	05/02/2011	11/03/2011								
	1	✓	✓								
	2	✓	✓								
	3	✓	✓								
	4	✓	✓								
	5	✓	✓								
	6	✓	✓								
	7	✓	✓								
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	11	✓	✓								
	12	✓	✓								
	13		✓								
	14		✓								
	15		✓								
	16		✓								
	17		✓								
	18		✓								

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L17	1	("6418558").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/11/03 09:41
L18	1	("6678892").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/11/03 09:42
L19	1	l17 and reed same intersymbol	US-PGPUB; USPAT; USOCR	OR	OFF	2011/11/03 10:03
S1	9	FHSS with unique with user	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:30
S2	6	S1 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:45
S3	0	FHSS with unique adj hop	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:46
S4	0	FHSS with each adj user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:46
S5	0	FHSS with individual adj user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:47
S6	0	(FHSS or "frequency hopping spread spectrum") with individual adj user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:47
S7	0	(FHSS or "frequency hopping spread spectrum") near user same unique	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:47
S8	9	(FHSS or "frequency hopping spread spectrum") with user same unique	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:48
S9	17	(FHSS or "frequency hopping spread spectrum") same unique same user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:48
S10	6	S9 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:48
S11	9	(FHSS or "frequency hopping spread spectrum") same multiple adj user!	US-PGPUB; USPAT	OR	OFF	2006/05/03 10:32
S12	91	(FHSS or "frequency hopping spread spectrum") same (pn or "hopping code")	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:50
S13	13	(FHSS or "frequency hopping spread spectrum") with ("hopping code")	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:50
S14	3	S13 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:51
S15	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2006/05/03 11:46
S16	1	("6342844").PN.	US-PGPUB; USPAT	OR	OFF	2006/05/03 11:46
S17	1	("5771441").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:55
S18	10725	"rechargeable battery" and	US-PGPUB;	OR	OFF	2006/08/28

		@ad<"20011220"	USPAT			15:55
S19	376	"rechargeable battery".ti. and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:55
S20	17	("rechargeable battery" and portable).ti. and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S21	3623043	("rechargeable battery" and portable) with mah andd @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S22	0	("rechargeable battery" and portable) with mah and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S23	3623041	("rechargeable battery" and portable) with ma-h andd @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S24	3623041	("rechargeable battery" and portable) with "ma-h" andd @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S25	0	("rechargeable battery" and portable) with "ma-h" and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S26	640693	("rechargeable battery" and portable) with milliamp hours and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S27	18	("rechargeable battery" and portable) and "milliamp hours" and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/31 12:17
S28	29	"5491839"	US-PGPUB; USPAT	OR	OFF	2006/08/30 12:56
S29	1	("5491839").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/30 12:56
S30	1	("5771441").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/30 12:56
S31	1	("6,107,147").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/31 12:17
S32	0	(10/648012).APP.	US-PGPUB; USPAT	OR	OFF	2006/09/25 09:26
S33	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2006/09/25 09:50
S34	422	(455/564.1,412,413).CCLS.	US-PGPUB; USPAT	OR	OFF	2006/09/25 09:50
S35	5294	(375/219,295-297,346,348).CCLS.	US-PGPUB; USPAT	OR	OFF	2006/09/25 10:02
S36	1	("20040223622").PN.	US-PGPUB; USPAT	OR	OFF	2006/09/25 10:04
S37	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2006/09/25 10:05
S38	1	("7,050,419").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:32
S39	1	("20010025358").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:37
S40	2618	(375/341,140,147).CCLS.	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:37
S41	1807	S40 and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:38
S42	8	("2001/0025358").URPN.	USPAT	OR	OFF	2007/03/20 09:51
S43	0	("2002/0025009").URPN.	USPAT	OR	OFF	2007/03/20 09:59
S44	0	("2002/0025009").URPN.	USPAT	OR	OFF	2007/03/20

						10:01
S45	12	("20020159543" | "5434623" | "5867532" | "5973642" | "6243423" | "6327314" | "6339612" | "6459728" | "6477210" | "6480554" | "6654429" | "6671338").PN. OR ("7099413").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:08
S46	74	"band pass" and demodulator and interleaver and "viterbi decoder"	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:08
S47	59	S46 and @ad<"20011220"	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:08
S48	17	("4278978" | "4635063" | "5175558" | "5493307").PN. OR ("6130643").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:15
S49	1	("5175558").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 10:16
S50	13	("4651155" | "4931977").PN. OR ("5175558").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:34
S51	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 11:40
S52	7186	(375/295,146,130,340,316,148).CCLS.	US-PGPUB; USPAT	OR	OFF	2007/03/20 11:41
S53	4473	S52 and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2007/03/20 11:41
S54	1	("20040223622").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:11
S55	5	"reed solomon" with "intersymbol interference"	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:13
S56	30	"reed solomon" same "intersymbol interference"	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:13
S57	21	S56 and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:27
S58	1	("20030045235").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:37
S59	1	("5790595").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:37
S60	2435	((375/262,265,341) or (714/794,795)).CCLS.	US-PGPUB; USPAT	OR	OFF	2007/03/24 09:15
S62	56	"375".clas. and "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2007/03/26 11:04
S64	1	("4970637").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 13:46
S65	755	(audio sound music voice) same (a/d "analog to digital") same (lpf "low pass")	US-PGPUB; USPAT	OR	OFF	2007/03/28 13:46
S66	282	(audio sound music voice) with (a/d "analog to digital") with ((lpf "low pass") and "digital")	US-PGPUB; USPAT	OR	OFF	2007/03/28 13:47
S67	227	(audio sound music voice) with (a/d "analog to digital") with ((lpf "low pass") and "digital") and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:33
S68	34712	"band pass filter" bpf with "direct	US-PGPUB;	OR	OFF	2007/03/28

		conversion receiver"	USPAT			15:33
S69	35	("band pass filter" bpf) with "direct conversion receiver"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:33
S70	8	S69 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:55
S71	1	("20030045235").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:16
S72	1	("20040223622").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:20
S73	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S74	364	"64-ary"	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S75	74	"64-ary" near modulat$4	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S76	46	S75 and @ad<"20011120"	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S77	2	(("4970637") or ("5790595")).PN.	US-PGPUB; USPAT	OR	OFF	2007/07/16 09:58
S78	3	(("4970637") or ("5790595") or ("20040223622")).PN.	US-PGPUB; USPAT	OR	OFF	2007/07/16 09:58
S79	3	("2004/0223622").URPN.	USPAT	OR	OFF	2007/07/16 11:25
S80	1	("5771441").PN.	US-PGPUB; USPAT	OR	OFF	2007/07/16 11:25
S81	60	("2236946" | "2828413" | "2840694" | "3080785" | "3085460" | "3087117" | "3296916" | "3579211" | "3743751" | "3781451" | "3825666" | "3863157" | "3901118" | "3906160" | "4004228" | "4229826" | "4335930" | "4344184" | "4369521" | "4430757" | "4453269" | "4464792" | "4471493" | "4612688" | "4647135" | "4721926" | "4794622" | "4845751" | "4899388" | "4988957" | "5025704" | "5214568").PN. OR ("5771441").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/16 11:26
S82	2	S81 and cdma	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/16 11:26
S83	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2008/05/20 11:41
S84	1	("20020072816").PN.	US-PGPUB; USPAT	OR	OFF	2008/05/20 14:24
S85	22	"fuzzy logic" and modulat$5 and filter and (dpsk "phase shift key")	US-PGPUB; USPAT	OR	OFF	2008/06/06 09:20
S86	0	"455".clas. and "375".clas. and S85	US-PGPUB; USPAT	OR	OFF	2008/06/06 09:21
S87	1	"10100351"	US-PGPUB; USPAT	OR	OFF	2008/06/06 11:49
S88	1	("6,678,892").PN.	US-PGPUB; USPAT	OR	OFF	2008/06/06 12:38
S89	3	("20030021429" | "20030076346" | "6867820").PN.	US-PGPUB; USPAT	OR	OFF	2008/06/06 12:42
S90	13	("4589134" | "4626892" | "5042070" | "5541638" | "5581621" | "5631850" |	US-PGPUB; USPAT;	OR	OFF	2008/06/06 12:43

		"5775939" | "6100936" | "6195438").PN. OR ("6867820").URPN.	USOCR			
S91	2	"10648012"	US-PGPUB; USPAT	OR	OFF	2009/02/14 10:23
S92	1	"12144729"	US-PGPUB; USPAT	OR	OFF	2009/02/14 10:31
S93	1	("5790595").PN.	US-PGPUB; USPAT	OR	OFF	2009/02/14 12:36
S94	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2009/02/14 12:37
S95	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2009/05/26 07:51
S96	1680	portable and music and CDMA and transmitter and receiver	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:35
S97	527	portable and music and CDMA and transmitter and receiver and private	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:35
S98	57	portable and music and CDMA and transmitter and receiver and private and "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:35
S99	0	S98 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:36
S100	41	S97 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:36
S101	1	("6678692").PN.	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:39
S102	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:39
S103	25	("5555466" | "5771441" | "6058288" | "6243645" | "6266815" | "6300880" | "6317039").PN. OR ("6678892").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:39
S104	63	("2236946" | "2828413" | "2840694" | "3080785" | "3085460" | "3087117" | "3296916" | "3579211" | "3743751" | "3781451" | "3825666" | "3863157" | "3901118" | "3906160" | "4004228" | "4229826" | "4335930" | "4344184" | "4369521" | "4430757" | "4453269" | "4464792" | "4471493" | "4612688" | "4647135" | "4721926" | "4794622" | "4845751" | "4899388" | "4988957" | "5025704" | "5214568").PN. OR ("5771441").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:42
S105	10	("20030045235" | "20040223622" | "5491839" | "5771441" | "5790595" | "5946343" | "6342844" | "6418558" | "6678892" | "6982132").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:42
S106	4453	"fuzzy logic" and @ad<"20011221"	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:48
S107	659	S106 and transmitter	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:48
S108	591	S106 and portable	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:48

S109	4	S106 and portable adj player	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:49
S110	0	"fuzzy logic" with reciever	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:50
S111	49	"fuzzy logic" with receiver	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:50
S112	27	S111 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:50
S113	192	"fuzzy logic" same receiver	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:51
S114	72	S113 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:52
S115	71	("4019141" | "4229829" | "5264795" | "5404577" | "5437057" | "5568516" | "5694467" | "5771438" | "5771441" | "5867223" | "5978689" | "6006115").PN. OR ("6424820").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/02 11:27
S116	34	S115 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:28
S117	31	bluetooth with (headphone headset earphone "head phone" "head set" "ear phone") with cdma	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:32
S118	2	S117 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:32
S119	32	wireless with (headphone headset earphone "head phone" "head set" "ear phone") with cdma	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:33
S120	3	S119 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:33
S121	57	(headphone headset earphone "head phone" "head set" "ear phone") with cdma	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:34
S122	10	S121 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:34
S123	0	WO0056093	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:36
S124	0	WO0056093	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2009/09/02 11:37
S125	0	WO/0056093	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2009/09/02 11:37
S126	2	(("5781542") or ("5799005")).PN.	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:42

S127	1	("6199076").PN.	US-PGPUB; USPAT	OR	OFF	2009/09/02 13:51
S128	0	woolfork-earl.in.	US-PGPUB; USPAT	OR	OFF	2009/11/23 11:44
S129	3	woolfork-c-$.in.	US-PGPUB; USPAT	OR	OFF	2009/11/23 11:44
S139	1	("7412294").PN.	US-PGPUB; USPAT	OR	OFF	2010/01/11 12:21
S140	1	("7412294").PN.	US-PGPUB; USPAT	OR	OFF	2010/06/01 09:29
S141	3	"12144729"	US-PGPUB; USPAT	OR	OFF	2010/06/01 09:34
S142	843	cdma and "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S143	66	S142 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S144	14	cdma same "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S145	5	S144 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S146	11	code same wireless same "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:49
S147	2	S146 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:49
S148	2704	(700/94).CCLS.	US-PGPUB; USPAT	OR	OFF	2010/10/21 12:51
S149	3	(("7412294") or ("7865258") or ("7684885")).PN.	US-PGPUB; USPAT	OR	OFF	2011/05/02 14:06

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S130	0	woolfork-earl.in.	USPAT; UPAD	OR	OFF	2009/11/23 11:44
S131	1	woolfork-c-$.in.	USPAT; UPAD	OR	OFF	2009/11/23 11:44
S132	195	(700/94).CCLS.	UPAD	OR	OFF	2009/11/23 11:59
S133	225	((700/94) or (455/3.06)).CCLS.	UPAD	OR	OFF	2010/01/11 11:18

11/3/2011 10:31:01 AM
C:\Users\aflanders\Documents\EAST\Workspaces\12940747.wsp

RESPONSE TO THE OFFICE ACTION DATED 11/14/2011

Response to the Arguments Posed in The Present Office Action

It states on page 2 of the present Office Action ("OA") that: "Lavelle (U.S. 6,678,892) filed 27, October 2000 is one of many issued patents that teaches of wireless digital communication to a headset." The applicant would like to point out that Lavelle does not teach wireless digital communication between an in-motion digital audio transmitter and in-motion digital audio receiver (e.g., a headset) as is claimed in the present invention.[1] Lavelle teaches a vehicle in-motion and within that vehicle exists a headset and transmitter mounted to the vehicle's body.[2] So while wireless transmission may have been conceived of in 2000, wireless transmission with an in-motion audio receiver and transmitter was not commonplace.

The Applicant does not ignore Altstatt that in pointing out that G.729 is a compression algorithm unequipped to transmit high quality audio (see page 10 of the OA). The argument provided by the Applicant is salient as the algorithm of G.729 could not be combined with the portable audio device of Altstatt to create a functioning unit.

As to the argument pertaining to intersymbol interference (ISI), it should be clarified that Lindemann applies Reed-Solomon encoding/decoding for the purpose of *detecting and correcting errors after a signal has been received.*[3] The OA also

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[1] Parent application 10/027,391 to the present invention states: "Such use includes the portable player systems such as cassette tape players that may be used during exercising as for example running."

[2] See column 10, lines 11-15 of Lavelle, which state: "the entertainment unit being mounted against the interior roof of the vehicle, the entertainment unit may also be mounted against the front portion of the vehicle or a combination of the roof and the front portion of the vehicle."

[3] Lindemann paragraph 0061 states: "Each transmission frame is Reed Solomon decoded to generate fully error corrected Transmission Frames."

recites Roberts (U.S. Patent No. 6,418,558) on page 7 to support the teaching of Reed-Solomon as an acceptable method of error detection.[4] Reed-Solomon, as referenced by Lindemann and Roberts, is directed toward *detecting and correcting the errors within a received signal*, (i.e., after the presence of a signal is detected, the signal is then analyzed for errors within the signal and then the errors are corrected). In stark contrast, the present invention reduces ISI for, among other things, lowering the error in *detecting the presence of the signal in the receiver*.[5]

The whole process of signal authentication in the present invention may be viewed as a three-step procedure:

(1) detect the presence of the correct signal (present invention),

(2) determine if any anomalies exist within the captured signal i.e., error detection (Reed-Solomon) and

(3) correct the anomalies within the signal that have been identified i.e., error correction (Reed-Solomon).

Reed-Solomon is clearly defined on page 4 of the OA as "nonbinary codes, which are capable of *correcting errors*." Reed-Solomon does not teach or suggest the novel way of reducing intersymbol interference as utilized in the present invention. To use a rough analogy, if there were two solutions of getting from point A to point B, Reed Solomon would be a car and the present invention would be a jet. No one would argue that a car would obviate a jet, each's individual function, problem

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[4] "**Some applications** demand more error detection and correction capability than others. An embodiment is shown which handles both unencoded parity-type detection/correction and more multiple types of more powerful methods, **such as Reed-Solomon encoding** . . . ." (emphasis added).

[5] Paragraph 0013 of parent application 10/027,391 states: "An encoder 36 may be used to reduce intersymbol interference (ISI) ... The reduction of ISI may lower the probability of a signal detection error in the audio receiver.").

solving and utility are disparate, just as Reed-Solomon is to the ISI solution used in the present invention.

Response to the Rejection of Claims 1-18 Under 35 U.S.C. 103

A finding of obviousness requires that "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertain." 35 U.S.C. §103(a). In *KSR Int'l Co. v. Teleflex, Inc.*, 127 S. Ct. 1727, 82 USPQ2d 1385 (2007), the Supreme Court stated that the following factors set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966) control an obviousness inquiry: (1) the scope and content of the prior art; (2) the differences between the prior art and the claimed invention; (3) the level of ordinary skill in the art; and (4) objective evidence of nonboviousness. *KSR*, 127 S. Ct. at 1734, 82 USPQ2d at 1388 (quoting *Graham*, 383 U.S. at 17-18, 14 USPQ at 467).

The *KSR* Court affirmed that it is "important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does . . . because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." *KSR*, 127 S. Ct. at 1741, 82 USPQ2d at 1396. Once the *Graham* factors have been addressed, the Examiner may apply the TSM test, asking whether (l) a teaching, suggestion or motivation exists in the prior art to combine the references cited, and (2) one skilled in the art would have a reasonable expectation of success. *See* USPTO Guidelines at 57534.

Further, in order to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka,* 490 F.2d 981, 180 USPQ 580 (CCPA 1974). Additionally, in considering a prior art reference, the reference must be considered in its entirety, *i.e.,* as a whole, including portions that would lead away from the claimed invention. *WL. Gore & Associates, Inc.* v. *Garlock. Inc., 721* F.2d 1540,220 USPQ 303 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984). A prior art reference is only appropriate where the "invention as a whole would be obvious to a person of ordinary skill in the field." In re Kumar, 418 F.3d 1361, 76 USPQ2d 1048, 1053 (Fed. Cir. 2005). Moreover, it is improper to combine references where the references teach away from their combination. *In re Grasselli,* 713 F.2d 731,743,218 USPQ 769, 779 (Fed. Cir. 1983). Indeed, "an applicant may rebut a prima facie case of obviousness by showing that the prior art teaches away from the claimed invention *in any material respect." In re Peterson*, 315 F.3d 1325, 1331 (Fed. Cir. 2003) (Emphasis added). In making an obviousness rejection, Examiners must provide evidence and clear argument as to how the prior art suggests the invention. *Sud-Chemie v. Multisorb Techs.,* 554 F. 3d 1001 (Fed. Cir. 2009).

Summary

The applicant is well aware that the prior art is taken as a whole, as is cited above, in the rejections posed. It is in this light that the Applicant respectfully urges the Examiner to review this invention. As is outlined in detail below, the prior art in combination do not teach or suggest the present invention and provide no motivation for one of ordinary skill to combine and solve the novel problems posed by a mobile system working with a single mobile transmitter and a single mobile receiver in a space containing other transmissions in the digital wireless spectrum.

Li teaches the necessity of intermediate links, such as, a base station to transmit wireless digital audio, thus removing the Li/Altstatt combination that is cited for teaching a base device in the combination's wireless CDMA headphone set. The Reed-Solomon technique of reducing interference is inapplicable and founded on a disparate approach to reducing interference, removing Lindemann as prior art for teaching the reduction of intersymbol interference in a comparable device. Thus, there is nothing predictable about the present invention's functioning of high fidelity transmission and reception of digital audio directly between one transmitter and one receiver in the presence of other users, and the rejections should be removed (see page 16 of the OA).

Amendments to the Claims

Claims 1-4 and 9-18 have been amended to state that the reduction of ISI, among other things, is used to aid in "lowering signal detection error." This addition is supported Paragraph 0013 of parent application 10/027,391 that states: "An encoder 36 may be used to reduce intersymbol interference (ISI) . . . . The reduction of ISI may lower the probability of a signal detection error in the audio receiver." Claims 5-9 as well as 15 and 17 have also been amended to include the language "fuzzy set membership functionality to enhance detection of said unique user code" (as supported by Patent 7,865,258 column 3 lines 56 – 67 and column 4 lines 1 – 5). The Applicant respectfully requests that the amendments be entered at this time.

The Combination of Altstatt and Li Cannot Obviate the Present Invention

The shortcomings of Altstatt enumerated above are alleviated by the combination of Li in the OA as discussed above. In particular, in the rejection of Claim 1 there are many shortcomings of Altstatt, namely that it does not disclose a: (1) digital system, (2) a receiver that can receive unique user code bit sequence and an original audio signal representation in the form of packets, (3) a direct conversion module configured to capture the packets embedded in the received spread spectrum signal, (4) a digital demodulator configured for independent CDMA communication, (5) a decoder operative to decode reduced intersymbol interference coding or original audio signal representation, (6) a digital-to-analog converter generating an audio output of said original audio signal representation, and (7) a module adapted to reproduce said generated audio output in response to unique user code bit sequence being recognized.[6] An eighth missing characteristic could be added, namely, that Altstatt uses a knob for the user to adjust to minimize interference in a channel. Altstatt alone cannot suggest the present invention.

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[6] See page 13 of the current Office Action.

At least seven essential elements of the present invention are identified by the Examiner as not taught or suggested by Altstatt. The rejection relies on the interjection of Li to teach CDMA digital transmission, and on Lindemann to reduce intersymbol interference. Similar arguments can be applied to claims 2-17. Altstatt can only be arguably applied to teach a (1) a wireless audio headphone for the receipt of an audio music representation signal and (2) an audio receiver, capable of mobile operation, configured for direct wireless communication with a mobile audio transmitter. Although, in contrast to the present invention, Altstatt requires the user to manually suppress unintended interference (Altstatt column 7 lines 6-8).

The present invention necessitates a great deal of added complexity in its additional elements to achieve a novel wireless digital audio system as is described in each of the Claims. For each Claim, the OA rejections are based on Altstatt in combination with Li and Lindemann.

However, the combination of Altstatt and Li does not teach or suggest the present invention. This has been discussed previously, for example, on page 2 of the August 4, 2010 of the Applicant's response to the Final Rejection dated 06/07/2010. The Examiner understands that Altstatt does not disclose a direct one-to-one digital transmitter-to-headphone communication link, thus, it should also be understood that Altstatt cannot realize the benefits of such a digital link as asserted."[7] Moreover, Li clearly discloses a cellular communication system.[8] A CDMA cellular

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[7] The Examiner's understanding is evidenced in the Office Action Mailed 08-09-2005, page 6: "However the system of Altstatt is an analog transmission system that, in operation, lacks the benefits of a digitally encoded and transmitted audio signal" and Office Action Mailed 05-17-2006, page 6 and Office Action Mailed 10-02-2006, page 10: "However, the system of Altstatt an analog transmission system that, operation lacks the benefits digitally encoded and transmitted audio signal."

[8] Li column 1 lines 57 – 63 "CDMA digital cellular communications system ...," See also Li column 6 lines 55 – 62 "IMT 2000 ... IS95 ... CDMA 2000. IMT 2000, IS95 and CDMA 2000 are all cellular (i.e., cell phone) standards and each requires the

network is a time-synchronous system that requires intermediate links (not a one-to-one direct link), for example, a cell phone tower between end-to-end transmission and reception to suppress interference.

The instant OA asserts: "It would be obvious to one of ordinary skill in the art at the time the invention was made to apply the digital CDMA wireless communication of Li to replace the FM modulation communication as taught by Altstatt." (see pgs. 14-15). Claims 1-4 and 8-18 of the present invention specifically disclose a direct one-to-one transmitter/receiver communication link[9] that the Altstatt/Li combination cannot teach or suggest. A close review of Altstatt/Li combination reveals that intermediate equipment (or steps) is required for the transmitter and headphone receiver to communicate. For example, the Altstatt/Li system must wirelessly transmit audio (Altstatt) to, at least, a base station and/or a cell phone tower (Li) prior to the receiver headphone receiving the audio.

