PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
H04L 1/06, H04B 7/06

A1

(11) International Publication Number: WO 00/36783

(43) International Publication Date: 22 June 2000 (22.06.00)

(21) International Application Number: PCT/EP98/07850

(22) International Filing Date: 3 December 1998 (03.12.98)

(71) Applicant *(for all designated States except US)*: FRAUNHOFER–GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E.V. [DE/DE]; Leonrodstrasse 54, D–80636 München (DE).

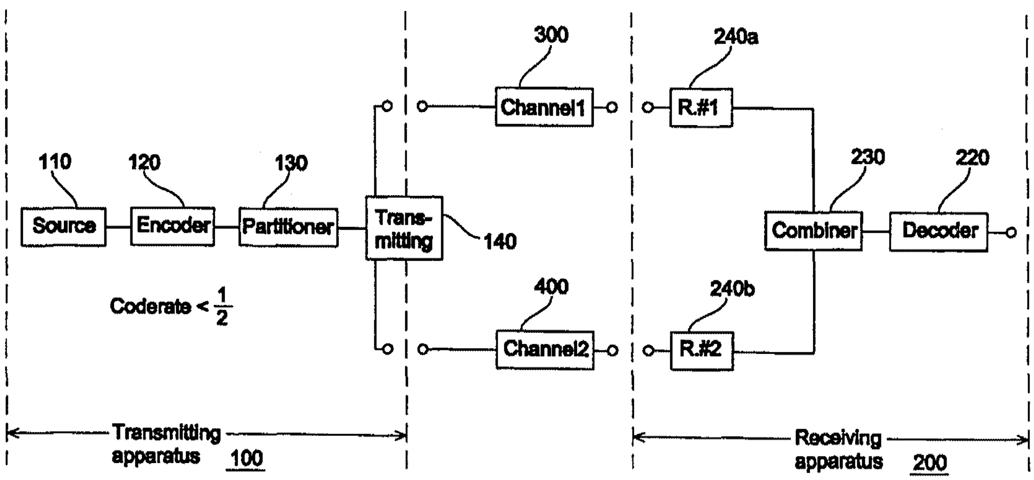
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: EBERLEIN, Ernst [DE/DE]; Waldstrasse 28b, D–91091 Grossenseebach (DE). BREILING, Marco [DE/DE]; Johann Jürgen Strasse 6, D–91052 Erlangen (DE). STOESSEL, Jan [DE/DE]; Parkstrasse 2, D–90409 Nürnberg (DE). GERHÄUSER, Heinz [DE/DE]; Saugendorf 17, D–91344 Waischenfeld (DE).

(74) Agent: SCHOPPE, Fritz; Schoppe & Zimmermann, Postfach 71 08 67, D–81458 München (DE).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: APPARATUS AND METHOD FOR TRANSMITTING INFORMATION AND APPARATUS AND METHOD FOR RECEIVING INFORMATION



(57) Abstract

An apparatus (100) for transmitting information comprises a bitstream source (110) for providing a bitstream representing the information, a redundancy adding encoder (120) for generating an encoded bitstream, which is arranged to output, for a first number of input bits and a second number of output bits. The apparatus (100) further comprises means (130) for partitioning the second number of output bits into the two portions of output bits and means (140) for transmitting the output bits of the first portion via a first channel (300) and the output bits of the second portion via second channel (400) being spatially different from the first channel (300). An inventive receiving apparatus (200) combines (230) the signals received via the first and second channels (300, 400) and uses both channel signals for channel decoding (220) by removing redundancy.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

Apparatus and Method For Transmitting Information
and
Apparatus and Method For Receiving Information

Specification

The present invention relates to concepts for digital broadcasting and, in particular, concepts for digital broadcasting suited for fading channels for wireless communication.

