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Parellel Concatenated Turbo Codes for Performance Analysis of Coded Ofdm in Dab

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Abstract

Orthogonal frequency division multiplexing (OFDM) supports wide range of high speed applications and has ability to provide data rate up to 100MBPS. Coded OFDM has ability to provide high performance along with low computational complexity. Although in literature, concatenated c convolutional coded OFDM has designed for effective BER analysis but it is designed for Digital audio broadcasting application only. In this work, a novel framework is proposed based on audio and digital images using convolutional coded OFDM scheme for BER analysis. Finally experimental results provide equipped performance along with minute computational complexity.

Keywords: Coded OFDM, Convolutional coding, BER analysis, Efficiency

1. INTRODUCTION

The telecommunications' industry is in the midst of a veritable explosion in Wireless technologies. Once exclusively military, satellite and cellular technologies are now commercially driven by ever more demanding consumers, who are ready for seamless communication from their home to their car, to their office, or even for outdoor activities. With this increased demand comes a growing need to transmit information wirelessly, quickly, and accurately. To address this need, communications engineer have combined technologies suitable for high rate transmission with forward error correction techniques. The latter are particularly important as wireless communications channels are far more hostile as opposed to wire alternatives, and the need for mobility proves especially challenging for reliable communications. For the most part, Orthogonal Frequency Division Multiplexing (OFDM) is the standard being used throughout the world to achieve the high data rates necessary for data intensive applications that must now become routine.

Orthogonal Frequency Division Multiplexing (OFDM) is a Multi-Carrier Modulation technique in which a single high rate data-stream is divided into multiple low rate data-streams and is modulated using sub-carriers which are orthogonal to each other. Some of the main advantages of OFDM are its multi-path delay spread tolerance and efficient spectral usage by allowing overlapping in the frequency domain. Also one other significant advantage is that the modulation and demodulation can be done using IFFT and FFT operations, which are computationally efficient.

2. BACKGROUND

(A) OFDM

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier transmission technique, which divides the available spectrum into many carriers, each one being modulated by a low rate data stream. OFDM is similar to FDMA in that the multiple user access is achieved by subdividing the available bandwidth into multiple channels,

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that are then allocated to users. However, OFDM uses the spectrum much more efficiently by spacing the channels much closer together. This is achieved by making all the carriers orthogonal to one another, preventing interference between the closely spaced carriers.

(B) Coded OFDM

Coded Orthogonal Frequency Division Multiplexing (COFDM) is the same as OFDM except that forward error correction is applied to the signal before transmission. This is to overcome errors in the transmission due to lost carriers from frequency selective fading, channel noise and other propagation effects. For this discussion the terms OFDM and COFDM are used interchangeably, as the main focus of this thesis is on OFDM, but it is assumed that any practical system will use forward error correction, thus would be COFDM.

3. PROPOSED METHOD

II. SYSTEM MODEL OF DAB USING CODED OFDM

A) A Simplified DAB Block Diagram

A general block diagram of the Digital Audio Broadcasting transmission system is shown in Fig. 1. The simple sign is encoded and connected to channel encoder. After channel coding the bit streams are QPSK mapped. The information is then gone to OFDM generator. The high information rate bit stream is separated into "N" parallel information surges of low information rate and separately regulated on to orthogonal subcarriers which is acknowledged utilizing IFFT calculation. Orthogonality of the subcarriers accomplishes zero Inter Image Interference, hypothetically [1]. At long last, the OFDM image is given cyclic prefix and the finished Touch outline structure is transmitted through an AWGN channel.

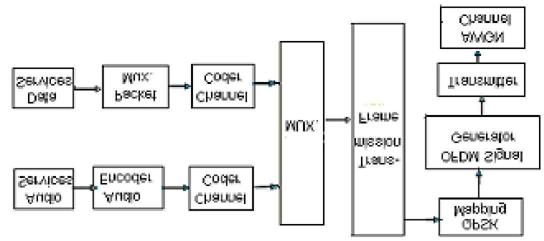

Figure 1: DAB transmitter – Block Diagram

B. DAB Transmission Modes

DAB system has four transmission modes, each with its own set of parameters, shown in Table-I [12]. In this paper Transmission Mode-I is selected for simulation.