Any attempt to eliminate the intermediate base station and/or cell phone tower would cause interference resulting from unintended transmission sources. In contrast claim language in the present invention states: "said audio having been wirelessly transmitted and reproduced virtually free from interference from device transmitted signals operating in the . . . spectrum." The Examiner has approved this language in the past. Item 3 of the Advisory Action dated 07/27/2011 submits that

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centralized control of a base station for operation. Li's centralized control base station system does not disclose a direct one-to-one transmitter-to-headphone communication link."

[9] For example, the in-motion transmitter/in-motion receiver embodiment language of Claim 2: "a digital audio receiver, capable of mobile operation, configured for direct digital wireless spread spectrum communication with a mobile digital audio transmitter."

the language of "direct communication" (or "directly communicable") adheres to a one-to-one architecture embodiment.[10]

Figure 9.1 "Block diagram of a cellular system" of Exhibit I is submitted, as a visual aid, to exemplify the architecture required to "apply the communication of Li to replace the FM modulation communication as taught by Altstatt" (without interference from unintended transmission sources). Moreover, the present invention is, among other things, related to a time-asynchronous system. Some differences between a CDMA Cellular time-synchronous system and a time-asynchronous system are detailed in section 2.1 "Imperfect Orthogonality of CDMA Codes" on page 155 of Exhibit II. The reference clearly discloses the problems that exist when attempting to substitute the CDMA cellular time-synchronous system equipment for time-asynchronous system equipment (as stated on page 19 of the OA "simple substitution of one known element ... for another ... to obtain predictable results").

Because Altstatt and Li cannot be combined to produce a useable and functioning device to transmit audio wirelessly virtually free of interference, Altstatt/Li combination fails to teach or suggest the present invention. As this combination is relied upon to reject all claims in the present invention, it is respectfully requested that the rejections be removed and the application be allowed. The current amendments to the claims do not change the scope or the analysis of the Altstatt/Li combination.

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[10] Item 3 of the Advisory Action states: "Previous they were only communicable, no direct requirement was present. The previous interpretation allowed for intermittent steps during communication while the new limitations preclude this interpretation."

The addition of Lindemann to the Altstatt/Li Combination does not Obviate Claims Directed to the Reduction of Intersymbol Interference

This section addresses the arguments raised on page 15 of the OA. Namely, it is asserted by the Examiner that: "The combination of Altstatt in view of Li fails to explicitly disclose that the decoder is operative to decode reduced intersymbol interference coding." Lindemann is added into the combination and relied upon for the disclosure of Reed-Solomon encoding/decoding as described in Roberts. The problem with this is that Reed-Solomon encoding/decoding does not reduce interference for the same purpose or in the same manner as the reduction of intersymbol interference in the present invention. In fact, Reed-Solomon functions so disparately, that it could not teach or motivate the reduction of intersymbol interference in the present invention.

Simply, the combination of Altstatt, Li and Lindemann, does not teach or suggest the present invention. The combination provides no motivation to one skilled in the art to create the present invention as disclosed. As previously stated, claims 1-4 and 8-18 include language of direct communication, whereas Altstatt with Li necessarily rely on an intermediate cellular communication architecture to wirelessly link (end-to-end) a transmitter with a receiver for the purpose of communicating audio without interference from unintended transmitter devices. Moreover, Altstatt, Li and Lindemann do not teach or suggest the reduction of ISI for, among other things, lowering the error in *detecting the presence of the signal in the receiver* (as pointed out previously). None of the cited prior art contemplates ISI. And as previously discussed, Lindemann utilizes Reed-Solomon for the purpose of *detecting and correcting errors within a received signal,* not for *detecting the presence of the signal* (as stated in the specification and claims). The Applicant is not arguing that Lindemann is not solving a particular problem through use of Reed-Solomon. The Applicant is merely attempting to provide an understanding that Lindemann approaches his particular problem in such a disparate fashion to the present invention that Lindemann could not teach or suggest to one of ordinary skill how to solve interference in the unique and superior fashion presented in the claims of the instant application. It is clear that the prior art in combination cannot obviate the present inventions, the rejections should be removed and the application placed into allowance.

DSPK is Not Notoriously well Known to be Used in CDMA Communication

Page 20 of the OA states: "DPSK modulation is notoriously well known to be used in CDMA communication." The Applicant respectfully disagrees that the benefits of DPSK are well known within the present invention as applied in this rejection to Claim 5. The wireless digital audio system of the present application that consists of, among other things, independent CDMA wireless communication of high quality audio (from an audio player) between a mobile transmitter and mobile receiver in direct communication, reducing ISI, utilizing a packet format, and lowering the error in detecting a signal while suppressing unintended transmissions within the wireless spectrum. This apparatus is novel in light of all of the prior art and is patentable.

These explanations remove the obviousness arguments for all remaining Claims 1-18 and . Thus, it is respectfully requested that for at least the reasons provided above, the prior art references are deficient in providing the present invention solution, and the remaining Claims should be in allowance.

Moreover, the Applicant would like to state that any other arguments made by the Examiner and not explicitly addressed in this response are not agreed to by the Applicant (e.g., the rejection to packet form for obviousness, DCR, etc). Silence as to any arguments made by the Examiner is not an assent to those arguments; the Applicant respectfully asserts that all claims in their present condition are allowable and patentable.

If there are any questions, concerns, or actions that can be taken to expedite the processing of this application, please do not hesitate to contact the Applicant's representative.

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EXHIBIT I

WIRELESS

communications

Principles & Practice

Theodore S. Rappaport

To connect mobile subscribers to the base stations, radio links are established using a carefully defined communication protocol called *common air interface* (CAI) which in essence is a precisely defined *handshake* communication protocol. The common air interface specifies exactly how mobile subscribers and base stations communicate over radio frequencies and also defines the control channel signaling methods. The CAI must provide a great deal of channel reliability to ensure that data is properly sent and received between the mobile and the base station, and as such specifies speech and channel coding.

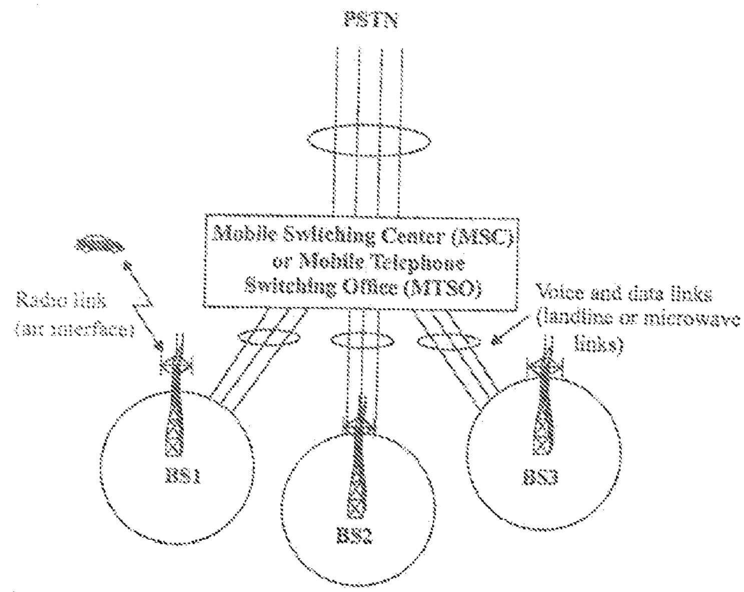

Figure 9.1
Block diagram of a cellular system.

At the base station, the air interface portion (i.e., signaling and synchronization data) of the mobile transmission is discarded, and the remaining voice traffic is passed along to the MSC on fixed networks. While each base station may handle on the order of 50 simultaneous calls, a typical MSC is responsible for connecting as many as 100 base stations to the PSTN (as many as 5,000 calls at one time), so the connection between the MSC and the PSTN requires substantial capacity at any instant of time. It becomes clear that networking strategies and standards may vary widely depending on whether a single voice circuit or an entire metropolitan population is served.

Unfortunately, the term *network* may be used to describe a wide range of voice or data connections, from the case of a single mobile user to the base station, to the connection of a large MSC to the PSTN. This broad network definition presents a challenge in describing the large number of strategies and

EXHIBIT II

CDMA-Based MAC Protocol for Wireless Ad Hoc Networks *

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ABSTRACT

We propose a CDMA-based power controlled medium access protocol for mobile ad hoc networks (MANETs). Unlike previously proposed protocols, ours accounts for the multiple access interference (MAI), thereby addressing the notorious near-far problem that undermines the throughput performance in MANETs. Channel-gain information obtained from overheard RTS and CTS packets over an out-of-band control channel is used to dynamically bound the transmission power of mobile terminals in the vicinity of a receiver. By properly estimating the required transmission power for data packets, the proposed protocol allows for interference-limited simultaneous transmissions to take place in the neighborhood of a receiving terminal. Simulation results indicate that compared to the IEEE 802.11 approach, the proposed protocol achieves a significant increase in network throughput at no additional cost in energy consumption.

Categories and Subject Descriptors

C.2.1 [**Network Architecture and Design**]: Wireless Communication; C.2.2 [**Network Protocols**]

General Terms

Algorithm, Design, Performance

Keywords

Ad hoc networks, CDMA, multi-access interference, near-far problem, power control, code assignment.

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MobiHoc'03, June 1 3, 2003, Annapolis, Maryland, USA.

1. INTRODUCTION

1.1 Motivation

Mobile ad hoc networks (MANETs) have recently been the topic of extensive research. The interest in such networks stems from their ability to provide a temporary wireless networking capability in scenarios where fixed infrastructures are lacking and are expensive or infeasible to deploy (e.g., disaster relief efforts, battlefields, etc.). While wide deployment of MANETs is yet to come, many efforts are currently underway to standardize protocols for the operation and management of such networks [26, 2].

One of the fundamental challenges in MANETs research is how to increase the overall network throughput while maintaining low energy consumption for packet processing and communications. The low throughput is attributed to the harsh characteristics of the radio channel combined with the contention-based nature of medium access control (MAC) protocols commonly used in MANETs. The focus of this paper is on improving the network throughput of a MANET by means of a CDMA-based design of the MAC protocol. Compared to the DCF (Distributed Coordination Function) mode of the IEEE 802.11 standard [3], which is currently the *de facto* MAC protocol for MANETs, our MAC protocol is shown to achieve a significant increase in network throughput for the same or less energy consumption per delivered packet.

CDMA is based on spread spectrum (SS) techniques, in which each user occupies the entire available bandwidth. At the transmitter, a digital signal of bandwidth, say B_1 bits/sec, is *spread* using (i.e., multiplied by) a pseudo-random noise (PN) code of bandwidth, say B_2 bits/sec ($B_2/B_1 \gg 1$ is called the *processing gain*). The PN code is a binary sequence that statistically satisfies the requirement of a random sequence, but that can be exactly reproduced at the intended receiver through precise mathematical rules. Using a locally generated PN code, the receiver *de-spreads* the received signal, recovering from it the original information. The enhancement in performance obtained from spreading the signal makes it possible for several, independently coded signals to occupy the same channel bandwidth, provided that each signal has a distinct PN code. This type of communication in which each transmitter-receiver pair has a distinct PN code for transmitting over a common channel is called CDMA [24].

Due to its superior characteristics, CDMA has been the access technology of choice in cellular systems, including the recently adopted 3G systems [22]. In such systems, CDMA has been shown to provide up to six times the capacity of TDMA- or FDMA-based solutions [12]. This throughput gain comes along with other desirable features, including graceful signal degradation, multipath resistance, inherent frequency diversity, and interference rejection. It is, therefore, of no surprise that CDMA is being considered for ad hoc networks. Interestingly, the IEEE 802.11 standard uses SS techniques at the physical layer[1], but only to mitigate the impact of the harsh wireless channel. More specifically, in the 802.11 protocol all transmitted signals are spread using a *common* PN code, precluding the possibility of multiple concurrent transmissions in the a vicinity of a receiver. This situation is exemplified in Figure 1, where the transmissions $A \rightarrow B$ and $C \rightarrow D$ cannot take place at the same time.

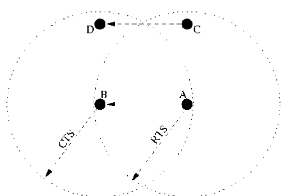

Figure 1: Example showing the low throughput of the 802.11 scheme (only one transmission can take place at a time).

1.2 Code Assignment and Spreading Protocol Issues

Enabling CDMA-based solutions for MANETs is fraught with challenges, which are essentially related to the absence of centralized control (i.e., a base station). First, a *code assignment protocol* is needed to assign distinct codes to different terminals. This problem is trivial in small networks, but becomes acute in large networks where the number of PN codes is smaller than the number of terminals[2], necessitating spatial reuse of the PN codes. Several code assignment protocols have been previously proposed (e.g., [14, 4, 11]). In general, these protocols attempt to assign codes to nodes with the constraint that all neighbors of a node have different PN codes [14].

Besides the code assignment protocol, a *spreading-code protocol* is also needed to decide which codes to use for packet transmission and for monitoring the channel in anticipation of a packet reception [30]. Such a protocol can be receiver-based, transmitter-based, or a hybrid. In a receiver-based protocol, the transmitter uses the code of the intended receiver to spread the packet, while an idle terminal constantly monitors its own code. This approach simplifies the receiver's circuitry because the receiver does not have to monitor the whole code set. Unfortunately, *primary collisions* are still possible, even under a correct code assignment (a primary collision involves two or more transmissions that are spread using the same code). For example, consider two non-neighboring nodes A and C that have two different codes. These nodes may have a common neighbor, say B, with its own code. A primary collision may occur if nodes A and C simultaneously attempt to transmit to node B using B's code[3]. The only way to guarantee that primary collisions cannot happen is to use different codes for different, concurrently transmitted *signals* (not nodes). Another disadvantage of the receiver-based approach is that a broadcast requires the transmitter to unicast the message to each receiver. In a transmitter-based spreading protocol, a transmission code is assigned to each terminal, and receivers must be able to monitor the activity on the whole set of PN codes. The advantage of this approach is that primary collisions cannot happen. In addition, broadcast is inherently supported. However, the drawback is that the receiver circuitry is very complex and expensive. Various hybrids of the above two approaches are also possible. For example, the authors in [30] proposed two hybrid schemes: the *common-transmitter-based protocol* and the *receiver-transmitter-based protocol*. In the first protocol, the fields in the packet header that contain the source and destination addresses are spread using a common code, while the rest of the packet is spread using the transmitter's code. An idle terminal constantly monitors the common code. Upon recognizing its address in the destination field, the listening terminal switches to the code of the transmitting node to receive the rest of the packet. The receiver-transmitter-based works similarly, but with the common code replaced with the receiver's code.

1.3 Goals and Paper Contributions

Several CDMA-based MAC protocols for MANETs have been proposed in the literature (e.g., [30, 15, 19, 11, 16]). These protocols, in general, are based on random channel access, whereby a terminal with a packet to transmit can proceed immediately with its transmission (starting, possibly, with an RTS/CTS exchange), irrespective of the state of the channel. We refer to such schemes as *random access CDMA* (RA-CDMA). Under appropriate code assignment and spreading-code schemes, RA-CDMA protocols are guaranteed to be free of primary collisions. However, as explained in details in Section 2, the nonzero cross-correlations between different CDMA codes can induce *multi-access interference* (MAI), resulting in *secondary collisions* at a receiver (collisions between two or more transmissions that use different CDMA codes). In the literature, this problem is known as the *near-far problem* [23]. As shown in Section 2, *the near-far problem can cause a significant reduction in network throughput, and hence cannot be overlooked when designing CDMA-based MAC protocols for MANETs.* Accordingly, the main goal of this paper is to provide a CDMA-based MAC solution for MANETs that addresses the near-far problem. In our protocol, the transmission powers are dynamically adjusted such that the MAI at any receiver is not strong enough

[1]Both direct sequence spread spectrum (DSSS) and frequency hopping spread spectrum (FHSS) are included in the IEEE 802.11 specifications. However, since DSSS has more desirable properties than FHSS, it has been favored in recent wireless standards, including IS-95. Accordingly, our focus in this paper is on DSSS techniques.

[2]The number of codes is usually constrained by the available spectrum and the required information data rate [29].

[3]Note, however, that if the received power of one signal is much greater than the other, then capture is still possible and the stronger signal can still be received correctly.

to cause a secondary collision. As indicated in our simulations, this results in a significant improvement in network throughput at no additional cost in energy consumption. In fact, the proposed protocol is shown to achieve some energy saving compared to the 802.11 scheme. To the best of our knowledge, this is the first attempt to address the near-far problem in the design of MAC protocols for MANETs.

The rest of the paper is organized as follows. In Section 2, we explain the near-far problem in detail and show its adverse effect on the throughput performance. Section 3 provides an overview of related CDMA-based protocols for MANETs. The proposed protocol is presented in Section 4, followed by simulation results and discussion in Section 5. Finally, our main conclusions are drawn in Section 6.

2. THE NEAR-FAR PROBLEM IN RA-CDMA

2.1 Imperfect Orthogonality of CDMA Codes

The roots of the near-far problem lies in the fact that unlike FDMA and TDMA channels which can be completely orthogonal, CDMA codes suffer from nonzero cross-correlation between codes. When a CDMA receiver de-spreads a signal, it effectively computes the cross-correlation between the signal and a locally generated PN sequence. If this PN sequence is identical to the one used to spread the signal at the transmitter (i.e., the message is intended to *this* receiver), cross-correlation computations restore the original information data. Otherwise, such computations result in either a zero or a nonzero value, depending on whether the system is *synchronous* or *asychnronous*.

A system is called time-synchronous if all signals originate from the same transmitter, as in the case of the downlink of a cellular CDMA network[4]. In here, synchrony is manifested in two ways. First, different transmissions that are intended for different receivers will have a common time reference. Second, from the viewpoint of a given mobile terminal, all signals (intended or not) propagate through the same paths, and thus suffer the same time delays. In synchronous systems, it is possible to design *completely orthogonal* spreading codes. In fact, in the IS-95 standard for cellular CDMA networks [24], each user of the channel is assigned a Hadamard (or Walsh) code. These codes are orthogonal and are used to "channelize" the available bandwidth.

On the other hand, a system is called time-asynchronous if signals originate from multiple transmitters, as in the case of the uplink of cellular networks and also in MANETs. The reasons behind the naming are twofold. First, since signals originate from *different* transmitters, it is generally not feasible to have a common time reference for all the transmissions that arrive at a receiver. Second, these transmissions propagate through different paths; thus, they suffer different time delays [25]. In an asynchronous system, it is *not* possible to design spreading codes that are orthogonal for all time offsets [24]. In this case, the cross-correlation between codes cannot be neglected. In fact, codes that are orthogonal in synchronous systems (e.g., Hadamard codes) exhibit high cross-correlation when not perfectly synchronized. Instead, PN codes that are designed specifically to have low cross-correlation are used.

[4]Mathematically, it is possible to have multiple transmitters and have a synchronous system. However, in practice, it is difficult to achieve perfect synchronization between those transmitters.

While the code design problem is crucial in determining the system performance, of greater importance is the problem of nonzero cross-correlation of the PN codes [23]. Unintended transmissions add nonzero MAI during the despreading at a receiver. The near-far problem is a severe consequence of MAI, whereby a receiver who is trying to detect the signal of the ith transmitter may be much closer in distance to, say, the jth transmitter than the ith transmitter. When all transmission powers are equal, the signal from the jth transmitter will arrive at the receiver in question with a sufficiently larger power than that of the ith transmitter, causing incorrect decoding of the ith transmission (i.e., a secondary collision).

2.2 Impact of the MAI Problem

We now elaborate on the performance implications of the MAI problem. Consider the reception of a packet at terminal i. Let $P_0^{(i)}$ be the average received power of the desired signal at the ith terminal. Suppose that there are K interfering transmissions with received powers P_j, $j = 1, \ldots, K$. The quality of the intended reception is adequately measured by the *effective bit energy-to-noise spectral density ratio* at the detector, denoted by $\mu^{(i)}$. For an asynchronous direct-sequence BPSK system, $\mu^{(i)}$ is given by [31, 27][5]:

$$\mu^{(i)} \triangleq \frac{E_b}{N_{0\mathrm{eff}}} = \left(\frac{2\sum_{j=1}^{K} P_j}{3W P_0^{(i)}} + \frac{1}{\mu_0} \right)^{-1} \quad (1)$$

where W is the processing gain and μ_0 is the $E_b/N_{0\mathrm{eff}}$ ratio at the detector in the absence of interference. As the interfering power increases, $\mu^{(i)}$ decreases, and the bit error probability increases. As an example, consider a CDMA system that uses BPSK modulation and a convolutional code with rate 1/2, constraint length 7, and soft decision Viterbi decoding. Let $W = 100$. To achieve a bit error probability of 10^{-6}, the required $E_b/N_{0\mathrm{eff}}$ is 5.0 dB [24]. Ignoring the thermal noise and using (1), the total interference power must satisfy:

$$\frac{\sum_{j=1}^{K} P_j}{P_0^{(i)}} \leq 47.43 \quad (2)$$

Transmitters are, in general, situated at different distances from the receiver. Suppose that the transmission powers are fixed and equal. Consider the case of one interferer ($K = 1$) at distance d_1 from the receiver. Let d_0 be the distance between the receiver and the intended transmitter. Using the two-ray propagation model for terrestrial communications (power loss $\sim 1/d^4$), it is easy to show that to satisfy the required bit error rate, we must have $d_1 \geq 0.38 d_0$. So if there is only one interferer that is at distance less than $0.38\, d_0$ from the receiver, reliable communication will not be possible (i.e., a secondary collision will occur).

[5]Assuming truly random sequences of a rectangular chip pulses and using a Gaussian approximation with constant but unequal powers.

The above example shows that the near-far problem can severely affect packet reception, and consequently, network throughput. A good measure of network throughput is given by the *expected forward progress* (EFP) per transmission, defined as the product of the *local* throughput of a terminal and the distance between the transmitter and the receiver [31]. The EFP was derived in [31] for multihop RA-CDMA networks, assuming a slotted system and Poisson distributed terminals in the 2D space. Let p be the probability that a terminal is transmitting a packet in a given time slot (i.e., the per-node load) and let L be the number of nodes that are within a circle centered at the transmitter and of radius that equals the transmitter-receiver separation distance. A scaled version of the EFP is plotted in Figure 2 as a function of p for various values of L. The figure shows that the EFP initially increases with p up to some point, say p^*, beyond which the EFP starts to decrease rapidly with p. This says that the channel becomes unstable when the load exceeds p^*, which is caused by the increase in the number of transmitted packets beyond the multiple access capability of the system. Our goal is to design a CDMA-based MAC protocol that prevents this rapid degradation in network throughput.

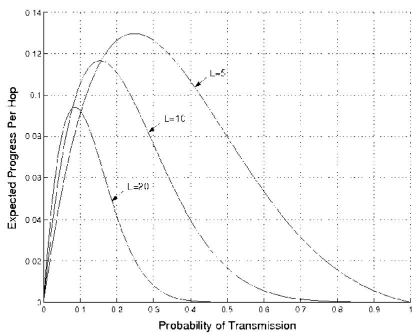

Figure 2: Throughput performance versus load in RA-CDMA networks.

