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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Presented for filing is a new continuation patent application of:

Applicant: HUI JIN, AAMOD KHANDEKAR, AND ROBERT J. MCELIECE

Title: SERIAL CONCATENATION OF INTERLEAVED CONVOLUTIONAL CODES FORMING TURBO-LIKE CODES

Assignee: California Institute of Technology

Enclosed are the following papers, including those required to receive a filing date under 37 C.F.R. § 1.53(b):

	Pages
Specification	13
Claims	3
Abstract	1
Declaration	To Be Filed Later
Drawings	5

Enclosures:

— Small entity statement. See 37 CFR 1.27.

This application is entitled to small entity status.

This application is a continuation (and claims the benefit of priority under 35 U.S.C. § 120) of U.S. Application Serial No. 12/165,606, filed June 30, 2008, which is a continuation of U.S. Application Serial No. 11/542,950, filed October 3, 2006, now U.S. Patent No. 7,421,032, which is a continuation of U.S. Application Serial No. 09/861,102, filed May 18, 2001, now U.S. Patent No. 7,116,710, which claims the priority of U.S. Provisional Application Serial No. 60/205,095, filed May 18, 2000, and is a continuation-in-part of U.S. Application Serial No. 09/922,852, filed August 18, 2000, now U.S. Patent No. 7,089,477. The disclosures of the prior applications are considered part of (and are incorporated by reference in) the disclosure of this application.

Basic Filing Fee			$0
Search Fee			$0
Examination fee			$0
Total Claims 14	over 20	**0 x $26**	$0
Independent Claims 2	over 3	**0 x $110**	$0
Fee for Multiple Dependent claims			$0
Fee for each additional 50 pages of Specification and Drawings over 100			$0
	(X+X-100)/50 = 0 x		
Total Filing fee			$0

Under 37 C.F.R. §1.53(f), no filing fee is being paid at this time.

If this application is found to be incomplete, or if a telephone conference would otherwise be helpful, please call the undersigned at (858) 720-5700.

Kindly acknowledge receipt of this application by returning the enclosed postcard.

Please direct all correspondence to the following:

97075
PTO Customer Number

Respectfully submitted,

/Hwa C. Lee 59747/

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Enclosures
HCL/jjc

SERIAL CONCATENATION OF INTERLEAVED CONVOLUTIONAL CODES FORMING TURBO-LIKE CODES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Application Serial No. 12/165,606, filed June 30, 2008, which is a continuation of U.S. Application Serial No. 11/542,950, filed October 3, 2006, now U.S. Patent No. 7,421,032, which is a continuation of U.S. Application Serial No. 09/861,102, filed May 18, 2001, now U.S. Patent No. 7,116,710, which claims the priority of U.S. Provisional Application Serial No. 60/205,095, filed May 18, 2000, and is a continuation-in-part of U.S. Application Serial No. 09/922,852, filed August 18, 2000, now U.S. Patent No. 7,089,477. The disclosures of the prior applications are considered part of (and are incorporated by reference in) the disclosure of this application.

GOVERNMENT LICENSE RIGHTS

[0002] The U.S. Government has a paid-up license in this invention and the right in limited circumstances to require the patent owner to license others on reasonable terms as provided for by the terms of Grant No. CCR-9804793 awarded by the National Science Foundation.

BACKGROUND

[0003] Properties of a channel affect the amount of data that can be handled by the channel. The so-called "Shannon limit" defines the theoretical limit of the amount of data that a channel can carry.

[0004] Different techniques have been used to increase the data rate that can be handled by a channel. "Near Shannon Limit Error-Correcting Coding and Decoding: Turbo Codes," by Berrou et al. ICC, pp 1064-1070, (1993), described a new "turbo code" technique that has revolutionized the field of error correcting codes. Turbo codes have sufficient randomness to allow reliable communication over the channel at a high data rate near capacity. However, they still retain sufficient structure to allow practical encoding and decoding algorithms. Still, the technique for encoding and decoding turbo codes can be relatively complex.

[0005] A standard turbo coder 100 is shown in Figure 1. A block of k information bits is input directly to a first coder 102. A k bit interleaver 106 also receives the k bits and interleaves them prior to applying them to a second coder 104. The second coder produces an output that has more bits than its input, that is, it is a coder with rate that is less than 1. The coders 102, 104 are typically recursive convolutional coders.

[0006] Three different items are sent over the channel 150: the original k bits, first encoded bits 110, and second encoded bits 112. At the decoding end, two decoders are used: a first constituent decoder 160 and a second constituent decoder 162. Each receives both the original k bits, and one of the encoded portions 110, 112. Each decoder sends likelihood estimates of the decoded bits to the other decoders. The estimates are used to decode the uncoded information bits as corrupted by the noisy channel.

SUMMARY

[0007] A coding system according to an embodiment is configured to receive a portion of a signal to be encoded, for example, a data block including a fixed number of bits. The coding system includes an outer coder, which repeats and scrambles bits in the data block. The data block is apportioned into two or more sub-blocks, and bits in different sub-blocks are repeated a different number of times according to a selected degree profile. The outer coder may include a repeater with a variable rate and an interleaver. Alternatively, the outer coder may be a low-density generator matrix (LDGM) coder.

[0008] The repeated and scrambled bits are input to an inner coder that has a rate substantially close to one. The inner coder may include one or more accumulators that perform recursive modulo two addition operations on the input bit stream.

[0009] The encoded data output from the inner coder may be transmitted on a channel and decoded in linear time at a destination using iterative decoding techniques. The decoding techniques may be based on a Tanner graph representation of the code.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figure 1 is a schematic diagram of a prior “turbo code” system.

[0011] Figure 2 is a schematic diagram of a coder according to an embodiment.

[0012] Figure 3 is a Tanner graph for an irregular repeat and accumulate (IRA) coder.

[0013] Figure 4 is a schematic diagram of an IRA coder according to an embodiment.

[0014] Figure 5A illustrates a message from a variable node to a check node on the Tanner graph of Figure 3.

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