TABLE I. Dab Transmission Modes

Trans-mission Mode	No. of Sub-carriers	Sub carrier spacing	FFT Length	Maximum Radio Frequency
TM I	1536	1 KHz	2048	≈ 375 MHz
TM II	384	4 KHz	512	≈ 1.5 GHz
TM III	192	8 KHz	256	≈ 3 GHz
TM IV	768	2 KHz	1024	≈ 750 MHz

III. CHANNEL CODING

A) Convolutional Encoding & Viterbi Decoding

A convolutional encoder comprises of a M-stage shift register with "k" inputs, endorsed associations with "n" modulo-2 adders and multiplexer that serializes the yields of the adders. Here the encoder chose has k=1, ie; the info succession touches base on a solitary information line. Subsequently the code rate is given by r = 1/n. In an encoder with a M stage shift enroll, the memory of the coder approaches M message bits and K = (M+1) movements are required before a message bit that has entered the movement register can at long last exit. This parameter K is alluded to as the imperative length of the encoder.

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The channel coding utilized for standard DAB comprises of code rate ½, memory 6, convolutional code with code generator polynomials 133 and 171 in octal organization [2]. For Spot lower code rates give better execution. Subsequently in this work, encoder with code rate=w̄ is chosen. One such convolutional encoder is appeared in Fig. 2. The quantity of registers=6. Consequently the imperative length K=7. Generator Polynomials are 171, 133 and 115 in octal organization. Reproduction is done for different estimations of limitation length and generator polynomials, which are given in Table-III.

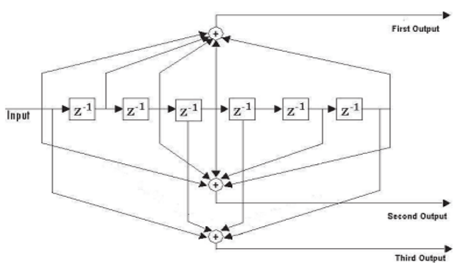

Figure 2: A rate w̄ convolutional encoder with constraint length, K=7

B) Parallel Concatenated Convolutional Turbo Coding & Decoding

Parallel Concatenated Convolutional turbo code (PCC turbo code) comprises of two or more Recursive Systematic Convolutional (RSC) coders working in parallel [8]. The reason for interleaver is to offer each encoder an irregular variant of the data bringing about equality bits from each RSC that are free.

On the receiving side there are same number of decoders as on the encoder side, each working on the same information and an independent set of parity bits.

In this work, to give same code rate to turbo encoder as on account of convolutional encoder, a parallel connection of two indistinguishable RSC encoders are utilized which gives a code rate of w̄. One such turbo encoder is appeared in Fig. 3, where the quantity of registers in each RSC encoder=2. Henceforth the limitation length K=3. Generator polynomials are 7 and 5 in octal arrangement. The number 7 indicates the input polynomial. ʌ is the arbitrary interleaver. Reenactment is completed for different estimations of requirement length, generator polynomials and input polynomials, which are given in Table-III.

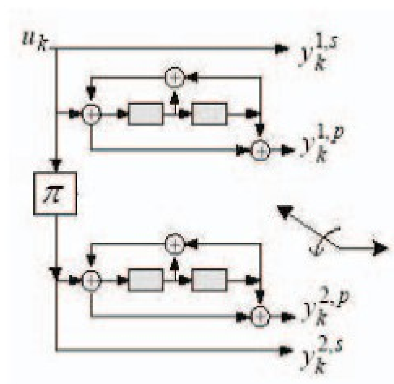

Figure 3: A rate w̄ turbo encoder with 2 parallel recursive systematic convolutional encoders, each with constraint length, K=3

The inputs are data bits and called uk. The yields are code bits. Of these, the yield of first encoder, yk1, s is known as the precise piece, and it is the same as the information bit. The second yield bit, yk1, p is the principal equality bit which is recursive deliberate piece. An interleaver, indicated by ʌ, is put in the middle of the two encoders to guarantee that the information got by the second encoder is measurably autonomous. The third yield bit, yk2, p is the second equality bit which is additionally a recursive deliberate piece. The fourth yield yk2, s is deterministically reshuffling adaptation of yk1, s, which is not transmitted.