3. RELATED WORK

In [30] the addresses part of the packet are spread using the common code, while the rest of the packet is spread using the transmitter-based approach. A receiver notes the address of the source terminal and uses this address to switch to the corresponding code. In [15] the authors proposed the coded tone sense protocol, in which K busy tones are associated with K spreading codes. During packet reception on a certain code, the receiving station broadcasts the corresponding busy tone. In [11] all terminals send the RTS-CTS packets on a common code, while the data packet are sent using a transmitter- or a receiver-based approach. Somewhat similar approaches were proposed in [16] and [34]. In all the above protocols, the authors assume perfect orthogonality between spreading codes, i.e., they ignore the near-far problem.

A reservation-based scheme was proposed in [33], whereby small control packets are used to request slot assignments for data packets. The authors investigated the use of FHSS to avoid MAI. Their approach, however, cannot be used for DSSS, which is the method of choice in recent wireless standards (e.g. IS-95).

In [6] and [10] the authors proposed distributed channel assignment algorithms for SS multihop networks. Those protocols, however, do not allow for any MAI, and hence cannot support concurrent transmissions of signals with different codes. Clustering as proposed in [18] is another interesting approach for power control in CDMA networks. It simplifies the forwarding function for most terminals, but at the expense of reducing network utilization (since all communications have to go through the cluster heads). This can also lead to the creation of bottlenecks.

In [28] the authors proposed the use of a multiuser detection circuit at the receiver to mitigate the near-far problem in MANETs. The proposed scheme also requires the use of GPS receivers to provide accurate position and timing information. Such a scheme relies heavily on physical layer techniques to mitigate MAI, and makes no effort to account for MAI at the MAC layer. Moreover, although it is feasible to deploy multiuser GPS receivers at the base station, presently it is impractical (and expensive) to implement such receivers within the mobile terminal. Recently, an interesting approach for joint scheduling and power control in ad hoc networks was proposed [9]. This approach, however, requires a central controller for executing the scheduling algorithm, i.e., it is not a truely distributed solution. Furthermore, it assumes the existence of a separate feedback channel that enables receivers to send their SNR measurements to their respective transmitters in a contention free manner.

In [5] and [8] the authors analyzed RA-CDMA protocols for MANETs in the presence of MAI. They assumed that transmissions of all neighbors produce the same noise effect, and therefore, the SNR threshold can be converted into a threshold on the number of transmissions (n) in the receiver's neighborhood. A packet is correctly received when that number is less than the predetermined threshold n. Hence, the protocol was called CDMA/n. Although such an approximation may not be accurate in topologies where nodes are not equally spaced, it shows that MAI can significantly degrade network performance.

4. THE PROPOSED PROTOCOL

4.1 Protocol Intuition and Design Goals

Before presenting the operational details of the protocol, it is constructive to first discuss how the near-far problem is being addressed in cellular networks and why the same solution cannot be extended to MANETs. In the uplink of a cellular CDMA system, the near-far problem is combated through a combination of open- and closed-loop power control, which ensures that each mobile terminal generates the *same* signal power at the base station. The base station monitors the received signal power from each terminal and instructs faraway terminals to increase their signal powers and closeby terminals to decrease theirs. Unfortunately, the same solution cannot be used in MANETs. To see why, consider the situation in Figure 3. Let d_{ij} denote the distance between nodes i and j. Suppose that A wants to communicate with B using a given code and C wants to communicate with D using a different code. Suppsoe that $d_{AB} \approx d_{CD}$, $d_{CB} \ll d_{AB}$, and $d_{AD} \ll d_{CD}$. Then, the MAI caused by C

makes it impossible for B to receive A's transmission. Similarily, the MAI caused by A makes it impossible for D to receive C's transmission. It is important to note that the two transmissions cannot take place simultaneously, irrespective of what transmission powers are selected (e.g., if A increases its power to combat the MAI at B, then this increased power will destroy the reception at D).

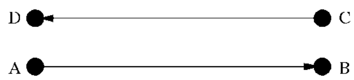

Figure 3: Example that demonstrates that power control alone is not enough to combat the near-far problem in MANETs.

The above example reveals two issues. First, it may not be possible for two transmissions that use two different spreading codes to occur simultaneously. Obviously, this is a medium access problem. Second, the two transmission can occur simultaneously if the terminals adjust their signal powers so that the interference caused by one transmission is not large enough to destroy packet reception at other terminals. Obviously, this is a power control problem. So the solution to the near-far problem has to have both elements: power control and medium access.

It is important here to differentiate between the spreading code protocol and the MAC protocol. The former decides which PN code is used to spread the signal, but does not solve the contention on the medium. On the other hand, the MAC protocol is responsible for minimizing or eliminating collisions, thereby, achieving good utilization of the available bandwidth. The use of the MAC protocol implies that even if a terminal has an available spreading code, it may not be allowed to transmit.

The design of our MAC protocol, described in detail in subsequent sections, is guided by the following objectives:

- The protocol must be asynchronous, distributed, and scalable for large networks. It must also involve minimal exchange of information and must be suitable for real-time implementation.
- The receiver circuitry should not be overly complex in the sense that it should not be required to monitor the whole code set.
- The protocol should adapt to channel changes and mobility patterns.
- Finally, although we assume that a code assignment protocol is running at a higher layer, the MAC protocol must minimize (or eliminate) collisions even if the code assignment is not "correct". This is important because it is usually difficult to guarantee correct code assignment at all times when network topology is continuously changing.

4.2 Architecture

In our design, we use two *frequency* channels, one for data and one for control (i.e., FDMA-like partitioning). A common spreading code is used by all nodes over the control channel, while *several* terminal-specific codes can be used over the data channel. This architecture is shown in Figure 4. Note that the different codes used over the data channel are not perfectly orthogonal. However, because of the frequency separation, a signal over the control channel is *completely* orthogonal to any signal (or code) over the data channel. The splitting of the available bandwidth into two non-overlapping frequency bands is fundamentally needed to allow a terminal to transmit and receive simultaneously over the control and data channels, *irrespective of the signal power*. As we explain shortly, our protocol utilizes this fact to allow interference-limited transmissions that use (quasi-orthogonal) data channel codes to proceed concurrently.

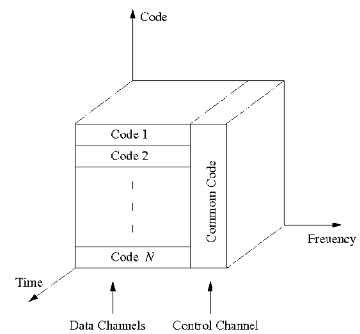

Figure 4: Data and control codes in the proposed protocol.

4.3 Channel Model and Protocol Assumptions

In designing our protocol, we assume that: (1) the channel gain is stationary for the duration of the control and the ensuing data packet transmission periods; (2) the gain between two terminals is the same in both directions; and (3) data and control packets between a pair of terminals observe similar channel gains.

In addition to the above assumptions, we assume that the radio interface can provide the MAC layer with the average power of a received control signal as well as the average interference power. Each terminal is equipped with two transceivers and a carrier-sense hardware that senses the control channel for any carrier signal. No carrier-sense is needed for the data channel. The carrier frequency spacing between the control and data channels is enough to ensure that the outgoing signal on one channel does not interfere with the incoming signal on the other channel.

4.4 Controlled Access CDMA (CA-CDMA) Protocol

Our CA-CDMA protocol is contention based and uses a modified RTS-CTS reservation mechanism. RTS and CTS packets are transmitted over the control channel (on the common code) at a fixed (maximum) power P_{max}. These packets are received by all potentially interfering nodes, as in the IEEE 802.11 scheme. However, in contrast to the IEEE 802.11 scheme and RA-CDMA protocols, interfering nodes *may* be allowed to transmit concurrently, depending on some criteria that will be discussed later. For the ensuing data packet, the receiver and the transmitter must agree on two parameters: the spreading code and the transmission power. Code selection can be done according to any code assignment scheme. As explained later, even if the code assignment scheme is not correct, our protocol will still function properly. The choice of the power level is critical and represents a tradeoff between link quality and MAI. More specifically, as the transmission power increases, the bit error rate at the intended receiver decreases (i.e., link quality improves), but the MAI added to other ongoing receptions increases (i.e., the quality of these receptions deteriorates). In addition to accounting for these two factors, our protocol also incorporates an interference margin in the power computations. This margin allows terminals at some interfering distance from the intended receiver to start new transmissions in the future. The computation of this margin is discussed in Section 4.5.

In the CA-CDMA protocol, terminals exploit knowledge of the power levels of the overheard RTS and CTS messages to determine the power that they can use without disturbing the ongoing receptions. In Section 4.6 we develop a distributed admission control strategy that decides when terminals at some distance can proceed concurrently with their transmissions.

We note here that the CA-CDMA protocol is, to some extent, similar to Qualcomm's CDMA protocol [17], adopted by the US Telecommunication Industry Association as the IS-95 standard for cellular networks. In both protocols, users contend on a control channel to request "network resources". However, the interpretation of "resources" is different in the two protocols; in the Qualcomm protocol, it refers to connection availability, while in the CA-CDMA protocol it refers to a " transmission floor." The similarity is important since the Qualcomm system has proven to be successful.

4.5 Interference Margin

An interference margin is needed to allow terminals at some distance from a receiver to start new transmissions in the future. In this section, we describe how this margin is computed. Consider an arbitrary receiver i. Let μ^* be the $E_b/N_{0\text{eff}}$ ratio that is needed to achieve the target bit error rate at that receiver. It follows from (1) that to achieve the target error rate, we must have

$$\frac{P_0^{(i)}}{P_{thermal} + P_{\text{MAI}}^{(i)}} \geq \mu^* \qquad (3)$$

where $P_0^{(i)}$ was defined before, $P_{thermal}$ is the thermal noise power and $P_{\text{MAI}}^{(i)}$ is the total MAI at receiver i (in (1) $P_{\text{MAI}}^{(i)} = 2\sum_{j=1}^{K} P_j/3W$). So the minimum required received power is $(P_0^{(i)})_{min} = \mu^*(P_{thermal} + P_{\text{MAI}}^{(i)})$.

The interference margin strongly depends on the network load, which itself can be conveyed in terms of the so-called *noise rise* ($\xi^{(i)}$), defined as follows:[6]

$$\xi^{(i)} \stackrel{\text{def}}{=} \frac{(\frac{E_b}{N_0})_{\text{unloaded}}}{(\frac{E_b}{N_0})_{\text{loaded}}} = \frac{P_{thermal} + P_{\text{MAI}}^{(i)}}{P_{thermal}} \qquad (4)$$

Note that $(P_0^{(i)})_{min} = \xi^{(i)}\mu^* P_{thermal}$ is also dependent on the noise rise. While more capacity can be achieved by increasing the noise rise (i.e., allowing larger $P_{\text{MAI}}^{(i)}$), the maximum allowable noise rise is constrained by two factors. First, Federal Communications Commission (FCC) regulations limit the power to some fixed value (e.g., 1 Watt for 802.11 devices). Given this maximum transmission power, as the noise rise is increased, the received power $(P_0^{(i)})_{min}$ must increase (μ^* and $P_{thermal}$ are constants) and hence, the maximum range (or coverage) for reliable communication will decrease. Second, increasing the noise rise increases the power used to transmit the packet, which in turn increases energy consumption. Energy is a scarce resource in MANETs, so it is undesirable to trade off energy for throughput.

We set the interference margin used by a transmitter to the maximum *planned* noise rise (ξ_{max}), which is obtained by taking into account the above two restrictions on $\xi^{(i)}$. The computations are performed as follows. First, we require that the maximum range, say $d_{\max}$, of our protocol be the same as the maximum range of the 802.11 scheme. For the maximum range, the power used in our protocol equals $\xi^{(i)}$ times the power used in the 802.11 standard. Thus, ξ_{max} cannot be greater than the ratio of the power limit set by the FCC and the power used in the 802.11 scheme. To account for the second constraint, we choose the interference margin in a manner that maintains the same *energy per bit* consumed in the 802.11 scheme. The value of the interference margin that achieves the above goals can be derived as follows. We assume that the transmission power attenuates with the distance d as k/d^n (k is a constant and $n \geq 2$ is the loss factor). The minimum required transmit power in CA-CDMA is:

$$P_{\text{CA-CDMA}} = \frac{\xi_{max}\mu^* P_{thermal} d^n}{k} \qquad (5)$$

Assuming that the distance d is uniformly distributed from zero to $d_{\max}$, we compute the expectation of $P_{\text{CA-CDMA}}$ with respect to d:

$$E[P_{\text{CA-CDMA}}] = \frac{\xi_{max}\mu^* \ P_{thermal} d_{\max}^n}{k(n+1)} \qquad (6)$$

As for the 802.11 protocol, its corresponding transmission power is:

$$P_{802.11} = \frac{\mu^* \ P_{thermal} d_{\max}^n}{k} \qquad (7)$$

Note that $P_{802.11}$ does not depend on d since the 802.11 standard uses a fixed transmission power.

Accordingly, to achieve equal average energy per bit consumption, we must have:

$$\frac{E\left[P_{\text{CA-CDMA}}\right]}{R_{\text{CA-CDMA}}} = \frac{P_{802.11}}{R_{802.11}} \qquad (8)$$

where $R_{\text{CA-CDMA}}$ and $R_{802.11}$ are the bit rates for the transmitted data packets in the CA-CDMA and 802.11 protocols, respectively. The reason why these rates can be different is that in our protocol we use two distinct frequency bands, one for control packets and one for data packets, while the standard uses only one band for all packets. Hence, for a fair comparison, data packets in the CA-CDMA protocol must be transmitted at a slower rate.

[6]This definition is similar but not exactly equal to the definition used in [22] for cellular systems.

From (6), (7), and (8), the interference margin is given by:

$$\xi_{max} = (n+1)\frac{R_{\text{CA-CDMA}}}{R_{802.11}} \tag{9}$$

As an example, consider the two-ray propagation model with $n = 4$, and let the control channel occupy 20% of the total available bandwidth. Then $\xi_{max} = 6$ dB. It is worth noting that 6 dB lies within the range of values used in already deployed cellular systems [22].

4.6 Channel Access Mechanism

We now describe the admission control and channel access strategy in the CA-CDMA protocol. The admission scheme allows only transmissions that cause neither primary nor secondary collisions to proceed concurrently. RTS and CTS packets are used to provide three functions. First, these packets allow nodes to estimate the channel gains between transmitter-receiver pairs. Second, a receiver i uses the CTS packet to notify its neighbors of the additional noise power (denoted by $P^{(i)}_{\text{noise}}$) that each of the neighbors can add to terminal i without impacting i's current reception. These neighbors constitute the set of *potentially interfering* terminals. Finally, each terminal keeps listening to the control channel regardless of the signal destination in order to keep track of the average number of active users in their neighborhoods. These functions are now explained in detail.

If terminal j has a packet to transmit, it sends a RTS packet over the control channel at $P_{\max}$, and includes in this packet the maximum *allowable* power level ($P^{(j)}_{\text{map}}$) that terminal j can use that will not disturb any ongoing reception in j's neighborhood. The computation of this power will be discussed shortly. The format of the RTS packet is similar to that of the IEEE 802.11, except for an additional two-byte field that contains the $P^{(j)}_{\text{map}}$ value.

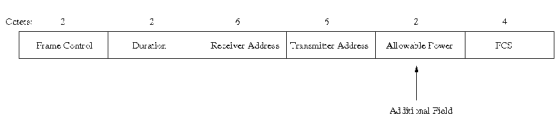

Figure 5: Format of the RTS packet in the CA-CDMA protocol.

Upon receiving the RTS packet, the intended receiver, say terminal i, uses the predetermined $P_{\max}$ value and the power of the received signal $P^{(ji)}_{\text{received}}$ to estimate the channel gain $G_{ji} = P^{(ji)}_{\text{received}}/P_{\max}$ between terminals i and j at that time (note that we assume channel reciprocity, and so $G_{ij} = G_{ji}$) . Terminal i will be able to correctly decode the data packet if transmitted at a power $P^{(ji)}_{\min}$ given by:

$$P^{(ji)}_{\min} = \frac{\mu^*(P_{thermal} + P^{(i)}_{\text{MAI-current}})}{G_{ji}} \tag{10}$$

where $P^{(i)}_{\text{MAI-current}}$ is the effective *current* MAI from all already ongoing (interfering) transmissions.

Note that because of the assumed stationarity in the channel gain over small time intervals, G_{ji} is approximately constant throughout the transmissions of the control packet and the ensuing data packet. Now, $P^{(ji)}_{\min}$ is the minimum power that terminal j must use for data transmission in order for terminal i to correctly decode the data packet *at the current level of interference*. This $P^{(ji)}_{\min}$, however, does not allow for any interference tolerance at terminal i, and thus all neighbors of terminal i will have to defer their transmissions during terminal i's ongoing reception (i.e., no simultaneous transmissions can take place in the neighborhood of i).

Now, according to the link budget calculations in Section 4.5, the power that terminal j is allowed to use to send to i is given by:

$$P^{(ji)}_{\text{allowed}} = \frac{\xi_{max}\mu^* P_{thermal}}{G_{ji}} \tag{11}$$

If $P^{(ji)}_{\text{allowed}} < P^{(ji)}_{\min}$, then the MAI in the vicinity of terminal i is greater than the one allowed by the link budget. In this case, i responds with a negative CTS, informing j that it cannot proceed with its transmission (the negative CTS is used to prevent multiple RTS retransmissions from j). The philosophy behind this design is to prevent transmissions from taking place over links that perceive high MAI. This consequently increases the number of active links in the network (subject to the available power constraints).

On the other hand, if $P^{(ji)}_{\text{allowed}} > P^{(ji)}_{\min}$, then it is possible for terminal i to receive j's signal but only if $P^{(ji)}_{\text{allowed}}$ is less than $P^{(j)}_{\text{map}}$ (included in the RTS). This last condition is necessary so that transmitter j does not disturb any of the ongoing transmissions in its vicinity. In this case, terminal i calculates the *interference power tolerance* $P^{(i)}_{\text{MAI-future}}$ that it can endure from *future* unintended transmitters. This power is given by:

$$P^{(i)}_{\text{MAI-future}} = \frac{3W\ G_{ji}}{2\ \mu^*}(P^{(ji)}_{\text{allowed}} - P^{(ji)}_{\min}) \tag{12}$$

Note that the factor $3W/2$ comes from the spreading gain (see (1)).

The next step is to equitably distribute this power tolerance among future potentially interfering users in the vicinity of i. The rational behind this distribution is to prevent one neighbor from consuming the entire $P^{(i)}_{\text{MAI-future}}$. In other words, we think of $P^{(i)}_{\text{MAI-future}}$ as a network resource that should be shared among various terminals. Let $K^{(i)}$ be the number of terminals in the vicinity of i that are to share $P^{(i)}_{\text{MAI-future}}$. This number is determined as follows. Terminal i keeps track of the number of simultaneous transmissions (i.e., load) in its neighborhood, which we donate by $K^{(i)}_{\text{inst}}$. This can be easily achieved by monitoring the RTS/CTS exchanges over the control channel. In addition, i keeps an average $K^{(i)}_{\text{avg}}$ of $K^{(i)}_{\text{inst}}$ over a specified window. Then, $K^{(i)}$ is calculated as:

$$K^{(i)} = \begin{cases} \beta(K^{(i)}_{\text{avg}} - K^{(i)}_{\text{inst}}), & \text{if } K^{(i)}_{\text{avg}} > K^{(i)}_{\text{inst}} \\ \beta, & \text{otherwise} \end{cases} \tag{13}$$

where $\beta > 1$ is a safety margin.

Now, the MAI at terminal i can be split into two components: one that is attributed to terminals that are within the range of i (denoted by $P^{(i)}_{\text{MAI-within}}$), and one that is caused by terminals outside that range (denoted by $P^{(i)}_{\text{MAI-other}}$). While terminal i can have some control over $P^{(i)}_{\text{MAI-within}}$, it cannot influence $P^{(i)}_{\text{MAI-other}}$. We account for this fact in the value of $P^{(i)}_{\text{noise}}$ as follows. In line with cellular systems, we assume that $P^{(i)}_{\text{MAI-other}} = \alpha P^{(i)}_{\text{MAI-within}}$, where $\alpha < 1$ and depends mainly on the propagation path loss factor (practical values for α are ≈ 0.5 for the two-ray model [22]). Accordingly, the interference tolerance $P^{(i)}_{\text{noise}}$ that each *future* neighbor can add to terminal i is given by

$$P^{(i)}_{\text{noise}} = \frac{P^{(i)}_{\text{MAI-future}}}{(1+\alpha)K^{(i)}} \tag{14}$$

When responding to j's RTS, terminal i indicates in its CTS the power level $P^{(ji)}_{\text{allowed}}$ that j must use. In addition, terminal i inserts $P^{(i)}_{\text{noise}}$ in the CTS packet and sends this packet back to terminal j at $P_{\max}$ over the control channel using the common code. The format of the CTS packet is shown in Figure 6.

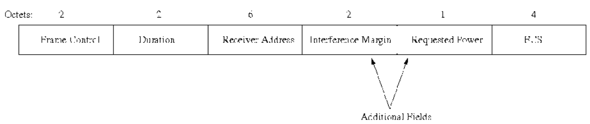

Figure 6: Format of the CTS packet in the proposed protocol.

A potentially interfering terminal, say s, that hears the CTS message uses the signal strength of the received CTS to compute the channel gain G_{si} between itself and terminal i. The channel gain along with the broadcasted $P^{(i)}_{\text{noise}}$ values are used to compute the maximum power $P^{(s)}_{\text{map}}$ that s can use in its future transmissions. More specifically, $P^{(s)}_{\text{map}}$ is taken as the minimum of the $P^{(k)}_{\text{noise}}/G_{sk}$ values, for all neighbors k of s (i.e., $P^{(s)}_{\text{map}}$ is updated dynamically whenever s overhears a new CTS). Note that it is possible for more than $K^{(i)}$ terminals to start transmitting during i's reception and this may result in MAI at i that is greater than $P^{(i)}_{\text{MAI-future}}$. We address this issue in Section 4.7.

The approach we discussed in this section provides a distributed mechanism for admission control. In contrast to cellular systems where the base station makes the admission decision, in here each terminal, and depending on previously heard RTS and CTS packets, decides whether its transmission can proceed or not.

Following a successful reception of a data packet, receiver i responds with an ACK packet, which is transmitted over the data channel using the same power level that would have been used if i were to send a data packet to j. We assume that enough FEC code is used to protect ACK packets from most types of collisions (given the small size of the ACK packets, the FEC overhead is not significant). A similar argument has been used in other, previously proposed protocols (e.g., [21]).

4.7 Protocol Recovery

In [7] the authors observed that when the transmission and propagation times of control packets are long, the likelihood of a collision between a CTS packet and a RTS packet of another contending terminal increases dramatically; the vulnerable period being twice the transmission duration of a control packet. At high loads, such a collision can lead to collisions with data packets, as illustrated in Figure 7. Suppose that terminal D starts sending a RTS to terminal C while C is receiving B's CTS that is intended to A. A collision happens at C, and hence, C is unaware of B's subsequent data reception. Afterwards, if C decides to transmit a CTS to D, it may destroy B's reception.

