Turbo Product Code used in Wireless Communication

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***Abstract*- Any communication system will be having an encoding and decoding, error correcting block, at the transmitter and receiver side respectively. Multimedia wireless applications are very popular, mainly due to high data rates. Turbo Product Code (TPC) used for encoding is an effective technique with reasonable decoding complexity. Original information is encoded and sent over a specific channel using different types of modulations. A wireless data transmission scheme that combines and encode techniques into one processing step can be used for various applications.**

The forward Error Correcting Code (ECC) are a new class of codes that can achieve exceptional error performance and energy efficiency at low Signal to Noise ratio (SNR).

The simulation result of estimate BER show that implementation of RS/Convolution codes/non-Convolution codes/Linear Block codes with under QPSK/BPSK/QAM technique is highly effective to combat inherent interface in wireless communication system. For that decoding of Turbo Product Code (TPC) using different algorithm and BER performance rate is substantially improved by increasing number of iteration used in decoding process.

I. INTRODUCTION

Turbo product codes are first presented by P. Elias in 1954, which are also called Tanner product codes, Block turbo codes. According to subcode class of codes, there are Reed Solomon product codes, BCH product codes, extended Hamming product codes with an additional parity check bit and single parity product codes. Turbo product codes are made from a multidimensional array of (n,k) block codes. Different code rates are achieved by using various length codes in two or three dimensions. For purpose of minimizing decoding complexity, TPCs are usually built from extended Hamming codes and parity codes. TPCs are a class of relatively new codes that offer a wide range of flexibility in terms of performance, complexity, and code rate. It is widely known that TPCs belong to linear block codes with turbo decoding algorithm. The main idea of turbo-decoder is to use iterative algorithm with many correction cycles and soft decisions on input and output of every iteration. The term "turbo code" in the market today generally doesn't refer to TPC, but means turbo convolutional code.

Increasing demand for information exchange is a characteristic of modern civilization. The transfer of information from source to destination has to be done in such a way so that the quality of information received should be as close as possible to the quality of transmitted information

Forward Error Correction

Forward error correction Or FEC is a type of Digital signal processing that enhances data reliability by introducing a known structure into a data sequence prior to transmission or storage. This allows the receiver to detect and correct errors without the need to ask the sender for additional data.

The Advantages of FEC at that a back-channel is not required and retransmission of data can be avoided, at the cost of higher bandwidth requirements. FEC is therefore applied in situations where transmissions are relatively costly or impossible. In particular, FEC information is usually added to most mass storage devices to protect against damage to the stored data.

FEC is accomplished by adding redundancy to the transmitted information using a predetermined algorithm. Each redundant bit is invariably a complex function of many original data bits. The original information may or may not appear in the encoded output therefore the codes that include the unmodified input in the output systematic, while those that do not are non-systematic.

An extremely simple example would be an analog to digital converter that sample three bits or signal strength data for every bit of transmitted data. If three samples are mostly zero, The transmitted bit would be zero. If three samples are mostly one, The transmitted bit would be a one. .

This allows an error in any one of the three samples to be checked by "democratic voting". This is a highly inefficient

FEC but it does show the principle behind it. In practical, FEC codes typically examine the last several dozen or even the last several hundred received bits to determine how to decode the current small handful of bits.

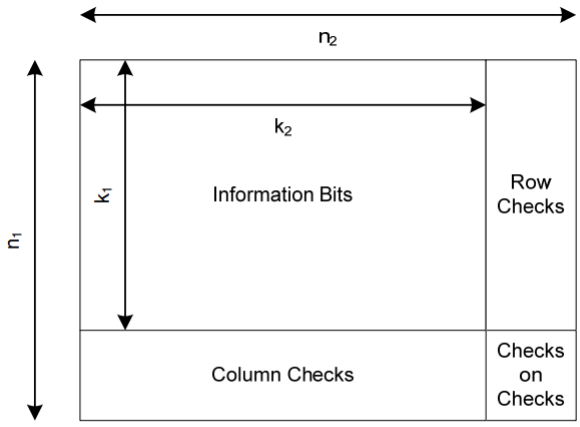
Triple Received	Interpreted as
000	0
001	0
010	0
100	0
011	1
101	1
110	1
111	1

FEC devices are often located close to the receiver of an analog signal, in the first stage of digital processing after a signal has been received. That is, FEC circuits are often an integral part off the analog to digital conversion process also involving digital modulation and demodulation or line coding and decoding. Many FEC gorgeous can also generate a bit error rate signal (BER) which can be used as feedback to fine-tube the analog receiving electronics. Soft decision algorithm such as Viterbi decoder can take analog data in and generate digital data on output. The maximum fraction of errors that can be corrected is obtained in advance by the design of the code,so different FEC codes are suitable for different conditions

Literature Survey

Turbo Product code Description

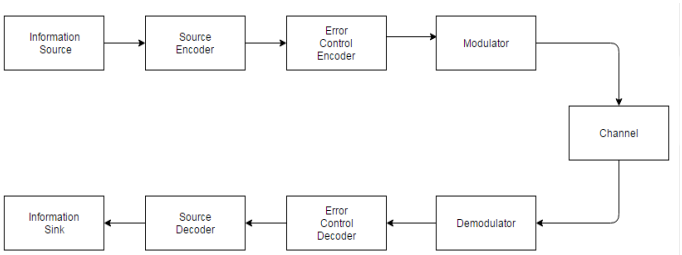
Turbo Product Codes has been shown to provide performance equivalent to other coding techniques but with much lower level ofcomplexity,suitable for hardware applications.TPC is one of the efficient channel coding techniques



A Simple Turbo-Product Code Example.