Satellite-based broadcasting systems provide an adequate communication link only in rural areas, in which only a small number of e.g. bridges exist. Additionally, rural areas usually do not have skyscrapers. Skyscrapers as well as bridges or, generally, densly built-up areas are obstacles to satellite-based communication systems, since carrier frequencies used for such communication links involve that a channel between a sender, e.g., a satellite, and a receiver, i. e. a mobile or stationary receiver, is characterised by the line of visual contact (line of sight) between the sender and the receiver. If a skyscraper comes into the line of visual contact, i.e., the transmission channel between the satellite and the receiver, which may be positioned in a car, the received signal power will decrease substantially.

Generally, it can be stated that in wireless systems (radio systems), changes in the physical environment cause the channel to fade. These changes include both relative movement between transmitter and receiver and moving scatters/reflectors in the surrounding space. In theoretical studies of wireless systems, the real channels are usually modelled so that they result in trackable analysis. The two major classes of fading characteristics are known as Rayleigh and Rician. A Rayleigh-fading environment assumes no line of sight and no fixed reflectors/scatters. The expected value of the fading is zero. If there is a line of sight, this can be modelled by Rician-fading, which has the same characteristics as the Rayleigh-fading, except for a non-zero expected radio.

Modern digital broadcasting systems know several means for reducing the impact of a channel fading. These concepts comprise channel coding on the one hand and several kinds of diversity on the other hand. The European standard for digital audio broadcasting (DAB), set out in Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) To Mobile, Portable and Fixed Receivers, ETS 300 401, ETS I - European Telecommunications Standards Institute, Valbonne, France, February 1995, uses differential quadrature phase-shift keying (DQPSK) as modulation technique. The channel encoding process is based on punctured convolutional coding, which allows both equal and unequal error protection. As a mother code, a convolutional code having a code rate of 1/4, a constraint length 7, and octal polynominals is used. The puncturing procedure allows the effective code rate to vary between 8/9 and 1/4. Channel coding by means of punctured convolutional codes is described in "Punctured Convolutional Codes of Rate (n-1)/n and Simplified Maximum Likelihood Decoding", J. Bibb Cain et al., IEEE Transactions on Information Theory, Vol. IT-25, No. 1, January 1979.

Punctured convolutional codes can be used in connection with many modulation techniques, such as OFDM, BPSK, QAM, etc.

Different channel encoding techniques are outlined in "Channel Coding with Multilevel/Phase Signals", Gottfried Ungerboeck, IEEE Transactions on Information Theory, Vol. IT 28, No. 1, pages 55 to 66, January 1982.

Bitstreams encoded by means of a convolutional encoder can be decoded by a decoder, in which the well-known Viterbi algorithm is implemented. This algorithm is capable of using the channel state information (see P. Hoeher "TCM on Frequency-Selective Length-Mobile Fading Channels", Proc. Tirrenia International Workshop Digital Communication, Tirrenia, Italy, September 1991). The Viterbi algorithm can be modified to provide reliability estimates together with the decoded sequence. This enables soft decoding. By applying a soft-output Viterbi algorithm, an improvement of about 2 dB is obtained in comparison to systems that implement "hard" decision.

With reference to Fig. 6, a simplified overview of a transmitter receiver system described in the European DAB Standard is illustrated. The transmitter receiver system generally comprises a transmitter section 60 and a receiver section 70. The transmitter section 60, in the simplest case, comprises a bitstream source 62, a channel encoder 64 and a transmitter 66. The receiver section 70, in the simplest case, comprises a receiver 72 and a channel decoder 74.

Fig. 7 illustrates a transmitting receiving setup providing for time diversity as well as space diversity. The transmitter section 60′ comprises the bitstream source 62 and the encoder 64 that have already been described with respect to Fig. 6. In addition, the receiver section 60′ comprises a first transmitter 66a and a second transmitter 66b. Both transmitters 66a and 66b are fed by the same signal output by the encoder 64 that is duplicated by a duplicator 67.

To obtain time diversity, a delay element 68 is coupled between the duplicator 67 and the second transmitter 66b.

In the case of satellite communication, the transmitters 66a and 66b are realised by two satellites that reside on different orbital positions spaced apart from each other.

The first channel is defined by the line of sight between

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.