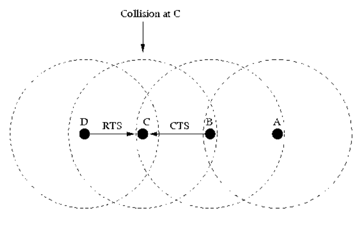

Figure 7: Example of a collision between control packets that eventually leads to a collision with a data packet.

Another problem that was mentioned earlier is if the interference goes above $P^{(\cdot)}_{\text{MAI-future}}$. In CA-CDMA, we avoid the above two problems as follows. Suppose that while receiving a data packet, terminal i hears a RTS message (destined to any terminal) that contains an allowable power $P^{(\cdot)}_{\text{map}}$ value that if used could cause an unacceptable interference with i's ongoing reception. Then terminal i shall respond *immediately* with a special CTS packet over the control channel, preventing the RTS sender from commencing its transmission. The duration field of the CTS packet contains the time left for terminal i to finish its ongoing reception. To see how this solution helps in reducing the likelihood of collisions with data packets, consider the situation in Figure 7. Suppose that terminal A sends a RTS to terminal B, and B responds back with a CTS that collides at C with a RTS from D. Now, C does not know about B's ongoing reception. Two scenarios can happen. In the first, terminal C may later wish to send a packet to, say, terminal D. It sends a RTS, which will be heard by terminal B. B responds back with a special CTS. Note that there is a good chance that B's special CTS will collide with the CTS reply from D; however, this is desirable since C will fail to recover D's CTS packet, and will therefore defer its transmission and invoke its backoff procedure. In essence, B's special CTS acts as a jamming signal to prevent C from proceedings with its transmission. The second possible scenario is that D (or any other terminal that is out of the maximum range of B) may send a new RTS to C. C will respond to D with a CTS, and D will start sending data to C. Simultaneously, A may be sending to B, without any collision. This is possible because in CA-CDMA, data and RTS/CTS packets are sent over orthogonal channels.

Note that in CA-CDMA we try to avoid likely collision scenarios such as the one mentioned in [7]. However, there are still few complicated (and definitely much less probable) scenarios where data packets may collide; recovery from such collisions is left to the upper layers.

4.8 Code Assignment

Because of the continuously changing network topology, it is difficult to guarantee correct code assignment at all time. Moreover, since not every node is active at all times, it may be desirable to oversubscribe the medium by assigning the same code to two neighboring terminals, thus violating the assignment goal. In this situation, it is the function of the MAC layer to reduce (or eliminate) contention on the medium. In CA-CDMA, this problem is addressed as follows. When terminal j sends a RTS, it inserts in that RTS the identity of the code that j intends to use for the ensuing data packet. A neighboring terminal that is receiving a packet on the *same* code can then respond back with the "special" CTS (explained in Section 4.7), which prevents j from commencing its data transmission. Note here the advantage of our architecture, which allows terminals to be informed about all neighborhood activities.

Another possible implementation is to combine the code assignment and access schemes [34]. In such an implementation, the RTS/CTS handshake over the common channel serves to reserve codes so that while the reception is ongoing, no other neighboring terminal can use any of the reserved codes. Although these two problems have been studied separately and dealt with at different layers in the protocol stack, there are two main motivations for combining them. The first is to reduce the overhead of exchanged information sharing. That is, information distributed to solve one problem (e.g., RTS and CTS) can be used to solve the other one (e.g., code assignment). Second, the MAC layer represents the most dynamic and mobility-transparent layer of the protocol stack. Thus, it is beneficial to do code assignment at the MAC layer. On the other hand, separating the two problems has its own advantages, including fairness. It is generally difficult to provide fairness in a contention-based MAC protocol. Thus, an upper layer code assignment can account for that.

5. PROTOCOL EVALUATION

5.1 Simulation Setup

We now evaluate the performance of the CA-CDMA protocol and contrast it with the IEEE 802.11 scheme. Our results are based on simulation experiments conducted using CSIM programs (CSIM is a C-based process-oriented discrete-event simulation package). In our simulations, we investigate both the network throughput as well as the energy consumption. For simplicity, data packets are assumed to have a fixed size. Each node generates packets according to a Poisson process with rate λ (same for all nodes). The routing overhead is ignored since the goal here is to evaluate the performance improvements due to the MAC protocol. Furthermore, because the interference margin is chosen so that the maximum transmission range under the CA-CDMA and 802.11 protocols is the same, it is safe to assume that both protocols achieve the same forward progress per hop. Consequently, we can focus on the one hop throughput, i.e., the packet destination is restricted to one hop from the source. The random waypoint model is used for mobility, with a host speed that is uniformly between 0 and 2 meters/sec. Note, however, that mobility has a little effect on our protocol, since an RTS-CTS exchange preceeds every packet transmission. The transmission periods for the RTS, CTS, data, and ACK packets are all in tens of milliseconds, so no significant changes in topology take place within these periods. The capture model is similar to the one in [32]. Other parameters used in the simulations are given in Table 1. These paraments correspond to realistic hardware settings [1].

Table 1: Parameters used in the simulations.

Data packet size	2 KB
802.11 data rate	2 Mbps
CA-CDMA data rate	1.6 Mbps
Control channel rate	400 Kbps
Processing gain	11
SNR threshold	10 dB
Reception threshold	−94 dBm
Carrier-sense threshold	−108 dBm
Thermal+receiver noise	-169 dBm/Hz
802.11 power	20 dBm
ξ_{max}	6 dB

5.2 Simulation Results

We consider two types of topologies: *random grid* and *clustered*. In the random grid topology, M mobile hosts are placed across a square area of length 3000 meters. The square is split into M smaller squares. The location of a mobile user is selected randomly within each of these squares. For each generated packet, the destination node is randomly selected from the one-hop neighbors.

The performance for random grid topologies is demonstrated in Figure 8. In parts (a) and (b), we set $M = 36$ and vary the packet generation rate (λ). Part (a) of the figure depicts the network throughput. It is shown that CA-CDMA achieves up to 280% increase over the throughput of the IEEE 802.11 scheme. This increase is attributed to the increase in the number of simultaneous transmissions. Furthermore, CA-CDMA saturates at about twice the load at which the 802.11 scheme saturates.

Part (b) of Figure 8 depicts the energy consumption versus λ. Energy consumption is the total energy used to *successfully transmit* a packet. It includes the energy of the control packets and the lost energy in retransmitting data and control packets in case of collisions. For almost all cases, CA-CDMA requires less than 50% of the energy required under the 802.11 scheme. This may, at first, seem to counterintuitive, since in Section 4.5 the interference margin was chosen so that both protocols consume the same energy per packet. However, according to the topology we examine here, the transmitter-receiver separation distance is not uniform. More links are formed with neighbors that are much closer than the maximum transmission range (1061 meters in our simulations). Unlike the 802.11 scheme, CA-CDMA makes use of shorter links to save energy. Note that in both protocols, the required energy increases with the load. The reason for this is that as λ increases, the probability of collisions also increases, and hence, more energy has to be spent on retransmissions.

In Part (c) of Figure 8 we investigate the effect of varying the number of nodes while the dimensions of the region are kept fixed (3000m×3000m). Persistent load is used in this experiment, i.e., nodes always have packets to send. As

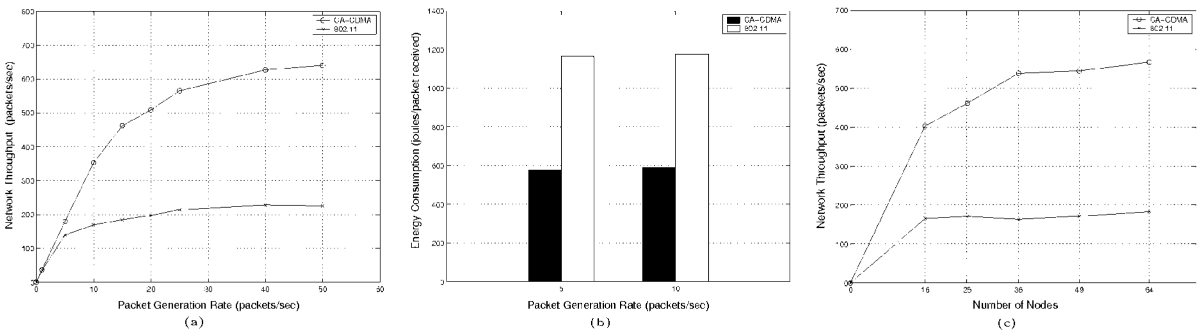

Figure 8: Performance of the CA-CDMA and the 802.11 protocols (random grid topologies).

shown in the figure, the throughput enhancement due to CA-CDMA increases with node density. This can be explained by noting that CA-CDMA bounds the transmission power rather that prevents simultaneous transmissions. Therefore, as the density of nodes increases, more concurrent links are formed and the network throughput increases. The 802.11 scheme reserves a fixed floor, and thus, all nodes within that floor have to defer their transmissions. Therefore, the density of the nodes has little effect on the 802.11 throughput.

The authors in [20] argued that traffic locality is the key factor in determining the feasibility of large ad hoc networks. This motivates studying the performance of CA-CDMA under *clustered* topologies. In such topologies, a node communicates mostly with nodes within its own cluster, and rarely with neighboring cluster nodes. These topologies are common in practice (e.g., a historical site where users of wireless devices move in groups). To generate a clustered topology, we consider an area of dimensions 1000×1000 (in meters). We let $M = 24$ nodes, which are split into 4 equal groups, each occupying a 100×100 square in one of the corners of the complete area. For a given source node, the destination is selected from the same cluster with probability $1 - p$ or from a different cluster with probability p. In each case, the selection from within the given cluster(s) is done randomly.

Part (a) of Figure 9 depicts the network throughput versus λ for $p = 0.25$. According to the 802.11 scheme, only one transmission can proceed at a time since all nodes are within the carrier-sense range of each other. However, according to CA-CDMA, three to four transmissions can proceed simultaneously, resulting in a significant improvement in network throughput. In Part (b) of the figure, we further investigate the locality of the traffic by fixing λ and varying p. Indeed, as the figure shows, the locality of the traffic can highly impact the network throughput of CA-CDMA, while the 802.11 performance is almost unchanged. As the traffic locality increases (i.e., p decreases) the enhancement of CA-CDMA increases.

6. CONCLUSIONS AND FUTURE WORK

In this paper, we proposed a CDMA-based power controlled MAC protocol for wireless ad hoc networks. This protocol, called CA-CDMA, accounts for the multiple access interference, thereby solving the near-far problem that undermines the throughput performance in MANETs. CA-CDMA uses channel-gain information obtained from overheard RTS and CTS packets over an out-of-band control channel to dynamically bound the transmission power of mobile terminals in the vicinity of a receiver. It adjusts the required transmission power for data packets to allow for interference-limited simultaneous transmissions to take place in the neighborhood of a receiving terminal.

We compared the performance of our protocol with that of the IEEE 802.11 scheme. Our simulation results showed that CA-CDMA can improve the network throughput by up to 280% and, at the same time, achieve 50% reduction in the energy consumed to successfully deliver a packet from the source to the destination. To the best of our knowledge, CA-CDMA is the first protocol to provide a solution to the near-far problem in CDMA ad hoc systems at the protocol level.

Our future work will focus on other capacity optimizations such as the use of directional antennas in CDMA-based protocols. Because of MAI effects, CDMA benefits significantly from smart antennas. Variable rate support is another optimization that we have not considered in this work. In [13] the authors showed that adapting the transmit power, data rate, and coding scheme achieves maximum spectral efficiency. The 802.11 scheme allows nodes to increase their information rate up to 11 Mbps when the power at the receiver is far more than necessary to achieve 2 Mbps. It could be possible to improve the proposed scheme by increasing the information rate (i.e, decreasing the prossing gain) when the MAI is much less than the planned interference margin (i.e., load is low). This is desirable to allow the developed protocol to adapt to different working conditions in terms of the load offered by the users in the network.

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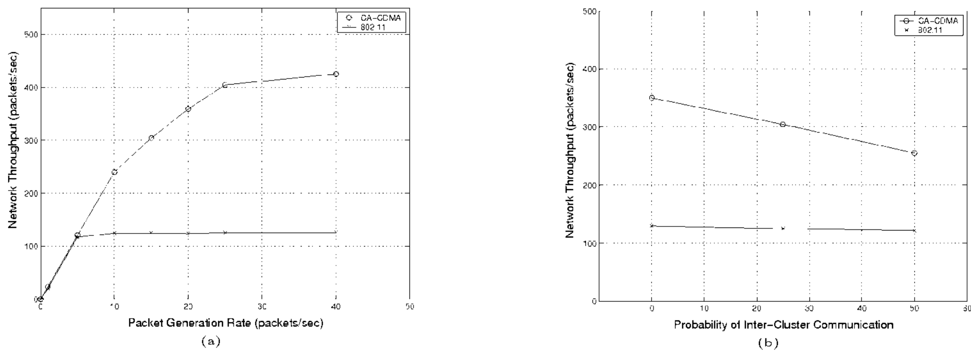

Figure 9: Performance of the CA-CDMA and 802.11 protocols as a function of λ (clustered topologies).

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CLAIMS

I claim:

1. (Currently Amended) A wireless digital audio headphone comprising:

a portable digital audio headphone receiver configured to receive a unique user code bit sequence and a original audio signal representation in the form of packets, said digital audio headphone receiver, capable of mobile operation and configured for direct digital wireless spread spectrum communication with a mobile digital audio transmitter ~~portable digital audio headphone receiver comprising;~~

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to said headphone receiver and said mobile digital audio transmitter, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code; ~~capture said packets embedded in the received spread spectrum signal;~~

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode reduced intersymbol interference coding of original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output in response to the unique user code bit sequence being recognized, said audio having been wirelessly transmitted and reproduced virtually free from interference from device transmitted signals operating in the wireless headphone spectrum.

2. (Currently Amended) A wireless digital audio headphone for receipt of a unique user code and a digital audio music representation signal in the form of a packet, said wireless digital audio headphone comprising:

a digital audio receiver, capable of mobile operation, configured for direct digital wireless spread spectrum communication with a mobile digital audio transmitter;

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio music representation signal respective to said headphone and said mobile digital audio transmitter, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code; ~~capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;~~

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

an interleaver to reduce transmission errors; and

a decoder operative to decode the applied reduced intersymbol interference coding of said audio music representation signal; and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence is being recognized, said audio having been wirelessly transmitted and reproduced virtually free from interference from device transmitted signals operating in the wireless headphone spectrum.

3. (Currently Amended) A wireless digital audio transmitter operatively coupled to a portable audio source and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio source, and configured to be directly communicable with a mobile receiver, is capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference to aid in lowering signal detection error of said audio representation signal respective to said mobile receiver and mobile said digital audio transmitter coupled to said audio source;

a channel encoder to reduce transmission errors; and

a digital modulator module configured for independent code division multiple access (CDMA) communication operation, said audio having been wirelessly transmitted and reproduced virtually free from interference from device transmitted signals operating in the wireless digital audio transmitter spectrum..

4. (Currently Amended) ~~A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said wireless digital audio receiver comprising:~~

~~a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;~~

~~a digital demodulator configured for independent CDMA communication operation;~~

~~a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;~~

~~a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and~~

~~a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio source virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.~~

A mobile wireless digital audio receiver, configured to receive a unique user code and a original audio signal representation in the form of packets, said unique user code configured to spread the spectrum of said signal and further configured for independent communication operation, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said mobile wireless digital audio receiver comprising:

a direct conversion module configured to capture packets and a correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to said mobile wireless digital audio receiver and said mobile digital audio transmitter, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation, said audio having been wirelessly transmitted and reproduced virtually free from interference from device transmitted signals operating in the wireless digital audio receiver spectrum.

5. (Currently Amended) A ~~wireless~~ digital audio transmitter operatively coupled to a ~~portable~~ audio source and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio source ~~and~~ is configured to be ~~directly~~ communicable with a ~~mobile~~ wireless digital audio receiver, said receiver utilizes fuzzy set membership functionality to enhance detection of said unique user code. ~~is capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:~~

~~an encoder operative to encode said original audio signal representation to reduce intersymbol interference;~~

~~an interleaver to reduce transmission errors; and~~

~~a digital modulator module configured for CDMA communication; independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation.~~

6. (Currently Amended) A wireless digital audio receiver ~~, capable of mobile operation,~~ configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further

configured to be ~~directly~~ communicable with a ~~mobile~~ digital audio transmitter, said wireless digital audio receiver comprising fuzzy set membership functionality to enhance detection of said unique user code.

~~a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;~~

~~a digital demodulator configured for independent CDMA communication operation;~~

~~an de-interleaver generating a corresponding digital output;~~

~~a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;~~

~~a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and~~

~~a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio source virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.~~

7. (Currently Amended) A wireless digital audio receiver for receipt of a unique user code and a digital music audio representation signal in a packet format, the unique user code configured to spread the said signal spectrum and further configured for independent communication operation, said wireless digital audio receiver comprising fuzzy set membership functionality to enhance detection of said unique user code.

~~a digital audio receiver, capable of mobile operation, configured for direct digital wireless communication with a mobile digital audio transmitter, wherein said mobile digital audio transmitter is operatively coupled to a portable audio player;~~

~~a direct conversion module configured to capture the packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;~~

~~a decoder operative to decode the applied reduced intersymbol interference coding of said audio representation signal; and~~

~~a digital–to–analog converter generating an audio output of said digital audio representation signal; and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence being recognized; said audio output being virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.~~

8. (Currently Amended) ~~A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and an original audio signal representation in the form of packets, the unique user code configured to spread the said signal spectrum and further configured for independent communication operation, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, wherein said mobile digital audio transmitter is operatively coupled to a portable audio player, said wireless digital audio receiver comprising:~~

~~a direct conversion module configured to capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;~~

~~a decoder operative to decode applied reduced intersymbol interference coding of said original audio signal representation ; and~~

~~a digital-to-analog converter generating an audio output of said original audio signal representation;~~

~~and a module adapted to reproduce said generated audio output, in response to the unique user code being recognized; said audio output being virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.~~

A mobile wireless digital audio receiver, configured to receive a unique user code and a original audio signal representation in the form of packets, said unique user code configured to spread the spectrum of said signal and further configured for independent communication operation, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said mobile wireless digital audio receiver comprising fuzzy set membership functionality to enhance detection of said unique user code;

9. (Currently Amended) A wireless digital audio transmitter operatively coupled to a portable audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver, is mobile, ~~and capable of being moved in any direction during operation,~~ the unique user code configured to spread the spectrum of said signal and further configured for independent communication operation, the mobile receiver utilizes fuzzy set membership functionality to enhance detection of said unique user code, said wireless digital audio transmitter comprising: an encoder operative to encode said original audio signal representation to reduce intersymbol interference to aid in lowering signal detection error of said audio representation signal respective to said mobile receiver and mobile said digital audio transmitter coupled to said audio player.

10. (Currently Amended) A portable wireless digital audio system for digital transmission of an original audio signal representation from a portable audio player to a portable digital audio headphone receiver, said portable wireless digital audio system comprising:

a digital audio transmitter operatively coupled to said portable audio player and transmitting a unique user code bit sequence with said original audio signal representation in packet format, wherein said digital audio transmitter operatively coupled to said audio player is capable of mobile operation, said digital audio transmitter comprising:

a encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent CDMA communication operation;

said digital audio transmitter configured for direct digital wireless communication with said portable digital audio headphone receiver, said portable digital audio headphone receiver comprising:

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to said headphone and mobile said digital audio transmitter operatively coupled to said audio player, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code; ~~capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code bit sequence;~~

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode the applied reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from said portable audio player and reproduced virtually free from interference from device transmitted signals operating in the wireless digital audio system spectrum.

11. (Currently Amended) A portable wireless digital audio system for digital transmission of an original audio signal representation from a portable audio player to a digital audio receiver, said portable wireless digital audio system comprising:

a digital audio transmitter operatively coupled to said audio player and transmitting a unique user code with said original audio signal representation in packet format, wherein said digital audio transmitter coupled to said audio player is

capable of being moved in any direction during operation, said digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference;

a digital modulator module configured for independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation;

said digital audio receiver capable of being moved in any direction during operation and in direct wireless communication with said digital audio transmitter, said digital audio receiver comprising:

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to said mobile digital audio receiver and mobile said digital audio transmitter operatively coupled to said audio player, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code; ~~capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code bit sequence;~~

a digital demodulator configured for independent CDMA communication operation;

a decoder operative to decode the applied reduced inter-symbol interference coding of said original audio signal representation;

a digital-to-analog converter generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from said audio player virtually free from interference from device transmitted signals operating in the wireless digital audio system spectrum.

12. (Currently Amended) A wireless digital audio receiver, capable of mobile operation, configured to receive a unique user code and a original audio signal representation in the form of packets, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said wireless digital audio receiver comprising:

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to mobile said digital audio receiver and said mobile digital audio transmitter, said packets embedded in a received spread spectrum signal, the captured packets corresponding to the unique user code; ~~capture packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;~~

a digital demodulator configured for independent code division multiple access communication operation;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter (DAC) generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from a portable audio player virtually free from interference from device transmitted signals operating in the digital wireless audio receiver spectrum.

13. (Currently Amended) A wireless digital audio headphone for receipt of a unique user code and a digital audio music representation signal in the form of a packet, said wireless digital audio headphone comprising:

a mobile digital audio receiver configured for direct digital wireless communication with a mobile digital audio transmitter;

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to said headphone and said mobile digital audio transmitter, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code; ~~packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;~~

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

a decoder operative to ~~receive and apply coding to reduce intersymbol interference of said audio representation signal respective to said headphone and said mobile digital audio transmitter;~~ decode reduced intersymbol interference coding of said original audio signal representation; and

a digital-to-analog converter (DAC) generating an audio output of said digital audio music representation signal; and a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted and reproduced virtually free from interference from device transmitted signals operating in the wireless headphone spectrum.

14. (Currently Amended) A mobile wireless digital audio receiver, configured to receive a unique user code and a original audio signal representation in the form of packets, said unique user code configured to spread the spectrum of said signal and further configured for independent communication operation, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said mobile wireless digital audio receiver comprising:

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to said mobile wireless digital audio receiver and said mobile digital audio transmitter, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to ~~receive and apply coding to reduce intersymbol interference of said audio representation signal respective to said mobile wireless digital audio receiver and said mobile digital audio transmitter~~ decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted and reproduced virtually free from interference from device transmitted signals operating in the wireless digital audio receiver spectrum.

15. (Currently Amended) A mobile wireless digital audio receiver, configured to receive a unique user code and a original audio signal representation in the form of packets, said unique user code configured to spread the spectrum of said signal and further configured for independent communication operation, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said mobile wireless digital audio receiver comprising:

fuzzy set membership functionality to enhance detection of said unique user code;

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to said mobile digital audio receiver and said mobile digital audio transmitter, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from an audio player and reproduced virtually free from interference from device transmitted signals operating in the wireless digital audio receiver spectrum.

~~A wireless digital audio transmitter operatively coupled to a portable audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver and capable of being moved in any direction during operation, said wireless digital audio transmitter comprising:~~

~~an encoder operative to encode said original audio signal representation to reduce intersymbol interference;~~

~~a digital modulator module configured for independent code division multiple access (CDMA) communication operation.~~

16. (Currently Amended) A wireless digital audio headphone for receipt of a unique user code and a digital audio representation signal in the form of a packet, said unique user code configured to spread the spectrum of said signal and further configured for independent communication operation, the wireless digital audio headphone further configured to be directly communicable with a mobile digital audio transmitter, said wireless digital audio headphone comprising:

fuzzy set membership functionality to enhance detection of said unique user code;

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to said headphone and said mobile digital audio transmitter, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from an audio player and reproduced virtually free from interference from device transmitted signals operating in the wireless headphone spectrum.