A two-dimensional product code is built from two component codes with parameters C 1 (n 1, k1, d1) andC2 (n 2, k2, d2), where ni, ki, di stand for code word length, number of information bits, and minimum hamming distance respectively [3].The product code P= C1 X C2 is obtained by placing (K1 X K2) information bits in an array of K1 rows and K2 columns .The parameters of product code P are n =n1 X n2,K=K1 X K2, d=d1 X d2 and code rate is R = R1XR2,where Ri is the code rate of Ci. Thus very long block codes can be built with large minimum Hamming distance. Figure. 2 shows the procedure for construction of a 2D product code using two block codes C1 and C2.All the rows of matrix P are the code words of C1 and all the columns of matrix P are code words of C2

II. BLOCK DIAGRAM



III. BLOCK DIAGRAM DESCRIPTION

Information Source:-The Information Source is the Source from where the information to be processed is obtained.

Source Encoder:-This block is used for converting data or signals by using a specific code. It is used mostly with four clearly discriminated purposes:

1) To remove redundancy or anything that is not going to be perceived by the information receiver or remain beyond the efficient goals of the received signal, typically named source encoder;
2) To increase redundancy, so that the decoder can eventually detect and correct the errors occurred within the reception of signals or symbols, are known as channel encoder.
3) To make the coded data unreadable, except if the recipient knows the code, by using different ciphers;
4) To permit the transmission of data through a channel with certain resources and limitations, corresponding in the MTC communication model to the transmitter-encoder, also named modulator -especially in telecommunications system.

Modulator
:-The Modulator converts the input bit stream into an electrical waveform suitable for transmission over the communication channel. Modulator can be efficiently used to reduce the effects of channel noise, to match the frequency spectrum of transmitted signal with channel characteristics, to provide the capability to multiplex many signals.

Channel:-The Channel provides the electrical connection between the source and destination. The different channels are: Pair of wires, Coaxial cable, Optical fibre, Radiochannel, Satellite channel or combination of any of these. In this system we use satellite channel for communication.

The communication channels have only finite Bandwidth, non ideal response, the signal often suffers amplitude and phase distortion as it travel over the channel. Also, the signal power decreases due to the attenuation of the channel. The signal is corrupted by unwanted, unpredictable electrical signal referred to as noise.The important parameters of the channel are Signal to Noise power Ratio (SNR), usable bandwidth, amplitude and phase response and the statistical properties of noise.

Demodulator:-The extraction of the message from the information bearing waveform produced by the modulation is accomplished by the demodulator. The output of the demodulator is bit stream. The important parameter is the method of demodulation

Source Decoder: This block performs the inverse operation of the encoder, whatever the purpose of the code:

1) The source decoder tries to restore the deleted redundancy;
2) The channel decoder removes the redundancy that has been introduced by the corresponding encoder, and correct those errors being detected;
3) The unencryptor makes the information readable; and
4) the demodulator or receiver-decoder identifies the symbol transmitted through the channel –normally according to a maximum likelihood standard and restate the data into its original form, i.e., how it was before the modulator.

Information Sink :- In this block the information that is received is used.

IV. ADVANTAGES

The benefits of using TPC are as follows:

- Less transmit power required from the battery operated device using TPC.
- No IP license required for encoding
- Standard IC's are available providing the required functionality thus, the TPC implementation price increase is minimal.
- A very low cost encoder, smaller batteries, smaller packages; it all adds up to reduced cost and improved performance
- Parallel processing can be done
- Process of decoding is simple and iterative

V. APPLICATION

- Turbo codes are used extensively in 3G and 4G mobile telephony standards; e.g., in HSPA, EV-DO and LTE.
- Media FLO, terrestrial mobile television system from Qualcomm.
- The interaction channel of satellite systems, such as DVB-RCS and DVB-RCS2.
- New NASA missions such as Mars Reconnaissance Orbiter now use turbo codes, as an alternative to RS-Viterbi codes.
- Turbo coding such as block turbo coding and convolutional turbo coding are used in IEEE 802.16 (Wi-MAX), a wireless metropolitan network standard.
- Broadband wireless access
- VSAT modems
- Wireless internet access
- Wireless LAN and Free Air Optical

VI. CONCLUSION

- Turbo Product Codes are an excellent fit for a variety of communication systems
- Due to their low complexity and excellent performance. We also put forward modified TPC- OFDM system which is a promising solution for supporting broadband wireless and multimedia communications in the 4th generation wireless communication system.
- OFDM has long been regarded as an efficient approach to combat the adverse effects of the wireless channel.

VII. FUTURE SCOPE

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- OFDM has long been regarded as an efficient approach to combat the adverse effects of the wireless channel.

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