For decoding, the Viterbi Algorithm is not suited to generate the A-Posteriori-Probability (APP) or soft decision output for each decoded bit. Here Maximum-A-Posteriori (MAP) algorithm is used for computing the metrics. Block diagram of turbo decoder is shown in Fig. 4.

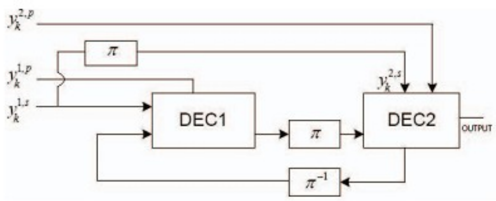

Figure 4: Turbo decoder – Block Diagram

In Fig. 4, DEC1 and DEC2 are 2 APP decoders. ʌ and ʌ -1 are random interleaver and deinterleaver respectively [14]. The symbol vector sent for each time are described by yk=(yk1, s, yk1, p, yk2, p). The goal is to take these and make a guess about the transmitted vector and hence code bits which in turn decode uk, the information bit.

4. Applications

- DAB - OFDM forms the basis for the Digital Audio Broadcasting (DAB) standard in the European market.
- ADSL - OFDM forms the basis for the global ADSL (asymmetric digital subscriber line) standard.
- Wireless Local Area Networks - development is ongoing for wireless point-to-point and point-to-multipoint configurations using OFDM technology.
- In a supplement to the IEEE 802.11 standard, the IEEE 802.11 working group published IEEE 802.11a, which outlines the use of OFDM in the 5GHz band.