~~A wireless digital audio transmitter operatively coupled to a audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver, is mobile, said wireless digital audio transmitter comprising:~~

~~an encoder operative to encode said original audio signal representation to reduce intersymbol interference respective to mobile said digital audio transmitter coupled to said audio player and said mobile receiver; and~~

~~a digital modulator module configured for independent code division multiple access (CDMA) communication operation and utilizing differential phase shift keying (DPSK) to modulate said original audio signal representation;~~

17. (Currently Amended) A mobile wireless digital audio receiver, configured to receive a unique user code and a original audio music signal representation in the form of packets, said unique user code configured to spread the spectrum of said music signal and further configured for independent communication operation, the wireless digital audio receiver further configured to be directly communicable with a mobile digital audio transmitter, said mobile wireless digital audio receiver comprising:

fuzzy set membership functionality to enhance detection of said unique user code;

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio music representation signal respective to said mobile digital audio receiver and said mobile digital audio transmitter, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;

a decoder operative to decode reduced intersymbol interference coding of said original audio signal representation;

a digital-to-analog converter generating an audio output of said original audio signal representation; and

a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from an audio player and reproduced virtually free from interference from device transmitted signals operating in the wireless digital audio receiver spectrum.

A wireless digital audio transmitter operatively coupled to a portable audio player and configured to transmit a unique user code and an original audio signal representation in the form of packets, wherein said digital audio transmitter coupled to said audio player, and configured to be directly communicable with a wireless mobile receiver, is mobile, the unique user code configured to spread the spectrum of said signal and further configured for independent communication operation, said wireless digital audio transmitter comprising:

an encoder operative to encode said original audio signal representation to reduce intersymbol interference respective to mobile said digital audio transmitter coupled to said audio player and said mobile receiver.

18. (Currently Amended) A wireless digital audio headphone for receipt of a unique user code and a digital audio representation signal in the form of a packet, said wireless digital audio headphone comprising:

a mobile digital audio receiver configured for direct digital wireless spread spectrum communication with a mobile digital audio transmitter;

a direct conversion module configured to capture packets and the correct bit sequence within the packets aided by lowering signal detection error through reduced intersymbol interference coding of said audio representation signal respective to said headphone and said mobile digital audio transmitter, said packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code; ~~packets embedded in the received spread spectrum signal, the captured packets corresponding to the unique user code;~~

a digital demodulator module configured for independent code division multiple access (CDMA) communication operation;

a decoder operative to ~~receive and apply coding to reduce intersymbol interference of said audio representation signal respective to said headphone and said mobile digital audio transmitter~~ decode reduced intersymbol interference coding of said original audio signal representation; and

a digital-to-analog converter generating an audio output of said digital audio representation signal; and a module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted and reproduced virtually free from interference from device transmitted signals operating in the wireless headphone spectrum.

Electronic Acknowledgement Receipt

EFS ID:	11624257
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	Wireless Digital Audio Music System
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	15-DEC-2011
Filing Date:	05-NOV-2010
Time Stamp:	11:02:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Arguments/Remarks Made in an Amendment	SubmittedResponse.pdf	1349231 a4834a6420b287e012fd620132a6e3f56f70f8c9	no	26

Warnings:

Information:

2	Claims	Megan_12940747_RCE_ClaimAmendments_RevD_Final.pdf	120073 88d8a4233ef122bb459c997699356361660af1b	no	16
Warnings:					
Information:					
		Total Files Size (in bytes):	1469304		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 12/940,747	Filing Date 11/05/2010	☐ To be Mailed

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY ☒ RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
			TOTAL			TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT 12/15/2011	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 18	Minus	** 20	= 0	X $30 =	0	OR	X $ =	
Independent (37 CFR 1.16(h))	* 18	Minus	***18	= 0	X $125 =	0	OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE	0	OR	TOTAL ADD'L FEE	

AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/KELLY HARRIS/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

68533 7590 01/24/2012

MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

EXAMINER	
FLANDERS, ANDREW C	
ART UNIT	PAPER NUMBER
2614	

DATE MAILED: 01/24/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/940,747	11/05/2010	C. Earl Woolfork	1028.5	8175

TITLE OF INVENTION: WIRELESS DIGITAL AUDIO MUSIC SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$870	$300	$0	$1170	04/24/2012

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

68533 7590 01/24/2012

MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/940,747	11/05/2010	C. Earl Woolfork	1028.5	8175

TITLE OF INVENTION: WIRELESS DIGITAL AUDIO MUSIC SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$870	$300	$0	$1170	04/24/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
FLANDERS, ANDREW C	2614	700-094000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   - ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
   (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
   1 ______
   2 ______
   3 ______

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies ______

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number ______ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
- ❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature ______ Date ______

Typed or printed name ______ Registration No. ______

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/940,747	11/05/2010	C. Earl Woolfork	1028.5	8175

68533 7590 01/24/2012

MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

EXAMINER	
FLANDERS, ANDREW C	
ART UNIT	PAPER NUMBER
2614	

DATE MAILED: 01/24/2012

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

PTOL-85 (Rev. 02/11)

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 12/940,747	Applicant(s) WOOLFORK, C. EARL	
	Examiner Andrew C. Flanders	Art Unit 2614	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the amendment filed 15 December 2011*.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are *1,2,10-13 and 15-18*.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☒ Examiner's Amendment/Comment
8. ☐ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

/Andrew C Flanders/
Primary Examiner, Art Unit 2614

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Megan Lyman on 05 January 2012.

The application has been amended as follows:

3. (Cancelled)

4. (Cancelled)

5. (Cancelled)

6. (Cancelled)

7. (Cancelled)

8. (Cancelled)

9. (Cancelled)

14. (Cancelled)

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Andrew C. Flanders whose telephone number is (571)272-7516. The examiner can normally be reached on M-F 8:30 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Curtis Kuntz can be reached on (571) 272-7499. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Andrew C Flanders/
Primary Examiner, Art Unit 2614

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12940747	WOOLFORK, C. EARL
	Examiner	**Art Unit**
	ANDREW C FLANDERS	2614

ORIGINAL		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
700	94	G	0	6	F	17 / 00 (2006.01.01)						

CROSS REFERENCE(S)

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	8	17												
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6	15														
7	16														

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 9	
/ANDREW C FLANDERS/ Primary Examiner.Art Unit 2614 (Primary Examiner)	01/09/2012 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12940747	WOOLFORK, C. EARL
	Examiner	**Art Unit**
	ANDREW C FLANDERS	2614

SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES

Search Notes	Date	Examiner
see history attached	5/2/11	acf
reviewed and repeated search history (including class search) of parent application 12/570,343	5/2/11	acf
edan, east and palm inventor search for double patenting	5/2/11	acf
updated	11/3/11	acf
updated	1/9/12	acf

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
700	94	1/9/12	acf

/ANDREW C FLANDERS/
Primary Examiner.Art Unit 2614

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	9	FHSS with unique with user	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:30
S2	6	S1 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:45
S3	0	FHSS with unique adj hop	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:46
S4	0	FHSS with each adj user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:46
S5	0	FHSS with individual adj user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:47
S6	0	(FHSS or "frequency hopping spread spectrum") with individual adj user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:47
S7	0	(FHSS or "frequency hopping spread spectrum") near user same unique	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:47
S8	9	(FHSS or "frequency hopping spread spectrum") with user same unique	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:48
S9	17	(FHSS or "frequency hopping spread spectrum") same unique same user	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:48
S10	6	S9 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:48
S11	9	(FHSS or "frequency hopping spread spectrum") same multiple adj user!	US-PGPUB; USPAT	OR	OFF	2006/05/03 10:32
S12	91	(FHSS or "frequency hopping spread spectrum") same (pn or "hopping code")	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:50
S13	13	(FHSS or "frequency hopping spread spectrum") with ("hopping code")	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:50
S14	3	S13 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2006/05/02 17:51
S15	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2006/05/03 11:46
S16	1	("6342844").PN.	US-PGPUB; USPAT	OR	OFF	2006/05/03 11:46
S17	1	("5771441").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:55
S18	10725	"rechargeable battery" and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:55
S19	376	"rechargeable battery".ti. and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:55
S20	17	("rechargeable battery" and portable).ti. and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S21	3623043	("rechargeable battery" and portable) with mah andd @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S22	0	("rechargeable battery" and portable) with mah and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57

S23	3623041	("rechargeable battery" and portable) with ma-h andd @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S24	3623041	("rechargeable battery" and portable) with "ma-h" andd @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S25	0	("rechargeable battery" and portable) with "ma-h" and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S26	640693	("rechargeable battery" and portable) with milliamp hours and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/28 15:57
S27	18	("rechargeable battery" and portable) and "milliamp hours" and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2006/08/31 12:17
S28	29	"5491839"	US-PGPUB; USPAT	OR	OFF	2006/08/30 12:56
S29	1	("5491839").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/30 12:56
S30	1	("5771441").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/30 12:56
S31	1	("6,107,147").PN.	US-PGPUB; USPAT	OR	OFF	2006/08/31 12:17
S32	0	(10/648012).APP.	US-PGPUB; USPAT	OR	OFF	2006/09/25 09:26
S33	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2006/09/25 09:50
S34	422	(455/564.1,412,413).CCLS.	US-PGPUB; USPAT	OR	OFF	2006/09/25 09:50
S35	5294	(375/219,295-297,346,348).CCLS.	US-PGPUB; USPAT	OR	OFF	2006/09/25 10:02
S36	1	("20040223622").PN.	US-PGPUB; USPAT	OR	OFF	2006/09/25 10:04
S37	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2006/09/25 10:05
S38	1	("7,050,419").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:32
S39	1	("20010025358").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:37
S40	2618	(375/341,140,147).CCLS.	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:37
S41	1807	S40 and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2007/03/20 09:38
S42	8	("2001/0025358").URPN.	USPAT	OR	OFF	2007/03/20 09:51
S43	0	("2002/0025009").URPN.	USPAT	OR	OFF	2007/03/20 09:59
S44	0	("2002/0025009").URPN.	USPAT	OR	OFF	2007/03/20 10:01
S45	12	("20020159543" | "5434623" | "5867532" | "5973642" | "6243423" | "6327314" | "6339612" | "6459728" | "6477210" | "6480554" | "6654429" | "6671338").PN. OR ("7099413").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:08
S46	74	"band pass" and demodulator and interleaver and "viterbi decoder"	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:08

S47	59	S46 and @ad<"20011220"	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:08
S48	17	("4278978" | "4635063" | "5175558" | "5493307").PN. OR ("6130643").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:15
S49	1	("5175558").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 10:16
S50	13	("4651155" | "4931977").PN. OR ("5175558").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/03/20 10:34
S51	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/20 11:40
S52	7186	(375/295,146,130,340,316,148).CCLS.	US-PGPUB; USPAT	OR	OFF	2007/03/20 11:41
S53	4473	S52 and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2007/03/20 11:41
S54	1	("20040223622").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:11
S55	5	"reed solomon" with "intersymbol interference"	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:13
S56	30	"reed solomon" same "intersymbol interference"	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:13
S57	21	S56 and @ad<"20011220"	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:27
S58	1	("20030045235").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:37
S59	1	("5790595").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/21 12:37
S60	2435	((375/262,265,341) or (714/794,795)).CCLS.	US-PGPUB; USPAT	OR	OFF	2007/03/24 09:15
S62	56	"375".clas. and "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2007/03/26 11:04
S64	1	("4970637").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 13:46
S65	755	(audio sound music voice) same (a/d "analog to digital") same (lpf "low pass")	US-PGPUB; USPAT	OR	OFF	2007/03/28 13:46
S66	282	(audio sound music voice) with (a/d "analog to digital") with ((lpf "low pass") and "digital")	US-PGPUB; USPAT	OR	OFF	2007/03/28 13:47
S67	227	(audio sound music voice) with (a/d "analog to digital") with ((lpf "low pass") and "digital") and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:33
S68	34712	"band pass filter" bpf with "direct conversion receiver"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:33
S69	35	("band pass filter" bpf) with "direct conversion receiver"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:33
S70	8	S69 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2007/03/28 15:55
S71	1	("20030045235").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:16
S72	1	("20040223622").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:20

S73	1	("5946343").PN.	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S74	364	"64-ary"	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S75	74	"64-ary" near modulat$4	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S76	46	S75 and @ad<"20011120"	US-PGPUB; USPAT	OR	OFF	2007/03/28 16:27
S77	2	(("4970637") or ("5790595")).PN.	US-PGPUB; USPAT	OR	OFF	2007/07/16 09:58
S78	3	(("4970637") or ("5790595") or ("20040223622")).PN.	US-PGPUB; USPAT	OR	OFF	2007/07/16 09:58
S79	3	("2004/0223622").URPN.	USPAT	OR	OFF	2007/07/16 11:25
S80	1	("5771441").PN.	US-PGPUB; USPAT	OR	OFF	2007/07/16 11:25
S81	60	("2236946" | "2828413" | "2840694" | "3080785" | "3085460" | "3087117" | "3296916" | "3579211" | "3743751" | "3781451" | "3825666" | "3863157" | "3901118" | "3906160" | "4004228" | "4229826" | "4335930" | "4344184" | "4369521" | "4430757" | "4453269" | "4464792" | "4471493" | "4612688" | "4647135" | "4721926" | "4794622" | "4845751" | "4899388" | "4988957" | "5025704" | "5214568").PN. OR ("5771441").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/16 11:26
S82	2	S81 and cdma	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/16 11:26
S83	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2008/05/20 11:41
S84	1	("20020072816").PN.	US-PGPUB; USPAT	OR	OFF	2008/05/20 14:24
S85	22	"fuzzy logic" and modulat$5 and filter and (dpsk "phase shift key")	US-PGPUB; USPAT	OR	OFF	2008/06/06 09:20
S86	0	"455".clas. and "375".clas. and S85	US-PGPUB; USPAT	OR	OFF	2008/06/06 09:21
S87	1	"10100351"	US-PGPUB; USPAT	OR	OFF	2008/06/06 11:49
S88	1	("6,678,892").PN.	US-PGPUB; USPAT	OR	OFF	2008/06/06 12:38
S89	3	("20030021429" | "20030076346" | "6867820").PN.	US-PGPUB; USPAT	OR	OFF	2008/06/06 12:42
S90	13	("4589134" | "4626892" | "5042070" | "5541638" | "5581621" | "5631850" | "5775939" | "6100936" | "6195438").PN. OR ("6867820").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/06 12:43
S91	2	"10648012"	US-PGPUB; USPAT	OR	OFF	2009/02/14 10:23
S92	1	"12144729"	US-PGPUB; USPAT	OR	OFF	2009/02/14 10:31
S93	1	("5790595").PN.	US-PGPUB; USPAT	OR	OFF	2009/02/14 12:36

S94	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2009/02/14 12:37
S95	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2009/05/26 07:51
S96	1680	portable and music and CDMA and transmitter and receiver	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:35
S97	527	portable and music and CDMA and transmitter and receiver and private	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:35
S98	57	portable and music and CDMA and transmitter and receiver and private and "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:35
S99	0	S98 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:36
S100	41	S97 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:36
S101	1	("6678692").PN.	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:39
S102	1	("6678892").PN.	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:39
S103	25	("5555466" | "5771441" | "6058288" | "6243645" | "6266815" | "6300880" | "6317039").PN. OR ("6678892").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:39
S104	63	("2236946" | "2828413" | "2840694" | "3080785" | "3085460" | "3087117" | "3296916" | "3579211" | "3743751" | "3781451" | "3825666" | "3863157" | "3901118" | "3906160" | "4004228" | "4229826" | "4335930" | "4344184" | "4369521" | "4430757" | "4453269" | "4464792" | "4471493" | "4612688" | "4647135" | "4721926" | "4794622" | "4845751" | "4899388" | "4988957" | "5025704" | "5214568").PN. OR ("5771441").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:42
S105	10	("20030045235" | "20040223622" | "5491839" | "5771441" | "5790595" | "5946343" | "6342844" | "6418558" | "6678892" | "6982132").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:42
S106	4453	"fuzzy logic" and @ad<"20011221"	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:48
S107	659	S106 and transmitter	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:48
S108	591	S106 and portable	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:48
S109	4	S106 and portable adj player	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:49
S110	0	"fuzzy logic" with reciever	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:50
S111	49	"fuzzy logic" with receiver	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:50

S112	27	S111 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:50
S113	192	"fuzzy logic" same receiver	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/01 11:51
S114	72	S113 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/01 11:52
S115	71	("4019141" | "4229829" | "5264795" | "5404577" | "5437057" | "5568516" | "5694467" | "5771438" | "5771441" | "5867223" | "5978689" | "6006115").PN. OR ("6424820").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2009/09/02 11:27
S116	34	S115 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:28
S117	31	bluetooth with (headphone headset earphone "head phone" "head set" "ear phone") with cdma	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:32
S118	2	S117 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:32
S119	32	wireless with (headphone headset earphone "head phone" "head set" "ear phone") with cdma	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:33
S120	3	S119 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:33
S121	57	(headphone headset earphone "head phone" "head set" "ear phone") with cdma	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:34
S122	10	S121 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:34
S123	0	WO0056093	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:36
S124	0	WO0056093	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2009/09/02 11:37
S125	0	WO/0056093	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2009/09/02 11:37
S126	2	(("5781542") or ("5799005")).PN.	US-PGPUB; USPAT	OR	OFF	2009/09/02 11:42
S127	1	("6199076").PN.	US-PGPUB; USPAT	OR	OFF	2009/09/02 13:51
S128	0	woolfork-earl.in.	US-PGPUB; USPAT	OR	OFF	2009/11/23 11:44
S129	3	woolfork-c-$.in.	US-PGPUB; USPAT	OR	OFF	2009/11/23 11:44
S139	1	("7412294").PN.	US-PGPUB; USPAT	OR	OFF	2010/01/11 12:21
S140	1	("7412294").PN.	US-PGPUB;	OR	OFF	2010/06/01

			USPAT			09:29
S141	3	"12144729"	US-PGPUB; USPAT	OR	OFF	2010/06/01 09:34
S142	843	cdma and "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S143	66	S142 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S144	14	cdma same "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S145	5	S144 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:46
S146	11	code same wireless same "fuzzy logic"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:49
S147	2	S146 and @ad<"20011221"	US-PGPUB; USPAT	OR	OFF	2010/10/18 09:49
S148	2704	(700/94).CCLS.	US-PGPUB; USPAT	OR	OFF	2010/10/21 12:51
S149	3	(("7412294") or ("7865258") or ("7684885")).PN.	US-PGPUB; USPAT	OR	OFF	2011/05/02 14:06
S150	1	("6418558").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/11/03 09:41
S151	1	("6678892").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/11/03 09:42
S152	1	S150 and reed same intersymbol	US-PGPUB; USPAT; USOCR	OR	OFF	2011/11/03 10:03

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	31	(700/94).CCLS.	UPAD	OR	OFF	2012/01/09 11:39
S130	0	woolfork-earl.in.	USPAT; UPAD	OR	OFF	2009/11/23 11:44
S131	1	woolfork-c-$.in.	USPAT; UPAD	OR	OFF	2009/11/23 11:44
S132	195	(700/94).CCLS.	UPAD	OR	OFF	2009/11/23 11:59
S133	225	((700/94) or (455/3.06)).CCLS.	UPAD	OR	OFF	2010/01/11 11:18

1/9/2012 11:47:07 AM
C:\Users\aflanders\Documents\EAST\Workspaces\12940747.wsp

Index of Claims	Application/Control No. 12940747	Applicant(s)/Patent Under Reexamination WOOLFORK, C. EARL
	Examiner ANDREW C FLANDERS	Art Unit 2614

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE									
Final	Original	05/02/2011	11/03/2011	01/09/2012							
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9	17		✓	=							
10	18		✓	=							

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

68555 7590 01/24/2012
MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

OPAP JAN 27 2012 PATENT & TRADEMARK OFFICE

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/940,747	11/05/2010	C. Earl Woolfork	1028.5	8175

TITLE OF INVENTION: WIRELESS DIGITAL AUDIO MUSIC SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$870	$300	$0	$1170	04/24/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
FLANDERS, ANDREW C	2614	700-094000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list
(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Megan Lyman
2 ______
3 ______

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: One-E-Way, Inc.
(B) RESIDENCE: (CITY and STATE OR COUNTRY): Pasedena, CA

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies ______

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)
☐ A check is enclosed.
☒ Payment by credit card. Form PTO-2038 is attached.
☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number ______ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)
☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature [signature] Date 01/27/2012
Typed or printed name Megan Lyman Registration No. 57054

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PTOL-85 (Rev. 02/11) Approved for use through 08/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

01/30/2012 EEKUBAY2 00000016 12940747
01 FC:2501 870.00 OP
02 FC:1504 300.00 OP

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/940,747	11/05/2010	2614	2412	1028.5	6	6

CONFIRMATION NO. 8175

CORRECTED FILING RECEIPT

68533
MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

OC000000052373460

Date Mailed: 02/03/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

C. Earl Woolfork, Pasadena, CA;

Power of Attorney: The patent practitioners associated with Customer Number 68533

Domestic Priority data as claimed by applicant

This application is a CON of 12/570,343 09/30/2009 PAT 7865258
which is a CON of 10/648,012 08/26/2003 PAT 7412294 *
which is a CIP of 10/027,391 12/21/2001 ABN *
(*)Data provided by applicant is not consistent with PTO records.

