CONVOLUTIONAL CODING ALGORITHM FOR ERROR CORRECTION

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Abstract – In wireless applications high throughput and better transmission quality can be achieved by parallel transmission of data, one of such technique is Orthogonal Frequency Division Multiplexing (OFDM) by adding channel coding to the uncoded OFDM, and the performance can be improved. In this dissertation, the system throughput of a working OFDM system has been enhanced by adding convolution coding. Convolution codes are used extensively in numerous applications in order to achieve reliable data transfer, including digital audio and video, mobile, radio communication, satellite deep space network communication. They can correct even burst and random errors. Simulation is done over Additive white Gaussian Noise (AWGN) channel has 64 sub carriers each is individually modulated by 16-QAM (Quadrature Amplitude Modulation). The performance parameter used for evaluation of BER (Bit Error Rate) with AWGN channel.

Key Words: QAM, QPSK, AWGN, Convolutional coding, OFDM.

1. INTRODUCTION

A reliable transmission of data is the need of every communication system. In communication systems the channel is most evil part. Here signal can get corrupted by noise, distorted and attenuated with many possibilities. The receiver must do its best to produce a received message that resembles the original message as much as possible. However there is always some ambiguity in reception. Shannon in his paper published in 1948, has given the fundamental theory of information theory which states that it is possible to transmit information through a noisy channel at any rate less than the capacity with an arbitrarily small probability of error.

It is increasingly believed that OFDM results in an improved downlink multimedia services requires high data rates communications, but this condition is significantly limited by inter-symbol interference (ISI) due to the existence of the multiple paths. Multicarrier modulation techniques, including OFDM modulation are considered as the most promising technique to combat this problem [4] OFDM technique is a multi-carrier transmission technique which is being recognized as an excellent method for high speed bi-directional wireless data communication. In wireless, satellite, and space communication systems, reducing error is critical. Wireless medium is quite different from the counterpart using wires and provides several advantages, for example; mobility, better productivity, low cost, easy installation facility and scalability. On the other hand, there are some restrictions and disadvantages of various transmission channels in wireless medium between receiver and transmitter where transmitted signals arrive at receiver with different power and time delay due to the reflection, diffraction and scattering effects. Besides the BER (Bit Error Rate) value of the wireless medium is relatively high. These drawbacks sometimes introduce destructive effects on the wireless data transmission performance. As a result, error control is necessary in these applications. During digital data transmission and storage operations, performance criterion is commonly determined by BER which is simply: Number of error bits / Number of total bits. Noise in transmission medium disturbs the signal and causes data corruptions. Relation between signal and noise is described with SNR (signal-to-noise ratio). Generally, SNR is explained with signal power / noise power and is inversely proportional with BER. It means, the less the BER result is the higher the SNR and the better communication quality [1].

2. LITERATURE REVIEW

Authors focused on training sequence design for efficient channel estimation in multiple input multiple-output filter bank multicarrier (FBMC) communications using offset quadrature amplitude modulation (OQAM). FBMC is a promising technique to achieve high spectrum efficiency as well as strong robustness against dispersive channels due to its feature of time-frequency localization. In this paper, authors proposes a new class of training sequences, which are formed by concatenation of two identical zero-correlation zone sequences whose auto-correlation and cross correlation are zero within a time-shift window around the in-phase position [1].

Author considers a robust SC-FDE design with imperfect channel knowledge at a receiver due to the channel estimation error. Based on a statistical model for channel estimation, the optimal equalization coefficients are derived under the criterion of minimizing the mean square error conditioned on a given channel estimate. The bit error rate is further analyzed and a tight performance approximation is proposed. Two robust FDE schemes in coded systems were also proposed, where feedback from the channel decoder is utilized to improve the equalization and/or channel estimation performance [2].

Authors proposed a joint estimation of the channel length and of the impulse response for OFDM systems, exploiting information criteria to find the best trade-off, in terms of Kullback-Leibler divergence, between noise rejection and channel description accuracy. So far, information criteria have not been used for practical channel length estimation methods, due to their prohibitive complexity. Authors show how to make them affordable, performing channel estimation in a recursive way that allows establishing the optimal channel length with a moderate incremental cost & achieved performance and robustness are very good [3].