5. RESULTS

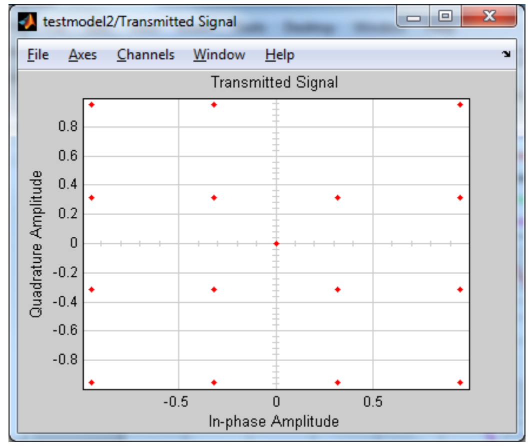

Figure 5: Transmitted Signal

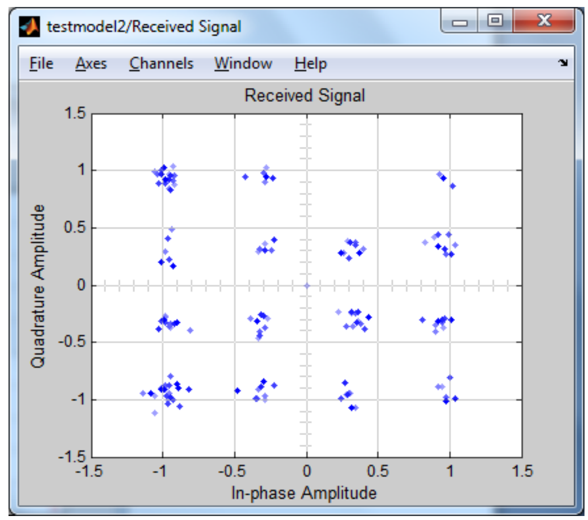

Figure 6: Received Signal

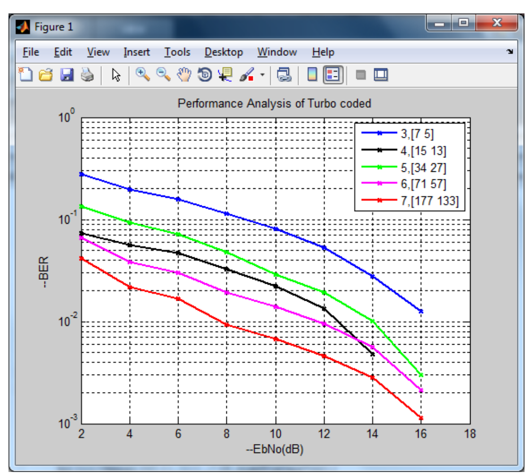

Figure 7: Performance Analysis Of Turbo Codes

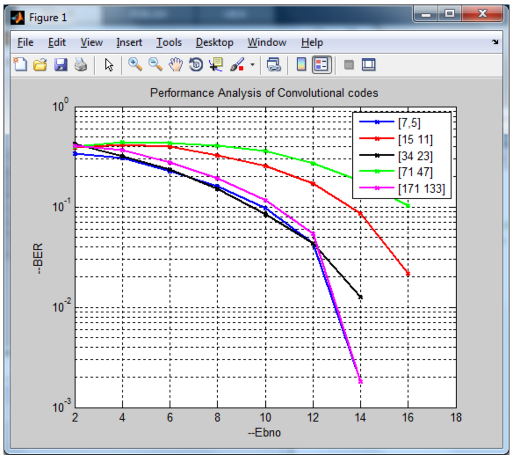

Figure 8: Performance Analysis Of Convolutional Codes

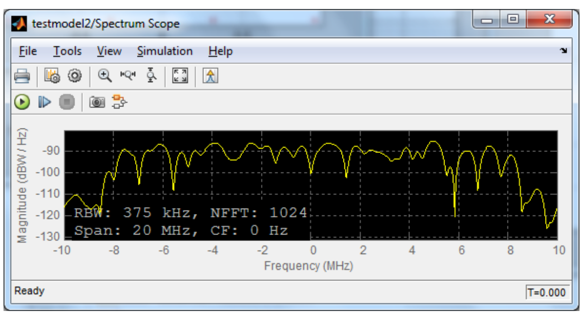

Figure 9: Frequency spectrum

6. EXTENSION WORK

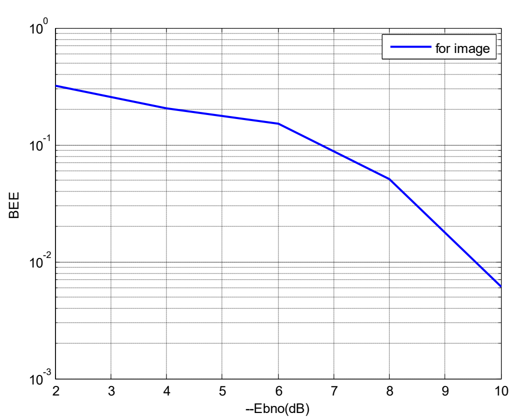

Figure 10: BER analysis for IMAGE

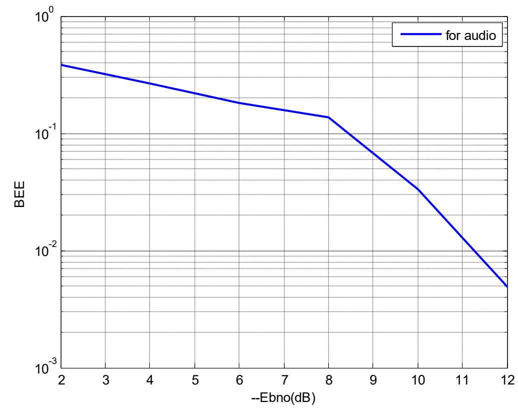

Figure 11: BER analysis for SPEECH

7. CONCLUSION

In this paper, the BER (Bit Error Rate) performances of Turbo & Convolutional coding is evaluated by varying different modulation scheme using AWGN &Rician channel. It has been deduced that the turbo coding provides better performances in AWGN as compared with Convolutional code & Convolutional coding provides better performances in Rician as compared with Turbo code. Turbo cod shows remarkable power efficiency in AWGN for low BER & also it operates at very low SNR. . The advantage of employing turbo coding in adaptive OFDM is revealed by comparing their performance with Convolutional code transmission system. A better adaptation algorithm is used to improve BER performance. This algorithm utilizes the average value of the instantaneous SNR of the subcarriers in the sub-band as the switching parameter. The simulation results show an improved BER performance in AWGN channel for turbo coded adaptive OFDM system rather than Convolutional code. Although in literature, concatenated c convolutional coded OFDM has designed for effective BER analysis but it is designed for Digital audio broadcasting application only. In this work, a novel framework is proposed based on audio and digital images using convolutional coded OFDM scheme for BER analysis.

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