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 11/17/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/940,747**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****

Title

WIRELESS DIGITAL AUDIO MUSIC SYSTEM

Preliminary Class

700

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/940,747	03/06/2012	8131391	1028.5	8175

68533 7590 02/15/2012
MEGAN LYMAN
1816 SILVER MIST CT.
RALEIGH, NC 27613

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

C. Earl Woolfork, Pasadena, CA;

PTO/SB/44 (09-07)
Approved for use through 08/31/2013. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 8131391

APPLICATION NO.: 12/940,747

ISSUE DATE : 03/06/2012

INVENTOR(S) : C. Earl Wolfork

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Claim 2 after "(CDMA) communication operation;" insert

--- a de-interleaver --

and cancel "an interleaver"

and delete "is" from: and a module adapted to reproduce said generated audio output, in response to the unique user code bit sequence "is" being recognized

MAILING ADDRESS OF SENDER (Please do not use customer number below):

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	12940747
Filing Date:	05-Nov-2010
Title of Invention:	WIRELESS DIGITAL AUDIO MUSIC SYSTEM
First Named Inventor/Applicant Name:	C. Earl Woolfork
Filer:	Megan Elizabeth Lyman
Attorney Docket Number:	1028.5

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Certificate of correction	1811	1	100	100
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**100**

Electronic Acknowledgement Receipt

EFS ID:	12372345
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	WIRELESS DIGITAL AUDIO MUSIC SYSTEM
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	22-MAR-2012
Filing Date:	05-NOV-2010
Time Stamp:	16:59:21
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$100
RAM confirmation Number	4236
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Request for Certificate of Correction	CertofCorrClaim2.pdf	164227 0863ea3f477e0b4fe0791ecd1a9a17aa76ed4c03	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30038 bd999d437926bd1fc0ea215c7eee5123c740d54e	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	194265	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,131,391 B2
APPLICATION NO. : 12/940747
DATED : March 6, 2012
INVENTOR(S) : C. Earl Wolfork

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 5, line 29-30, Claim 2 after "(CDMA) communication operation;" insert -- a de-interleaver --

Column 5, line 31, Claim 2 cancel "an interleaver"

Column 5, line 39, Claim 2 delete "is"

Signed and Sealed this
First Day of May, 2012

David J. Kappos
Director of the United States Patent and Trademark Office

PTO/SB/44 (09-07)
Approved for use through 08/31/2013. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.
(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 8131391

APPLICATION NO.: 12/940,747

ISSUE DATE : 03/06/2012

INVENTOR(S) : C. Earl Woolfork

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Claim 6 after "audio transmitter, said packets embedded in" insert

--- a received spread spectrum signal --

and cancel "the received spread spectrum signal"

MAILING ADDRESS OF SENDER (Please do not use customer number below):

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	12940747
Filing Date:	05-Nov-2010
Title of Invention:	WIRELESS DIGITAL AUDIO MUSIC SYSTEM
First Named Inventor/Applicant Name:	C. Earl Woolfork
Filer:	Megan Elizabeth Lyman
Attorney Docket Number:	1028.5

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Certificate of correction	1811	1	100	100
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**100**

Electronic Acknowledgement Receipt

EFS ID:	12990870
Application Number:	12940747
International Application Number:	
Confirmation Number:	8175
Title of Invention:	WIRELESS DIGITAL AUDIO MUSIC SYSTEM
First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
Filer Authorized By:	
Attorney Docket Number:	1028.5
Receipt Date:	12-JUN-2012
Filing Date:	05-NOV-2010
Time Stamp:	13:20:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$100
RAM confirmation Number	10054
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Request for Certificate of Correction	CertofCorrClaim6.pdf	163966 6ac576844efb00dbfbfadab3fded0110f638f67a	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30038 930775acc8666cfb4dbc67c809a6ae9d902ed892	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	194004	

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New Applications Under 35 U.S.C. 111

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,131,391 B2
APPLICATION NO. : 12/940747
DATED : March 6, 2012
INVENTOR(S) : C. Earl Woolfork

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 7, lines 33-34, Claim 6 after "audio transmitter, said packets embedded in" delete

"the received spread spectrum signal" and insert

-- a received spread spectrum signal --.

Signed and Sealed this
Thirty-first Day of July, 2012

David J. Kappos

David J. Kappos
Director of the United States Patent and Trademark Office

AO 120 (Rev. 3/04)

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Central District of California on the following ☑ Patents or G Trademarks:

DOCKET NO.	DATE FILED 7/13/2012	U.S. DISTRICT COURT Central District of California
PLAINTIFF ONE-E-WAY, INC. CV12-06135	DEFENDANT JAYBIRD GEAR, LLC	

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 8,131,391	3/6/2012	One-E-Way, Inc.
2		
3		
4		
5		

12 JUL 16 PM 3:59

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY G Amendment G Answer G Cross Bill G Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13356949
	Filing Date	2012-24-01
	First Named Inventor	C. Earl Woolfork
	Art Unit	2656
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5048057		1991-09-10	Holmdel, Saleh	
	2	6381053		2002-04-30	Ste-foy, Fathallah	
	3	5420585		1995-05-30	Adams, W.B.	

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	1	GB2261347	GB	A	1993-05-12	Livneh,Noam		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	13356949
	Filing Date	2012-24-01
	First Named Inventor	C. Earl Woolfork
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	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

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	1		☐

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Examiner Signature		Date Considered	

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13356949
	Filing Date	2012-24-01
	First Named Inventor	C. Earl Woolfork
	Art Unit	2656
	Examiner Name	Andrew Flanders
	Attorney Docket Number	1028.5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☒ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Megan Lyman/	Date (YYYY-MM-DD)	2013-02-04
Name/Print	Megan Lyman	Registration Number	57054

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(12) UK Patent Application (19) GB (11) 2 261 347 (13) A

(43) Date of A publication 12.05.1993

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(52) UK CL (Edition L)
H4P PRV
H4L LDDRCW L1H10 L27H4 L27H7A L27H9
U1S S2204 S2213

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(58) Field of search
UK CL (Edition K) **H4L LDDRCP LDDRCW LDDRCX LDDRQ LDDRX, H4P PDCSL PR**
INT CL[5] **H03M 13/12, H04L 25/49 25/497**
Online databases: WPI

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(54) Detection of data bits in a slow frequency hopping communication system

(57) In the detecting process, the carrier to interference (C/I) power ratio of the hop of a slow frequency hopping spread spectrum signal (112), is estimated (124) by using the data samples (120) of the hop. Subsequently, a data bit (130) is detected by using the estimated C/I power ratio (126). The detection process (128) may include utilizing maximum likelihood decoding techniques to derive a data bit (130) from decision metrics and the estimated C/I power ratio (126). The decision metrics correspond to a measurement of the distance of data samples (120) from constellation points within a constellation space representating data samples (120) previously used to generate decision metrics. The detection process (128) also may include utilizing the estimated C/I power ratio (126) in combining data samples (120) of the hop as received from two or more diversity receiver branches.

FIG.1

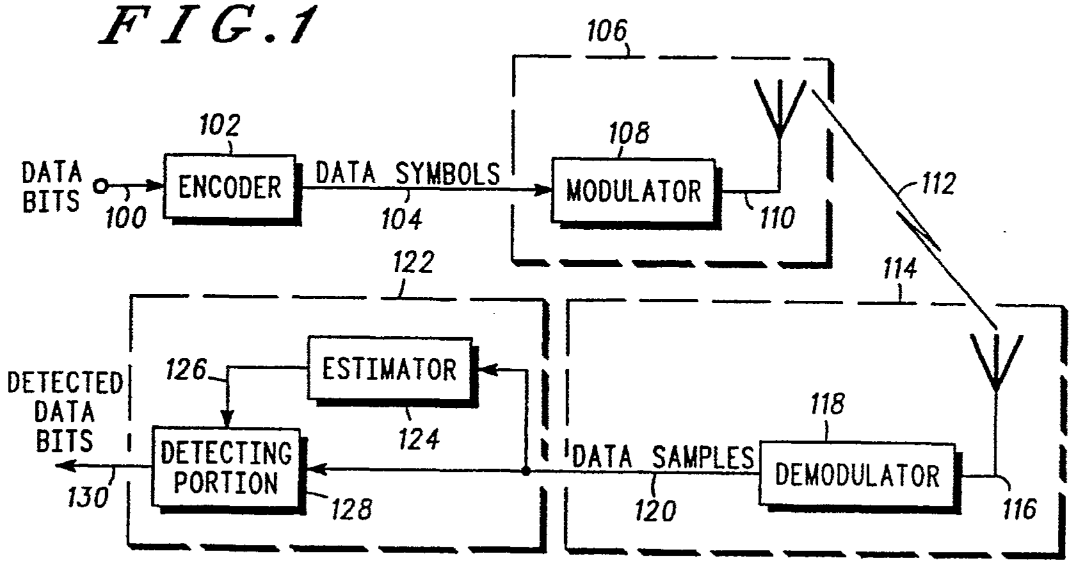

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FIG. 1

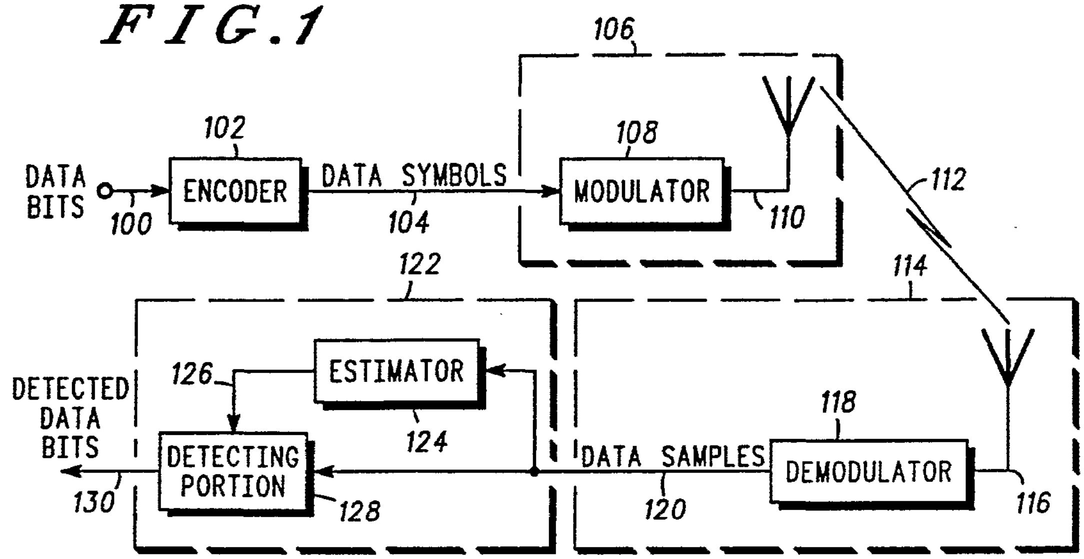
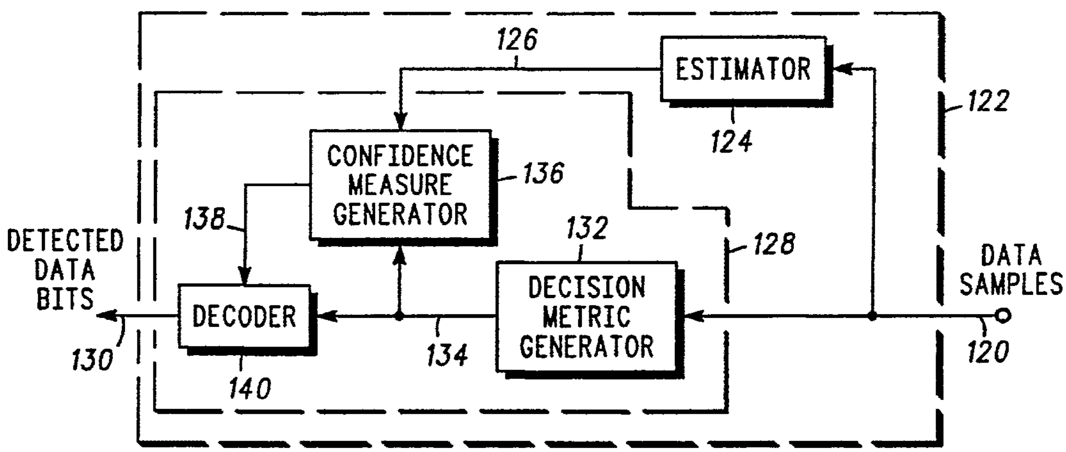
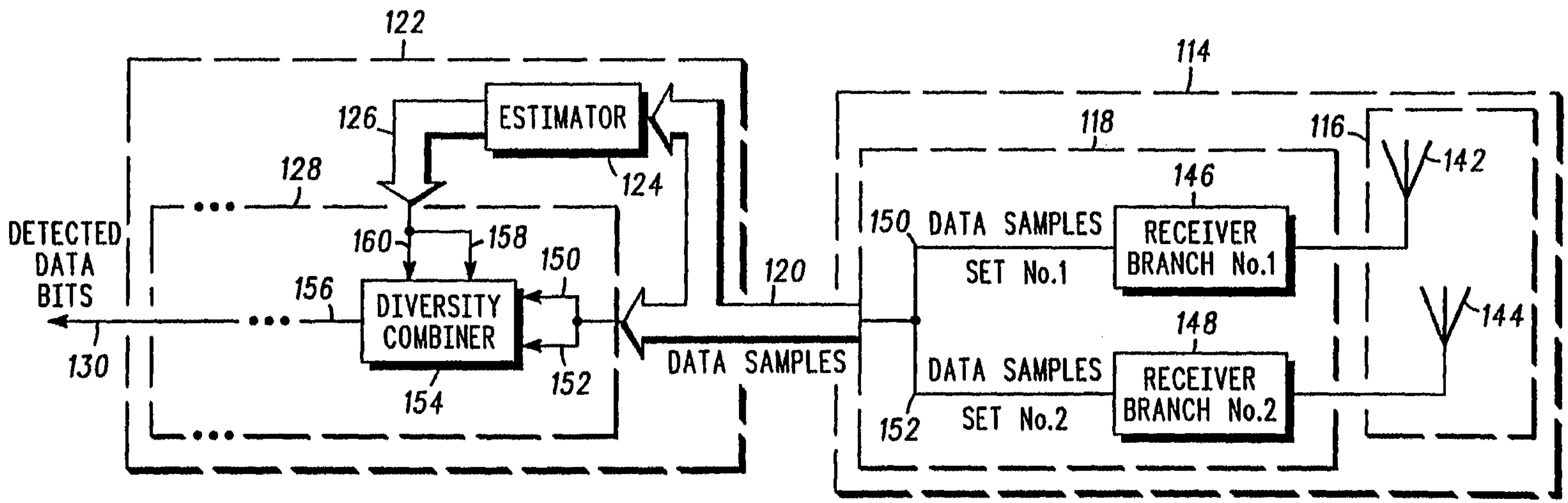

106
102
108
DATA BITS
ENCODER
DATA SYMBOLS
MODULATOR
112
100
104
110
122
114
ESTIMATOR
118
DETECTED DATA BITS
126
124
DETECTING PORTION
DATA SAMPLES
DEMODULATOR
130
128
120
116

FIG. 2


126
ESTIMATOR
122
124
CONFIDENCE MEASURE GENERATOR
136
138
132
128
DETECTED DATA BITS
DECISION METRIC GENERATOR
DATA SAMPLES
DECODER
130
134
120
140



122
ESTIMATOR
126
124
128
DETECTED
DATA
BITS
160
158
150
156
DIVERSITY
COMBINER
130
154
152
120
DATA SAMPLES
114
118
116
142
146
150
DATA SAMPLES
SET No.1
RECEIVER
BRANCH No.1
144
148
DATA SAMPLES
SET No.2
RECEIVER
BRANCH No.2
152

FIG.3

22...

METHOD AND APPARATUS FOR IMPROVING DETECTION OF DATA BITS IN A SLOW FREQUENCY HOPPING COMMUNICATION SYSTEM

Field of the Invention

The present invention relates to communication systems which employ spread-spectrum signals and, more particularly, to a method and apparatus for improving a soft decision algorithm in a slow frequency hopping spread spectrum communication system.

Background of the Invention

Communication systems take many forms. In general, the purpose of a communication system is to transmit information-bearing signals from a source, located at one point, to a user destination, located at another point some distance away. A communication system generally consists of three basic components: transmitter, channel, and receiver. The transmitter has the function of processing the message signal into a form suitable for transmission over the channel. This processing of the message signal is typically referred to as modulation. The function of the channel is to provide a physical connection between the transmitter output and the receiver input. The function of the receiver is to process the received signal so as to produce an estimate of the original message signal. This processing of the received signal is referred to as demodulation.

Two types of two-way communication channels exist, namely, point-to point channels and point-to-multipoint channels. Examples of point-to-point channels include wirelines (e.g., local telephone transmission), microwave links, and optical fibers. In contrast, point-to-multipoint channels provide a capability where many receiving stations may be reached simultaneously from a single transmitter (e.g. cellular radio telephone communication systems). These point-to-multipoint systems are also termed Multiple Access Systems (MAS).

Analog and digital transmission methods are used to transmit a message signal over a communication channel. The use of digital methods offers several operational advantages over analog methods, including but not limited to: increased immunity to channel noise and interference, flexible operation of the system, common format for the transmission of different kinds of message signals, improved security of communication through the use of encryption, and increased capacity.

These advantages are attained at the cost of increased system complexity. However, through the use of very large-scale integration (VLSI) technology, a cost-effective way of building the hardware has been developed.

To transmit a message signal (either analog or digital) over a band-pass communication channel, the message signal must be manipulated into a form suitable for efficient transmission over the channel. Modification of the message signal is achieved by means of a process termed modulation. This process involves varying some parameter of a carrier wave in accordance with the message signal in such a way that the spectrum of the modulated wave matches the assigned channel bandwidth. Correspondingly, the receiver is required to recreate the original message signal from a degraded version of the transmitted signal after propagation through the channel. The re-creation is accomplished by using a process known as demodulation, which is the inverse of the modulation process used in the transmitter.

In addition to providing efficient transmission, there are other reasons for performing modulation. In particular, the use of modulation permits multiplexing, that is, the simultaneous transmission of signals from several message sources over a common channel. Also, modulation may be used to convert the message signal into a form less susceptible to noise and interference.

For multiplexed communication systems, the system typically consists of many remote units (i.e. subscriber units) which require active service over a communication channel for a short or discrete portion of the communication channel resource rather than continuous use of the resources on a communication channel. Therefore, communication systems have been designed to incorporate the characteristic of communicating with many remote units for brief intervals on the same communication channel. These systems are termed multiple access communication systems.

One type of communication system which can be a multiple access system is a spread spectrum system. In a spread spectrum system, a modulation technique is utilized in which a transmitted signal is spread over a wide frequency band within the communication channel. The frequency band is much wider than the minimum bandwidth required to transmit the information being sent. A voice signal, for example, can be sent with amplitude modulation (AM) in a bandwidth only twice that of the information itself. Other forms of modulation, such as low deviation frequency modulation (FM) or single sideband AM , also permit information to be transmitted in a bandwidth comparable to the bandwidth of the information itself. However, in a spread spectrum system, the modulation of a signal to be transmitted often includes taking a baseband signal (e.g., a voice channel) with a bandwidth of only a few kilohertz, and distributing the signal to be transmitted over a frequency band that may be many megahertz wide. This is accomplished by modulating the signal to be transmitted with the information to be sent and with a wideband encoding signal.

Three general types of spread spectrum communication techniques exist, including:

<u>Direct Sequence</u>
The modulation of a carrier by a digital code sequence whose bit rate is much higher than the information signal bandwidth. Such systems are referred to as "direct sequence" modulated systems.

<u>Hopping</u>
Carrier frequency shifting in discrete increments in a pattern dictated by a code sequence. These systems are called "frequency hoppers." The transmitter jumps from frequency to frequency within some predetermined set; the order of frequency usage is determined

by a code sequence. Similarly "time hopping" and "time-frequency hopping" have times of transmission which are regulated by a code sequence.

Chirp

Pulse-FM or "chirp" modulation in which a carrier is swept over a wide band during a given pulse interval.

Information (i.e. the message signal) can be embedded in the spread spectrum signal by several methods. One method is to add the information to the spreading code before it is used for spreading modulation. This technique can be used in direct sequence and frequency hopping systems. It will be noted that the information being sent must be in a digital form prior to adding it to the spreading code, because the combination of the spreading code and the information typically a binary code involves module-2 addition. Alternatively, the information or message signal may be used to modulate a carrier before spreading it.

Thus, a spread spectrum system must have two properties: (1) the transmitted bandwidth should be much greater than the bandwidth or rate of the information being sent and (2) some function other than the information being sent is employed to determine the resulting modulated channel bandwidth.

Spread spectrum communication systems can be implemented as multiple access systems in a number of different ways. One type of multiple access spread spectrum system is a code division multiple access (CDMA) system. CDMA spread spectrum systems may use direct sequence (DS-CDMA) or frequency hopping (FH-CDMA) spectrum spreading techniques. FH-CDMA systems can further be divided into slow frequency hopping (SFH-CDMA) and fast frequency hopping (FFH-CDMA) systems. In SFH-CDMA systems several data symbols, representing a sequence of data bits which are to be transmitted, modulate the carrier wave within a single hop. Whereas, in FFH-CDMA systems the carrier wave hops several times per data symbol.

In a SFH-CDMA system, multiple communication channels are accommodated by the assignment of portions of a broad frequency and or time band to each particular channel. For example, communication between two communication units in a particular communication channel is accomplished by using a frequency synthesizer to generate a carrier wave in a particular portion of a predetermined broad frequency band for a brief period of time. The frequency synthesizer uses an input spreading code to determine the particular frequency from within the set of frequencies in the broad frequency band at which to generate the carrier wave. Spreading codes are input to the frequency synthesizer by a spreading code generator. The spreading code generator is periodically clocked or stepped through different transitions which causes different or shifted spreading codes to be output to the frequency synthesizer. Therefore, as the spreading code generator is periodically clocked, then so too is the carrier wave frequency hopped or reassigned to different portions of the frequency band. In addition to hopping, the carrier wave is modulated by data symbols representing a sequence of data bits which are to be transmitted. A common type of carrier wave modulation used in SFH-CDMA systems is M-ary frequency shift keying (MFSK), where $k = \log_2 M$ data symbols are used to determined which one of the M frequencies is to be transmitted.

Multiple communication channels are allocated by using a plurality of spreading codes to assign portions of the frequency band to different channels during the same time period. As a result, transmitted signals are in the same broad frequency band of the communication channel, but within unique portions of the broad frequency band assigned by the unique spreading codes. These unique spreading codes preferably are orthogonal to one another such that the cross-correlation between the spreading codes is approximately zero. Particular transmitted signals can be retrieved from the communication channel by despreading a signal representative of the sum of signals in the communication channel with a spreading code related to the particular transmitted signal which is to be retrieved from the communication channel. Further, when the spreading codes are orthogonal to one another, the received signal can be correlated with a particular spreading code such that only the desired signal related to the particular spreading code is enhanced while the other signals are not enhanced.

It will be appreciated by those skilled in the art that several different spreading codes exist which can be used to separate data signals from one another in a CDMA communication system. These spreading codes include but are not limited to pseudonoise (PN) codes and Walsh codes. A Walsh code corresponds to a single row or column of the Hadamard matrix. For example, in a 64 channel CDMA spread spectrum system, particular mutually orthogonal Walsh codes can be selected from the set of 64 Walsh codes within a 64 by 64 Hadamard matrix.

Further it will be appreciated by those skilled in the art that the data signals are typically channel coded to improve performance of the communication system by enabling transmitted signals to better withstand the effects of various channel impairments, such as noise, fading, and jamming. Typically, channel coding reduces the probability of bit error, and/or reduces the required signal to noise ratio usually expressed as bit energy per noise density (E_b/N_0), to recover the signal at the cost of expending more bandwidth than would otherwise be necessary to transmit the data signal.

A typical spread spectrum transmission involves expanding the bandwidth of an information signal, transmitting the expanded signal and recovering the desired information signal by remapping the received spread spectrum into the original information signals bandwidth. This series of bandwidth trades used in spread spectrum signalling techniques allows a communication system to deliver a relatively error-free information signal in a noisy environment or communication channel. The quality of recovery of the transmitted information signal from the communication channel is measured by the error rate (i.e., the number of errors in the recovery of the transmitted signal over a particular time span or received bit span) for some E_b/N_0. As the error rate increases the quality of the signal received by the receiving party decreases. As a result, communication systems typically are designed to limit the error rate to an upper bound or maximum so that the degradation in the quality of the received signal is limited. In CDMA spread spectrum communication systems, the error rate is related to the noise interference level in the communication channel which is directly related to number of simultaneous but code divided users within the communication channel. Thus, in order to limit the maximum error rate, the number of simultaneous code divided users in the communication channel is limited. However, the error rate can be reduced by using channel coding schemes. The error rate can also be reduced by using diversity combining. Therefore, by using channel coding and/or diversity combining schemes the number of simultaneous users in a communication channel can be increased while still maintaining the same maximum error rate limit.