Transmission scheme for OFDM have been investigated here. The advantage of employing adaptive transmission scheme is described by comparing their performance with fixed transmission system. A better adaptation algorithm is used to improve the throughput performance. This algorithm utilizes the average value of the instantaneous SNR of the subcarriers in the switching parameter. The results show an improved throughput performance with considerable BER performance [5].

Authors proposed a COFDM based WiMax here,which promises to cater these high speed and high quality applications. Worldwide Interoperability for Microwave Access (WiMax) is an IEEE 802.16 standard-based broadband wireless access (BWA) technology which employs Coded orthogonal frequency division multiplexing access (COFDM). This work analyses Bit Error Rate for WiMax based COFDM system with QPSK modulation scheme under various channel conditions like AWGN, Rayleigh, Rician and Nakagami-m. It has been observed that performance of Nakagami fading channel is better than other fading channels [6].

3. CONVOLUTIONAL ENCODING

To convolutionally encode data, start with k memory registers, each holding 1 input bit. Unless otherwise specified, all memory registers start with a value of 0. The encoder has n modulo-2 adders (a modulo 2 adder can be implemented with a single Boolean XOR gate, where the logic is: 0+0 = 0, 0+1 = 1, 1+0 = 1, 1+1 = 0), and n generator polynomials — one for each adder (see figure below). An input bit m_1 is fed into the leftmost register. Using the generator polynomials and the existing values in the remaining registers, the encoder outputs n bits. Now bit shift all register values to the right (m_1 moves to m_0, m_0 moves to m_{-1}) and wait for the next input bit. If there are no remaining input bits, the encoder continues output until all registers have returned to the zero state.

The figure below is a rate 1/3 (m/n) encoder with constraint length (k) of 3. Generator polynomials are G_1 = (1,1,1), G_2 = (0,1,1), and G_3 = (1,0,1). Therefore, output bits are calculated (modulo 2) as follows:

$$n_1 = m_1 + m_0 + m_{-1}$$
$$n_2 = m_0 + m_{-1}$$
$$n_3 = m_1 + m_{-1}.$$

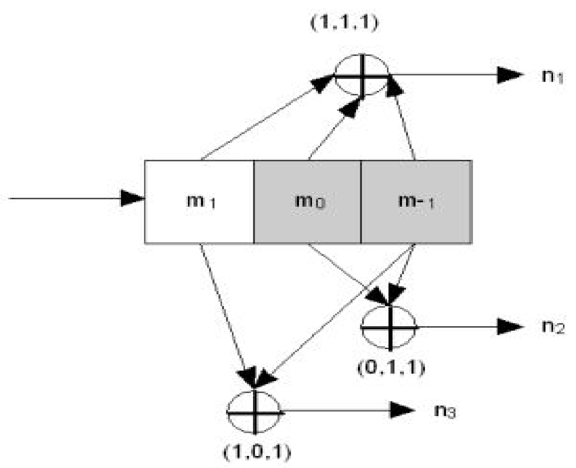

Figure 1: Convolutional encoding

4. PROPOSED METHODOLOGY

Steps for methodology are:

1. Consider the binary generator and start with the number of simulation process in first simulation process we concerned with evaluating the performance of different modulation with the help of convolutional error correcting with AWGN channel using different modulation technique.
2. In the first simulation i.e. simulation with convolutional error correcting codes with AWGN channels with BPSK, QPSK & 16-QAM modulation in this simulation we evaluating the performance of BPSK modulation in terms of BER (bit error rate) for different values of E_b/N_o.
3. So, from the first simulation of error correcting with AWGN channel with BPSK, 16-QAM, QPSK modulation we conclude that BER of error correcting codes with 16-QAM modulation is quite low as compared to other modulation technique.
4. As a result, in the second simulation the effect of Convolutional codes on considered OFDM system with 16-QAM under AWGN has been investigated. It is seen that convolutional code with OFDM system combat against the noise in channels to achieve better performance.
5. From simulation results it is observed that convolutional code with OFDM (CC-OFDM) system. Performance analysis of BER evaluation of normal OFDM is poor than that of CC-OFDM. BER performance of the CC-OFDM with hard decoding method with

QAM modulation has been observed the better than the normal OFDM system.