As discussed in Digital Communications: Fundamentals and Applications by Bernard Sklar, published by Prentice Hall, Englewood

Cliffs, New Jersey in 1988, especially chapters 5 and 6 entitled "Channel Coding" found on pages 245-380, several of these channel coding and decoding schemes have been developed for use in communication systems. Among the decoding schemes discussed is using a maximum-likelihood (ML) decoding algorithm. In addition to the discussion found in Sklar's book above-mentioned, Gottfried Ungerboeck described in general MLSE decoding algorithms in "Adaptive Maximum-Likelihood Receiver for Carrier-Modulated Data-Transmission Systems", IEEE Transactions on Communications, vol. com-22, no. 5, May 1974, p.p. 624-636. However, a need exists for ML decoding schemes to be specifically optimized for use in frequency hopping spread spectrum communication systems. In optimizing the communication system with respect to the ML decoding algorithm, one starting point is analyzing the implementation of the ML decoding algorithm to the particular environment to which it is to be used. For the purposes of this discussion, the environment will include convolutional encoders and ML decoding algorithms similar to the Viterbi decoding algorithm. It will be appreciated by those skilled in the art that these principles can be applied to other encoding techniques such as block encoding and ML decoding algorithms other than Viterbi-like algorithms. Through the use of these optimized decoding schemes, the number of simultaneous users in a communication system can be increased over the number of simultaneous users in a communication system using non-optimized decoding algorithms while maintaining the same maximum error rate limit.

Several of diversity combining schemes have been developed for use in communication systems. Among the diversity combining schemes is the diversity reception technique described in U.S. Pat. No. 5,031,193 entitled "Method and Apparatus for Diversity Reception of Time-Dispersed Signals". This patent describes diversity combining stages which perform either bit by bit selection of or maximal ratio combining of signals received from several receiver branches. The diversity combined signal may optionally be subsequently used in estimating the received sequence. Another diversity reception scheme is described in U. S. Pat. No. 4,271,525 entitled " Adaptive Diversity Receiver For Digital Communications". This patent describes an adaptive diversity receiver using an adaptive transversal filter for each receiver branch, followed by a decision feedback equalizer. The tap gains of the transversal filters are updated via feedback from the output of the equalizer, and other points in the receiver. However, a need exists for diversity combining schemes to be specifically optimized for use in frequency hopping spread spectrum communication systems. In optimizing the communication system with respect to diversity combining, one starting point is analyzing the implementation of diversity combining to the particular environment to which it is to be used. For the purposes of this discussion, the environment will include at least two receiver branches and a signal combining technique of either bit by bit selection or maximal ratio combining. It will be appreciated by those skilled in the art that these principles can be applied to other diversity combining techniques. Through the use of these optimized diversity combining schemes, the number of simultaneous users in a communication system can be increased over the number of simultaneous users in a communication system using non-optimized diversity combining techniques while maintaining the same maximum error rate limit.

Summary of the Invention

A method and apparatus is provided for improving detection of data bits in data samples of a hop of a slow frequency hopping spread spectrum signal. In the detecting process, the carrier to interference (C/I) power ratio of the hop is estimated by using the data samples of the hop. Subsequently, a data bit is detected by using the estimated C/I power ratio. The detection process may include utilizing maximum likelihood decoding techniques to derive a data bit from decision metrics and the estimated C/I power ratio. The decision metrics correspond to a measurement of the distance of data samples from constellation points within a constellation space representing data samples previously used to generate decision metrics. The detection process also may include utilizing the estimated C/I power ratio in combining data samples of the hop as received from two or more diversity receiver branches.

Brief Description of the Drawings

FIG. 1 is a block diagram showing a preferred embodiment slow frequency hopping communication system.

FIG. 2 is a block diagram showing a preferred embodiment data bit detection portion which utilize maximum likelihood decoding techniques.

FIG. 3 is a block diagram showing preferred embodiment receiving and data bit detection portions which utilize diversity combining techniques.

Detailed Description

Referring now to FIG. 1, a preferred embodiment slow frequency hopping (SFH) communication system is shown. In optimizing the communication system, one starting point is analyzing the implementation of the ML decoding algorithm and diversity combining techniques to the particular environment to which it is to be used. For the purposes of this discussion, the environment will include convolutional encoding of data bits prior to transmission and slow frequency hopping signaling. It will be appreciated by those skilled in the art that these principles can be applied to other encoding techniques such as block encoding as well as other signalling techniques having properties similar to slow frequency hopping signalling such as time hopping signalling.

In order to design either a convolutional decoder to perform optimal ML decoding or a diversity combiner to perform optimal diversity combining, obtaining knowledge about the received carrier signal power to interference signal power ratio (i.e., C/I power ratio) is desirable. Measurement of the actual C/I power ratio in SFH communication systems can be difficult since the carrier signal hops at discrete time intervals over a broad frequency band. The C/I power ratio may change with each hop, since the interference in different portions of the broad frequency band may vary by the frequency. This variance of the interference at different frequencies may be due to signals other than the desired signal being transmitted at or near the same frequency as the desired frequency as well as from spurious noise bursts from electrical power generators and transmission lines, solar flares, atmospheric disturbances and the like. Therefore, since actual measurement is difficult, an approximation of the C/I power ratio in SFH communication systems is desirable.

In accordance with a preferred embodiment of the present invention one such approximation of the the C/I power ratio is proposed. In this preferred embodiment an assumption concerning the communication channel conditions has been made. This assumption is that the C/I power ratio remains constant over the duration of a single hop. Such an assumption is valid so long as the duration of the hop is short enough to be able to reasonably assume that the magnitude of the power interference sources in the communication channel would be constant over the hop. The preferred embodiment approximation or estimate of the C/I power ratio of a hop of a SFH spread spectrum signal is measured according to the following equation for Ψ:

$$\Psi = \frac{Ave^2\{Re\{z\}\}}{Ave\{|z|^2\} - Ave^2\{Re\{z\}\}} \qquad \text{(eq. 1)}$$

In the equation (eq. 1), z represents the phase modulation cancelled forms of the data samples of a hop of the SFH signal. The data samples are samples of the complex envelope of the hop where the hop has been modulated by nth phase shift keying. Cancellation of nth phase shift keying modulation of the hop of the slow frequency hopping spread spectrum signal can be accomplished by raising the complex envelope of the hop to the nth power. As a result, z represents the phase modulation cancelled forms of the data samples which comprise samples of the complex envelope of the hop raised to the nth power for the nth phase shift keying modulated hop of the slow frequency hopping spread spectrum signal. For example, a complex envelope of a bi-phase shift key modulated (BPSK) hop of a SFH signal is raised to the second power (i.e., squared) in order to generate a phase modulation cancelled form of the hop. Similarly, a complex envelope of a quadrature phase shift key modulated (QPSK) hop of a SFH signal is raised to the fourth power in order to generate a phase modulation cancelled form of the hop.

In addition, in the equation (eq. 1), $Ave^2\{Re\{z\}\}$ is the square of the average of the real portion of z over the hop. More precisely, z_k represents a single phase modulation cancelled data sample where the data sample is represented as a complex number having a real and an imaginary portion. In addition, N is the number of data samples of the complex envelope of the hop. Thus, $Ave^2\{Re\{z\}\}$ may be computed by squaring the result of the following equation:

$$\frac{1}{N}\sum_{k=1}^{N} Re\{z_k\} \qquad \text{(eq. 2)}$$

in which the real portions of each data sample z_i of the hop are summed together and subsequently divided by the number of data samples of the hop.

In addition, in the equation (eq. 1), $Ave\{|z|^2\}$ is the average of the square of the magnitude of the complex valued z (i.e. where z has a real and imaginary portion) over the hop. More precisely, as noted above, z_k represents a single phase modulation cancelled data sample where the data sample is represented as a complex number having a real and an imaginary portion. In addition, N is the number of data samples of the complex envelope of the hop. Thus, $Ave\{|z|^2\}$ may be computed according to the following equation:

$$\frac{1}{N}\sum_{k=1}^{N}|z_k|^2 \qquad \text{(eq. 3)}$$

in which the square of the absolute value of each data sample z_k is summed together and subsequently divided by the number of data samples of the hop.

It will be appreciated by those skilled in the art that any monotonically related form of the estimate of the C/I power ratio (Ψ) may be used without departing from the scope of the present invention. For example, an estimate maybe formed using Ψ in which Ψ is raised to a power greater or less than one, Ψ is multiplied or divided by a constant value or variable, and/or Ψ is added to or subtracted from a constant value or variable. Further, it will be appreciated by those skilled in the art that this preferred embodiment C/I power ratio estimate (Ψ) has several advantages. These advantages include the ease of calculation of the estimate (Ψ) due to simple arithmetic operations being performed on digital values which represent data samples. Another advantage is the lack of need for measurements other than those already being done in the data bit detecting process. The sampling of the complex envelope of the hop is already being done in conjunction with the data bit detecting process. Further, measurement of the actual C/I power ratio would involve the additional steps of measuring the power of the carrier and interference signals over the hop. Yet another advantage is that this estimate (Ψ) does not require any prior knowledge concerning the data bits being transmitted within of the hop of the SFH signal.

This estimate of the C/I ratio (Ψ) of a hop is a monotonous function of the actual C/I power ratio. A derivation of a proof this statement follows. Each data sample (x_k) of the complex envelope of the received hop of the SFH signal is described by the following equation:

$$x_k = P + n_r + jn_i \qquad \text{(eq. 4)}$$

where P is the average amplitude of the received data sample and n_r, n_i are the real and imaginary components of the interference. Both n_r, n_i are independent, zero mean normal variables, with equal variance σ_n^2 (i.e. they can be modeled as white, Gaussian noise). However, these following derivations can be easily extended by one skilled in the art to non-Gaussian noise. The actual C/I power ratio can be described as:

$$\frac{C}{I} = \frac{2 \cdot Ave^2\{Re\{x_k\}}{Var[Re\{x_k\}] + Var[Im\{x_k\}]} = \frac{P^2}{\sigma_n^2} \qquad \text{(eq. 5)}$$

When a BPSK modulated SFH signal is used in the communication system, the derivation of the proof that the estimated C/I power ratio (Ψ) of (eq. 1) is a monotonous function of the actual C/I power ratio continues as follows.

$$z_k = x_k^2 = (P + n_r + jn_i)^2 = (P + n_r)^2 - n_i^2 + j2(P + n_r)n_i \qquad \text{(eq. 6)}$$

where z_k represents a single phase modulation cancelled data sample where the data sample (x_k) is represented as a complex number having a real and an imaginary portion and (eq. 4) was substituted into (eq. 6) for x_k.

In addition, in the equation (eq. 1), Ave{Re{z}} is the average of the real portion of z over the hop. More precisely,

$$\begin{aligned} Ave\{Re\{z\}\} &= \overline{(P + n_r)^2} - \overline{n_i^2} \\ &= \overline{P^2} + \overline{2Pn_r} + \overline{n_r^2} - \overline{n_i^2} \\ &= P^2 + 0 + \sigma_n^2 - \sigma_n^2 = P^2 \end{aligned} \qquad \text{(eq. 7)}$$

where the real portion of z_k as defined in (eq. 6) was substituted in (eq. 7) and, in accordance with the definition of Gaussian noise model given above and the definition of the nth central moment of a Gaussian random variable, the average of n_r and n_i (i.e., $\overline{n_r}$ and $\overline{n_i}$) each go to zero over the hop and average of n_r^2 and n_i^2 (i.e., $\overline{n_r^2}$ and $\overline{n_i^2}$) each go to σ_n^2.

In addition, in the equation (eq. 1), $|z_k|^2$ is the square of the absolute value of z_k. More precisely,

$$\begin{aligned}
|z_k|^2 &= \left[(P + n_r)^2 - n_i^2\right]^2 + [2(P + n_r)n_i]^2 \\
&= (P + n_r)^4 - 2(P + n_r)^2 n_i^2 + n_i^4 + 4(P + n_r)^2 n_i^2 \\
&= (P + n_r)^4 + 2(P + n_r)^2 n_i^2 + n_i^4 \\
&= (P^4 + 4P^3 n_r + 6P^2 n_r^2 + 4P n_r^3 + n_r^4) \\
&\qquad + (2P^2 n_i^2 + 2P n_r n_i^2 + 2n_r^2 n_i^2) + n_i^4 \qquad \text{(eq. 8)}
\end{aligned}$$

where the definition of z_k from (eq. 6) was substituted in (eq. 8).

In addition, in the equation (eq. 1), Ave{$|z|^2$} is the average of the square of the magnitude of the real and imaginary portions of z over the hop. More precisely,

$$\begin{aligned}
\text{Ave}\{|z|^2\} &= \overline{P^4} + \overline{4P^3 n_r} + \overline{6P^2 n_r^2} + \overline{4P n_r^3 + n_r^4} \\
&\qquad + \overline{2P^2 n_i^2} + \overline{2P n_r n_i^2} + \overline{2n_r^2 n_i^2} + \overline{n_i^4} \\
&= P^4 + 0 + 6P^2\sigma_n^2 + 0 + 3\sigma_n^4 + 2P^2\sigma_n^2 + 0 + 2\sigma_n^4 + 3\sigma_n^4 \\
&= P^4 + 8P^2\sigma_n^2 + 8\sigma_n^4 \qquad \text{(eq. 9)}
\end{aligned}$$

where the square of the absolute value of z_k as defined in (eq. 8) was substituted in (eq. 9). In addition, in accordance with the definition of Gaussian noise model given above and the definition of the nth central moment of a Gaussian random variable, the average of an odd power of n_r and n_i (i.e., $\overline{n_r}$ and $\overline{n_i}$) each go to zero over the hop and average of an even power n of n_r and n_i (i.e., $\overline{n_r}$ and $\overline{n_i}$) each go to a factor defined as:

$$\overline{n_r^n} = \overline{n_i^n} = 1 \cdot 3 \cdot 5 \cdot (n-1) \cdot \sigma_n^n \qquad \text{(eq. 10)}$$

such that $\overline{n_r^2} = \overline{n_i^2} = \sigma_n^2$ and $\overline{n_r^4} = \overline{n_i^4} = 3\sigma_n^4$.

Thus, (eq. 5), (eq. 7) and (eq. 9) can be substituted into (eq. 1) as follows to derive an expression of the estimate of the power ratio (Ψ) in terms of actual C/I power ratio:

$$\Psi = \frac{\mathrm{Ave}^2\{\mathrm{Re}\{z\}\}}{\mathrm{Ave}\{|z|^2\} - \mathrm{Ave}^2\{\mathrm{Re}\{z\}\}}$$
$$= \frac{P^4}{P^4 + 8P^2\sigma_n^2 + 8\sigma_n^4 - P^4} = \frac{P^4}{8P^2\sigma_n^2 + 8\sigma_n^4}$$
$$= \frac{(C/I)^2}{8(C/I) + 8} \qquad \text{(eq. 11)}$$

which is a monotonic function of C/I since the derivative of the estimate (Ψ) with respect to the actual C/I is greater than zero for all real and positive values of C/I. More precisely,

$$\frac{\delta\Psi}{\delta(C/I)} = \frac{\delta}{\delta(C/I)} \frac{(C/I)^2}{8(C/I) + 8} = \frac{8(C/I)^2 + 16(C/I)}{[8(C/I) + 8]^2} > 0 \qquad \text{(eq. 12)}$$

Thus, for a BPSK modulated SFH signal the estimated C/I power ratio (Ψ) of (eq. 1) is a monotonous function of the actual C/I power ratio.

When a QPSK modulated SFH signal is used in the communication system, the derivation of the proof that the estimated C/I power ratio (Ψ) of (eq. 1) is a monotonous function of the actual C/I power ratio continues as follows.

$$z_k = x_k^4 = (P + n_r + jn_i)^4$$
$$= (P + n_r)^4 - 6(P + n_r)^2 n_i^2 + n_i^4 + j4(P + n_r)n_i[(P + n_r)^2 - n_i^2] \qquad \text{(eq. 13)}$$

where z_i represents a single phase modulation cancelled data sample where the data sample (x_k) is represented as a complex number having a real and an imaginary portion and (eq. 4) was substituted into (eq. 13) for x_k.

In addition, in the equation (eq. 1), Ave{Re{z}} is the average of the real portion of z over the hop. More precisely,

$$\mathrm{Ave}\{\mathrm{Re}\{z\}\} = \overline{(P + n_r)^4} - \overline{6(P + n_r)^2 n_i^2} + \overline{n_i^4}$$
$$= \left(\overline{P^4} + \overline{4P^3 n_r} + \overline{6P^2 n_r^2} + \overline{4Pn_r^3} + \overline{n_r^4}\right)$$
$$- \left(\overline{6P^2 n_i^2} + \overline{12 n_r n_i^2} + \overline{6 n_r^2 n_i^2}\right) + \overline{n_i^4}$$
$$= P^4 + 0 + 6P^2\sigma_n^2) + 0 + 3\sigma_n^2 - 6P^2\sigma_n^2 - 0 - 6\sigma_n^4 + 3\sigma_n^4$$
$$= P^4 \qquad \text{(eq. 14)}$$

where the real portion of z_K as defined in (eq. 13) was substituted in (eq. 14) and, in accordance with the definition of Gaussian noise model given above and the definition of the nth central moment of a Gaussian random variable, the average of an odd power of n_r and n_i (i.e., $\overline{n_r}$ and $\overline{n_i}$) each go to zero over the hop and average of an even power n of n_r and n_i (i.e., $\overline{n_r}$ and $\overline{n_i}$) each go to a factor defined in (eq. 10) such that $\overline{n_r^2} = \overline{n_i^2} = \sigma_n^2$ and $\overline{n_r^4} = \overline{n_i^4} = 3\sigma_n^4$.

In addition, in the equation (eq. 1), $|z_K|^2$ is the square of the absolute value of z_K. More precisely,

$$\begin{aligned}
|z_K|^2 &= \left[(P + n_r)^4 - 6(P + n_r)^2 n_i^2 + n_i^4\right]^2 \\
&\quad + \left[4(P + n_r)n_i[(P + n_r)^2 - n_i^2]\right]^2 \\
&= (P + n_r)^8 - 12(P + n_r)^6 n_i^2 + 38(P + n_r)^4 n_i^4 - 12(P + n_r)^2 n_i^6 + n_i^8 \\
&\quad + 16(P + n_r)^2 n_i^2[(P + n_r)^4 - 2(P + n_r)^2 n_i^2 + n_i^4] \\
&= (P + n_r)^8 - 12(P + n_r)^6 n_i^2 + 38(P + n_r)^4 n_i^4 - 12(P + n_r)^2 n_i^6 + n_i^8 \\
&\quad + 16(P + n_r)^6 n_i^2 - 32(P + n_r)^4 n_i^4 + 16(P + n_r)^2 n_i^6 \\
&= (P + n_r)^8 + 4(P + n_r)^6 n_i^2 + 6(P + n_r)^4 n_i^4 + 4(P + n_r)^2 n_i^6 + n_i^8 \\
&= (P^8 + 8P^7 n_r + 28P^6 n_r^2 + 56P^5 n_r^3 + 70P^4 n_r^4 + 56P^3 n_r^5 \\
&\quad + 28P^2 n_r^6 + 8P n_r^7 + n_r^8) \\
&\quad + 4(P^6 + 6P^5 n_r + 15P^4 n_r^2 + 20P^3 n_r^3 + 15P^2 n_r^4 \\
&\quad + 6P n_r^5 + n_r^6) n_i^2 \\
&\quad + 6(P^4 + 4P^3 n_r + 6P^2 n_r^2 + 4P n_r^3 + n_r^4) n_i^4 \\
&\quad + 4(P^2 + 2P n_r + n_r^2) n_i^6 + n_i^8
\end{aligned} \qquad \text{(eq. 15)}$$

where the definition of z_K from (eq. 13) was substituted in (eq. 15).

In addition, in the equation (eq. 1), Ave{$|z|^2$} is the average of the square of the magnitude of the real and imaginary portions of z over the hop. More precisely,

$$\begin{aligned}
\text{Ave}\{|z|^2\} &= \Big(\overline{P^8 + 8P^7 n_r + 28P^6 n_r^2 + 56P^5 n_r^3 + 70P^4 n_r^4} \\
&\quad \overline{+ 56P^3 n_r^5 + 28P^2 n_r^6 + 8P n_r^7 + n_r^8} \Big) \\
&\quad + \Big[\overline{4\big(P^6 + 6P^5 n_r + 15P^4 n_r^2 + 20P^3 n_r^3 + 15P^2 n_r^4} \\
&\quad \overline{+ 6P n_r^5 + n_r^6\big) n_i^2} \Big] \\
&\quad + \Big(\overline{6(P^4 + 4P^3 n_r + 6P^2 n_r^2 + 4P n_r^3 + n_r^4) n_i^4} \Big) \\
&\quad + \Big(\overline{4(P^2 + 2P n_r + n_r^2) n_i^6} \Big) + \overline{n_i^8}
\end{aligned}$$

The above expression can be simplified by eliminating the terms which go to zero (i.e. those terms having n_r or n_i raised to an odd power) results in the following expression:

$$\begin{aligned}
&= \left(\overline{P^8 + 28P^6 n_r^2 + 70P^4 n_r^4 + 28P^2 n_r^6 + n_r^8}\right) \\
&\quad + \left[\overline{4\left(P^6 + 15P^4 n_r^2 + 15P^2 n_r^4 + n_r^6\right) n_i^2}\right] \\
&\quad + \left(\overline{6(P^4 + 6P^2 n_r^2 + n_r^4) n_i^4}\right) \\
&\quad + \left(\overline{4(P^2 + n_r^2) n_i^6}\right) + \overline{n_i^8} \\
&= \left(\overline{P^8 + 28P^6 n_r^2 + 70P^4 n_r^4 + 28P^2 n_r^6 + n_r^8}\right) \\
&\quad + \left(\overline{4P^6 n_i^2 + 60P^4 n_r^2 n_i^2 + 60P^2 n_r^4 n_i^2 + 4n_r^6 n_i^2}\right) \\
&\quad + \left(\overline{6P^4 n_i^4 + 36P^2 n_r^2 n_i^4 + 6n_r^4 n_i^4}\right) \\
&\quad + \left(\overline{4P^2 n_i^6 + 4n_r^2 n_i^6}\right) + \overline{n_i^8} \\
&= \overline{P^8} + \overline{28P^6 n_r^2} + \overline{70P^4 n_r^4} + \overline{28P^2 n_r^6} + \overline{n_r^8} \\
&\quad + \overline{4P^6 n_i^2} + \overline{60P^4 n_r^2 n_i^2} + \overline{60P^2 n_r^4 n_i^2} + \overline{4n_r^6 n_i^2} \\
&\quad + \overline{6P^4 n_i^4} + \overline{36P^2 n_r^2 n_i^4} + \overline{6n_r^4 n_i^4} \\
&\quad + \overline{4P^2 n_i^6} + \overline{4n_r^2 n_i^6} + \overline{n_i^8} \\
&= P^8 + 28P^6 \sigma_n^2 + 210P^4 \sigma_n^4 + 420P^2 \sigma_n^6 + 105\sigma_n^8 \\
&\quad + 4P^6 \sigma_n^2 + 60P^4 \sigma_n^4 + 180P^2 \sigma_n^6 + 60\sigma_n^8 \\
&\quad + 18P^4 \sigma_n^4 + 108P^2 \sigma_n^6 + 54\sigma_n^8 \\
&\quad + 60P^2 \sigma_n^6 + 60\sigma_n^8 + 105\sigma_n^8 \\
&= P^8 + 32P^6 \sigma_n^2 + 288P^4 \sigma_n^4 + 768P^2 \sigma_n^6 + 384\sigma_n^8 \qquad \text{(eq. 16)}
\end{aligned}$$

where the square of the absolute value of z_k as defined in (eq. 8) was substituted in (eq. 9). In addition, , in accordance with the definition of Gaussian noise model given above and the definition of the nth central moment of a Gaussian random variable, the average of an odd power of n_r and n_i (i.e., $\overline{n_r^n}$ and $\overline{n_i^n}$) each go to zero over the hop and average of an even power n of n_r and n_i (i.e., $\overline{n_r^n}$ and $\overline{n_i^n}$) each go to a factor defined in (eq. 10) such that $\overline{n_r^2} = \overline{n_i^2} = \sigma_n^2$, $\overline{n_r^4} = \overline{n_i^4} = 3\sigma_n^4$, $\overline{n_r^6} = \overline{n_i^6} = 15\sigma_n^6$, and $\overline{n_r^8} = \overline{n_i^8} = 105\sigma_n^8$.

Thus, (eq. 5), (eq. 14) and (eq. 16) can be substituted into (eq. 1) as follows to derive an expression of the estimate of the power ratio (Ψ) in terms of actual C/I power ratio:

$$\begin{aligned}\Psi &= \frac{\mathrm{Ave}^2\{\mathrm{Re}\{z\}\}}{\mathrm{Ave}\{|z|^2\} - \mathrm{Ave}^2\{\mathrm{Re}\{z\}\}} \\ &= \frac{P^8}{P^8 + 32P^6\sigma_n^2 + 288P^4\sigma_n^4 + 768P^2\sigma_n^6 + 384\sigma_n^8 - P^8} \\ &= \frac{P^8}{32P^6\sigma_n^2 + 288P^4\sigma_n^4 + 768P^2\sigma_n^6 + 384\sigma_n^8} \\ &= \frac{(C/I)^4}{32(C/I)^3 + 288(C/I)^2 + 768(C/I) + 384}\end{aligned} \quad \text{(eq. 17)}$$

which is a monotonic function of C/I since the derivative of the estimate (Ψ) with respect to the actual C/I is greater than zero for all real and positive values of C/I. More precisely,

$$\begin{aligned}\frac{\delta\Psi}{\delta(C/I)} &= \frac{\delta}{\delta(C/I)} \frac{(C/I)^4}{32(C/I)^3 + 288(C/I)^2 + 768(C/I) + 384} \\ &= \frac{288(C/I)^5 + 1536(C/I)^4 + 1152(C/I)^3}{\left(32(C/I)^3 + 288(C/I)^2 + 768(C/I) + 384\right)^2} > 0\end{aligned} \quad \text{(eq. 18)}$$

Thus, for a QPSK modulated SFH signal the estimated C/I power ratio (Ψ) of (eq. 1) is a monotonous function of the actual C/I power ratio.

It will be appreciated by those skilled in the art that the above derivations can be extended to any nth phase shift keying modulated SFH signal to prove that the estimated C/I power ratio (Ψ) of (eq. 1) is a monotonous function of the actual C/I power ratio for any nth phase shift keying modulated SFH signal.

Since this estimate of each hop's C/I power ratio (Ψ) of (eq. 1) is a monotonous function of the actual C/I power ratio, this estimate of each hop's C/I power ratio (Ψ) may preferably be used to determine a level of confidence that a particular hop was detected properly by a receiving station. The number of levels of confidence which may be determined can be varied depending on the particular use for the level of confidence. For example, two levels of confidence may be determined for use in a hard decision environment. The two levels of confidence include: (1) full confidence which corresponds to the estimated C/I power ratio being at or above a particular threshold and (2) no confidence which corresponds to the estimated C/I power ratio being below the particular threshold. In another example, several levels of confidence may be determined for use in a soft decision environment. These several levels of confidence correspond to increasing confidence as the estimated C/I power ratio increases in value.

A description of a preferred embodiment communication system, shown in FIG. 1, which incorporates the above mentioned optimizing principles for a data bit detection in a SFH signal follows. In the encoding portion 102 of the communication system, traffic channel data bits 100 are input to an encoder 102 at a particular bit rate. The input traffic channel data bits can include either voice converted to data by a vocoder, pure data, or a combination of the two types of data. Encoder 102 preferrably encodes the input data bits 100 into data symbols 104 at a fixed encoding rate with an encoding algorithm which facilitates subsequent maximum likelihood decoding of the data symbols into data bits (e.g. convolutional or block coding algorithms).

The data symbols 104 may optionally then be interleaved by the encoding portion 102. Typically, interleaving increases the output distance between the consecutively input non-interleaved data symbols. This interleaving of data symbols causes burst of errors to be spread out in time and thus to be handled by the data bit detector as if they were random errors. This interleaving thereby allows random-error-correcting coding (e.g. convolutional coding) to be useful in a bursty noise communication channel (e.g. radio frequency communication channels). The interleaving preferably is limited to a predetermined size of the block of data symbols. The block size preferably is derived from the maximum number of data symbols, representing input data bits 100, which can be transmitted at a predetermined chip rate within a predetermined length transmission block. Subsequently, the interleaved data symbols 104 are output from the encoding portion 102. It will be appreciated by those skilled in the art that several different variations of interleaving could be implemented without departing from the scope of the present invention. For example, several different techniques can be used to interleave the data symbols (e.g., convolutional or block interleaving). In addition, the size of the interleaving block could be altered to accommodate different transmission lengths or rates. Also, the dimensions of the matrix could be altered to increase or decrease the interleaved distance between consecutively input groups of data symbols.

The interleaved data symbols 104 are then input to a transmitting portion 106 of the communication system. It will be appreciated by those skilled in the art that additional coding of the data symbols 104 may be done in the transmitting portion 106 to enable multiple access by several users to the same communication channel. Such encoding may include coding which ensures orthogonality of an individual users encoded traffic channel bits from other users encoded traffic channel bits. However, this additional coding typically depends upon the specific implementation of the SFH communication system. Further, this additional coding typically will not interfere with the implementation of the teachings of the present invention as described herein as long as the additional encoding is done after the initial encoding and the additional decoding is done prior to the preferred embodiment data bit detection process. The interleaved data symbols 104 are prepared for transmission over a communication channel as a SFH signal by a modulator 106. Subsequently, the modulated sequence is provided to an antenna 110 for transmission over the communication channel 112.

A receiving portion 114 of the communication system receives the transmitted SFH spread spectrum signal from over the communication channel 112 through antenna 116. Each hop of the received SFH signal preferably is sampled into data samples 120 by demodulator 118. Subsequently, the data samples 120 are output to the detector 122 of the communication system.

If the encoder 102 of the communication has interleaved the data symbols, then the detector 122 deinterleaves the data samples by using a technique which is substantially inverse to the interleaving technique used in the encoder 102. After, if necessary, such deinterleaving, the detector 122 of the communication system inputs the data samples 120 into a an estimator 124 which preferrably generates an estimate of the C/I power ratio (Ψ) 126 for each hop in accordance with the algorithm described above as (eq. 1) and reproduced below:

$$\Psi = \frac{\mathrm{Ave}^2\{\mathrm{Re}\{z\}\}}{\mathrm{Ave}\{|z|^2\} - \mathrm{Ave}^2\{\mathrm{Re}\{z\}\}} \qquad \text{(eq. 1)}$$

The symbol z preferrably represents the phase modulation cancelled forms of the data samples of a hop of the SFH signal. The data samples preferrably are samples of the complex envelope of the hop where the hop has been modulated by nth phase shift keying. Cancellation of nth phase shift keying modulation of the hop of the slow frequency hopping spread spectrum signal preferrably is accomplished by raising the complex envelope of the hop to the nth power. As a result, z represents the phase modulation cancelled forms of the data samples which comprise samples of the complex envelope of the hop raised to the nth power for the nth phase shift keying modulated hop of the slow frequency hopping spread spectrum signal. It will be appreciated by those skilled in the art that any monotonically related form of the estimate of the C/I power ratio (Ψ) may be used without departing from the scope of the present invention.

The detector 122 of the communication system also inputs the data samples 120 into the detecting portion 128 which detects data bits 130 in the data samples 128 of each particular hop by using the estimated C/I power ratio 126 for that particular hop which was generated by the estimator 124.

The preferred embodiment described in reference to FIG. 1 may be further extended into a more specific use in the detection process of the C/I power ratio estimate 126 to the decoding process as shown in FIG. 2. In FIG. 2, the detector 122 input the data samples 120 associated with each hop into a decision metric generator 132 of the detecting portion 128. The decision metric generator 132 uses the input data samples 120 to generate decision metrics 134 associated with each hop which correspond to a distance of an input data sample from a constellation point within a constellation space representing previously input data samples 120. These decision metrics 134 correspond to possible transitions within a maximum likelihood decoding trellis which decoder 140 will subsequently be determining.

The estimator 124 inputs the estimate of the C/I power ratio (Ψ) 126 associated with each hop into the detecting portion 128. The detecting portion 128 provides the C/I power ratio estimates (Ψ) 126 to a confidence measure generator 136. The confidence measure generator 136 also receives the decision metrics 134 associated with each hop from the decision metric generator. The confidence measure generator 136 uses the C/I power ratio estimate (Ψ) 126 associated with a particular hop to determine a level of confidence 138 in the accuracy of the decision metrics 134 associated with the particular hop (i.e., accurately or actually relate to the transmitted encoded data bits 100). For example, if the C/I power ratio estimate (Ψ) 126 for the hop is below a predetermined threshold, then the probability that the data samples 120 of that hop actually represent the transmitted encoded data bits 100 is low. As a result the decision metrics 134 are probably not actually related to the transmitted encoded data bits 100, because the data samples 120 of the hop probably do not correspond to the transmitted encoded data bits 100.

The number of different levels of confidence 138 which may be determined for a particular hop can be varied depending on the particular use for the level of confidence 138. For example, two levels of confidence in the decision metrics 134 of each hop may be determined for use in a hard decision environment. The two levels of confidence include: (1) full confidence which corresponds to the estimated C/I power ratio being at or above a particular threshold and (2) no confidence which corresponds to the estimated C/I power ratio being below the particular threshold. In response to a full confidence measure 138, the associated decision metrics 134 for the hop would be used by the decoder 140. However, in response to a no confidence measure 138, the associated decision metrics 134 for the hop would not be used by the decoder 140. In another example, several levels of confidence in the decision metrics 134 of each hop may be determined for use in a soft decision environment. These several levels of confidence correspond to increasing confidence as the estimated C/I power ratio 138 increases in value. In response to the increasing level of confidence measure 138, the associated decision metrics 134 for the hop would be given greater weight by decoder 140. Such a weighting system of the decision metrics 134 by a decoder 140 is often termed using side information about the decision metrics 134.

The decoder 140 preferably generates estimated data bits 130 by utilizing maximum likelihood decoding techniques to derive the estimated traffic channel data bits 130 from the decision metrics 134 of each hop and the associated confidence measures 138 which are input to the decoder 140. When the traffic channel data bits 100 have been convolutionally encoded, the maximum likelihood decoding techniques which are used may based upon the Viterbi decoding algorithm.

The preferred embodiment described in reference to FIG. 1 may be further extended into a more specific use in the detection process of the C/I power ratio estimate 126 to the diversity combining process as shown in FIG. 3. In FIG. 3, the receiving portion 114 of the communication system.

receives the transmitted SFH spread spectrum signal from over the communication channel 112 through antenna structure 116. The antenna structure 116 preferrably includes at least a first receiving antenna 142 and a second receiving antenna 144. The first receiving antenna 142 is preferrably geographically displaced from the second receiving antenna 144 such that a diversity antenna structure is formed. Each hop of the SFH signal as received by the first and second antennae 142 and 144 is preferrably input to the demodulator 118. Demodulator 118 includes a first and second receiver branch 146 and 148, respectively. The first receiver branch 146 is coupled to the first antenna 142 in order to demodulate and sample each hop of the SFH signal 122 received by the first antenna 142 into a first data sample set 150. Similarly, the second receiver branch 148 is coupled to the second antenna 144 in order to demodulate and sample each hop of the SFH signal 122 received by the second antenna 144 into a second data sample set 152. Subsequently, the sets of data samples 150 and 152 (collectively described as data samples 120) are output to the detector 122 of the communication system. The data samples 120 may preferrably be coupled to detector 122 on a data bus having each of the data sample sets 150 and 152 thereon or by a set of individual data signal couplers for each data samples set 150 and 152.

The detector 122 of the communication system inputs the sets of data samples 120 into an estimator 124 which preferrably generates a first and a second estimate of the C/I power ratio (Ψ) 158 and 160 (collectively described as C/I power ratio estimate 126) for each hop corresponding to the first and second set of data samples 150 and 152, respectively, in accordance with the algorithm described above as (eq. 1). These C/I power ratio estimates 126 are output to the detecting portion 128.

Similarly, the detector 122 of the communication system inputs the sets of data samples 120 (i.e. first and second sets 150 and 152, respectively) into the detecting portion 128. The detecting portion provides the first and second data sample sets 150 and 152 to a diversity combiner 154. The diversity combiner 154 combines the first and second sets of data samples 150 and 152, respectively, into a single combined set of data samples 156. The diversity combining is accomplished by using weighting coefficients for the first and second sets of input data samples 150 and 152 of each hop which are derived from the associated first and second C/I power ratio estimate 158 and 160 input .

The diversity combiner 154 uses the first and second C/I power ratio estimate (Ψ) 158 and 160, respectively, associated with a particular hop to determine a level of confidence in the accuracy of the reception of the first and second set of data samples 150 and 152, respectively associated with the particular hop by the receiving portion 114. For example, if the first C/I power ratio estimate (Ψ) 158 for the hop is below a predetermined threshold, then the probability that the first set of data samples 150 of that hop actually represent the transmitted encoded data bits 100 is nominal.

The number of different levels of confidence in the accuracy of reception which may be determined for a particular hop can be varied depending on the particular use for the level of confidence. For example, two levels of confidence of each hop may be determined for use in a hard decision environment. The two levels of confidence include: (1) full confidence which corresponds to the estimated C/I power ratio being at or above a particular threshold and (2) no confidence which corresponds to the estimated C/I power ratio being below the particular threshold. In response to a full confidence measure, the associated set of data samples for the hop would be used by the diversity combiner 154 in generating the single combined set of data samples 156 for the hop. However, in response to a no confidence measure, the associated set of data samples for the hop would not be used by the diversity combiner 154 in generating the single combined set of data samples 156 for the hop. In another example, several levels of confidence in the accuracy of reception of each hop may be determined for use in a soft decision environment. These several levels of confidence correspond to increasing confidence as the estimated C/I power ratio 126 increases in value. In response to the increasing level of confidence, the associated set of data samples for the hop would be assigned greater weighting coefficients by the diversity combiner 154. It will be appreciated by those skilled in the art that these diversity combining techniques can be extended to combining a plurality of sets of data samples received on a corresponding plurality of receiver branches.

Subsequently, single combined set of data samples 156 preferrably is used by the detecting portion 128 to detect data bits 130 in the data samples. Such detection may be accomplished by using a decoding technique similar to the one described above in reference to FIG. 2. However, other types of detection of data bits in the combined set of data samples 156 could be used without departing from the spirit and scope of preferred embodiment diversity combining invention as claimed.

Although the invention has been described and illustrated with a certain degree of particularity, it is understood that the present disclosure of embodiments has been made by way of example only and that numerous changes in the arrangement and combination of parts as well as steps may be resorted to by those skilled in the art without departing from the spirit and scope of the invention as claimed. For example, the modulator, antennas and demodulator portions of the preferred embodiment communication system as described were directed to CDMA spread spectrum signals transmitted over a radio communication channel. However, as will be understood by those skilled in the art, the communication channel could alternatively be an electronic data bus, wireline, optical fiber link, or any other type of communication channel.

Claims

What is claimed is:

1. An apparatus comprising a detector, the detector having detecting means for detecting data bits in input data samples of a hop of a slow frequency hopping spead spectrum signal, the improvement is characterized by:
   (a) the detector having estimator means, operatively coupled to the detector means, for estimating the carrier to interference power ratio of the hop of the slow frequency hopping signal by using the input data samples of the hop; and
   (b) the detecting means using the estimated carrier to interference power ratio to detect data bits in the input data samples of the hop of the slow frequency hopping signal.

2. The apparatus of claim 1 wherein the detector estimator means comprises means for computing the estimated carrier to interference power ratio with a metric at least comprising a monotonically related function (ψ) defined as follows:

$$\Psi = \frac{\mathrm{Ave}^2\{\mathrm{Re}\{z\}\}}{\mathrm{Ave}\{|z|^2\} - \mathrm{Ave}^2\{\mathrm{Re}\{z\}\}}$$

where,

z = phase cancelled forms of the input data samples wherein the input data samples represent the complex envelope of an nth phase shift keying modulated hop of the slow frequency hopping spread spectrum signal

$\mathrm{Ave}^2\{\mathrm{Re}\{z\}\}$ = the square of the average of the real portion of z over the hop

$\mathrm{Ave}\{|z|^2\}$ = the average of the square of the magnitude of the complex valued z over the hop.

3. The apparatus of claim 2 wherein cancellation of nth phase shift keying modulation of the hop of the slow frequency hopping spread spectrum signal includes raising the complex envelope of the hop to the nth power whereby z represents the phase cancelled forms of the input data samples which comprise data samples of the complex envelope of the hop raised to the nth power for the nth phase shift keying modulated hop of the slow frequency hopping spread spectrum signal.

4. The apparatus of claim 1 wherein the detector detecting means comprises:

(a) means for generating decision metrics from the input data samples of the hop, each decision metric corresponding to a distance of an input data sample from a constellation point within a constellation space representing previously input data samples;

(b) means for generating a measure of confidence of the accuracy of the decision metrics based upon the estimated carrier to interference power ratio of the hop; and

(c) decoding means for generating an estimated data bit by utilizing maximum likelihood decoding techniques to derive a data bit from the decision metrics and the accuracy measure of confidence of the decision metrics.

5. The apparatus of claim 1 wherein:

(a) the input data samples of the hop of the slow frequency hopping spread spectrum signal comprise a plurality of sets of input data samples of the hop, each set corresponding to input data samples of the hop as received from one of a plurality of diversity receiver branches;

(b) the estimator means comprises means for estimating a carrier to interference power ratio of the hop of the slow frequency hopping signal associated with each particular set of input data samples by using the particular set of input data samples of the hop; and

(c) the detector detecting means comprises diversity combining means for combining the plurality of sets of input data samples into a set of input data samples in accordance with weighting coefficients for each particular set of input data samples derived from the estimated carrier to interference power ratio associated with the particular set of input data samples.

6. The apparatus of claim 1 further comprising:
   (a) receiving means for receiving a slow frequency hopping spread spectrum signal from over a communication channel; and
   (b) sampling means, operatively coupled to the receiving means and the detector, for sampling a hop of the received slow frequency hopping spread spectrum signal into data samples and inputting the data samples of the hop of the received slow frequency hopping spread spectrum signal to the detector.

7. The apparatus of claim 1 further comprising:
   (a) encoding means for encoding input data bits into data symbols with an encoding algorithm which facilitates subsequent detection of data bits in samples of the data symbols;
   (b) a transmitting means, operatively coupled to the encoding means, for transmitting the data symbols over a communication channel as a slow frequency hopping spread spectrum signal;
   (c) receiving means for receiving the slow frequency hopping spread spectrum signal from over the communication channel; and
   (d) sampling means, operatively coupled to the receiving means and the detector, for sampling a hop of the received slow frequency hopping spread spectrum signal into data samples and inputting the data samples of the hop of the received slow frequency hopping spread spectrum signal to the detector.

8. A method of communicating with slow frequency hopping spread spectrum signals including recovering data bits from data samples of a hop of a slow frequency hopping spread spectrum signal, the recovering steps comprising detecting data bits in the data samples of the hop of the slow frequency hopping signal, the improvement is characterized by:
   (a) estimating the carrier to interference power ratio of the hop of the slow frequency hopping signal by using the data samples of the hop; and
   (b) the detecting step using the estimated carrier to interference power ratio to detect data bits in the data samples of the hop of the slow frequency hopping signal.

9. The method of claim 8 wherein the recovering step of estimating comprises computing the estimated carrier to interference power ratio with a metric at least comprising a monotonically related function (ψ) defined as follows:

$$\Psi = \frac{Ave^2\{Re\{z\}\}}{Ave\{|z|^2\} - Ave^2\{Re\{z\}\}}$$

where,

z = phase cancelled forms of the input data samples wherein the phase cancelled forms of the input data samples are derived by raising the complex envelope of the hop to the nth power whereby z represents the phase cancelled forms of the input data samples which comprise data samples of the complex envelope of the hop raised to the nth power for the nth phase shift keying modulated hop of the slow frequency hopping spread spectrum signal

$Ave^2\{Re\{z\}\}$ = the square of the average of the real portion of z over the hop

$Ave\{|z|^2\}$ = the average of the square of the magnitude of the complex valued z over the hop.

10. The method of claim 8 wherein:

(a) the data samples of the hop of the slow frequency hopping spread spectrum signal comprise a plurality of sets of data samples of the hop, each set corresponding to data samples of the hop as received from one of a plurality of diversity receiver branches;

(b) the recovering step of estimating comprises estimating a carrier to interference power ratio of the hop of the slow frequency hopping signal associated with each particular set of data samples by using the particular set of data samples of the hop; and

(c) the recovering step of detecting comprises diversity combining the plurality of sets of data samples into a set of data samples in accordance with weighting coefficients for each particular set of data samples derived from the estimated carrier to interference power ratio associated with the particular set of data samples.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition K) H4P (PR, PDCSL); H4L (LDDRCP, LDDRCW, LDDRCX, LDDRQ, LDDRX)

(ii) Int Cl (Edition 5) H04L 25/49, 25/497; H03M 13/12

Search Examiner

K WILLIAMS

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search

4 DECEMBER 1992

Documents considered relevant following a search in respect of claims 1-10

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2191912 A (SIGNAL PROCESSORS) See whole specification	1, 8
A	GB 2185367 A (NIPPON TELEGRAPH) See page 3, lines 18-27	1, 8

Category	Identity of document and relevant passages	Relevant to claim(s,

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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First Named Inventor/Applicant Name:	C. Earl Woolfork
Customer Number:	68533
Filer:	Megan Elizabeth Lyman
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDSForm.pdf	611842 0a705ae4ae2c35fa67f60b3b98b351b613c28f7e	no	4

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2	Foreign Reference	GB2261347A.pdf	1578492 2f71e5677b6bb7ea7996d9aabc1708702fd758a6	no	35
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AO 120 (Rev. 3/04)

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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Central District of California on the following ☑ Patents or G Trademarks:

DOCKET NO.	DATE FILED 7/13/2012	U.S. DISTRICT COURT Central District of California
PLAINTIFF ONE-E-WAY, INC. CV12-06135		DEFENDANT JAYBIRD GEAR, LLC
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 8,131,391	3/6/2012	One-E-Way, Inc.
2		
3		
4		
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12 JUL 16 PM 3:59

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY G Amendment G Answer G Cross Bill G Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT
SEE ATTACHED ORDER

CLERK	(BY) DEPUTY CLERK	DATE
Terry Nafisi	Phyllis Lopez	3/15/2013

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