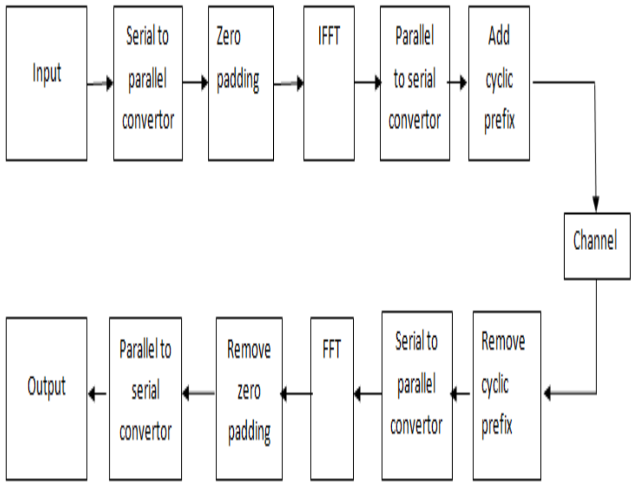

Figure2: Block diagram of OFDM system

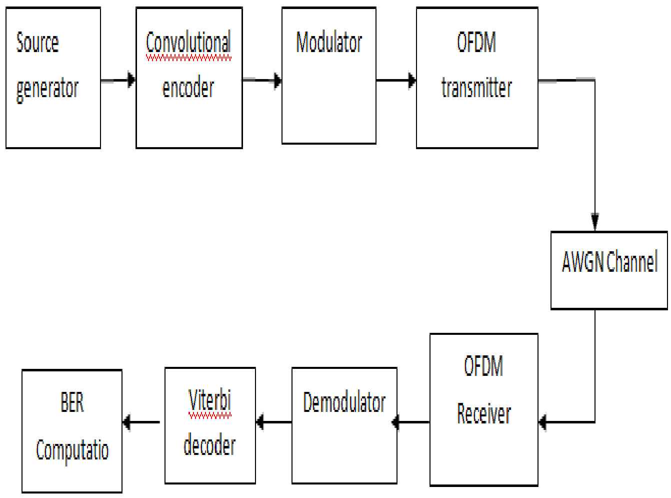

Figure 3: Block diagram of CC-OFDM

5. RESULTS AND DISCUSSION

We implemented the convolutional error correcting codes with 16-QAM with AWGN channel in Matlab 7.8.0 (R2009a). Initially the performance of BPSK, 16-QAM &QPSK with convolutional error correcting codes with AWGN channel is evaluated and analyzed that 16-QAM modulation technique provides better BER as compared to other modulation technique.

OFDM technology promises to be a key technique for achieving the high data capacity and spectral efficiency requirements for wireless communication systems. CC-OFDM is a powerful modulation technique to achieve higher bit rate and long range data access.

Table 1: Comparison with different modulator in terms of BER

S.NO	E_b/N_o(dB)	BPSK	16-QAM	QPSK
1.	1(dB)	0.475	**0.0091**	0.5
2.	2(dB)	0.4833	**0.00412**	0.4958
3.	3(dB)	0.4542	**0.000154**	0.5083
4.	4(dB)	0.3438	**0.0000414**	0.5417
5.	5(dB)	0.1771	**0.00000216**	0.4833
6.	7(dB)	0.0294	**0.000000323**	0.3775
7.	10(dB)	0.000107	**0.000000014**	0.1156
8.	12(dB)	0.000023	**0.0**	0.03612
9.	15(dB)	0.0000045	**0.0**	0.0004509
10,	18(dB)	0.00000012	**0.0**	0.0000232

5.1 RESULT OF FIRST SIMULATION

In this simulation the Bernoulli binary generator block generates the random binary numbers using a Bernoulli distribution. This block acts as a information source. Here we are using BPSK, 16-QAM & QPSK modulation scheme. The signal is passed through the AWGN channel. This is acting as a noise source. During the simulation, the performance is evaluated for various Eb/No i.e. 0 to 18 dB. The characteristics of the AWGN channel are changed by varying Eb/No from 0 to 18 dB to observe the BER performance. The Error rate calculation block compares the input data and the data received after demodulation and calculates the error rate. The display will show the BER at the end of simulation.. For convolutional codes we need to set the rate & constraint length parameters for convolutional encoder.

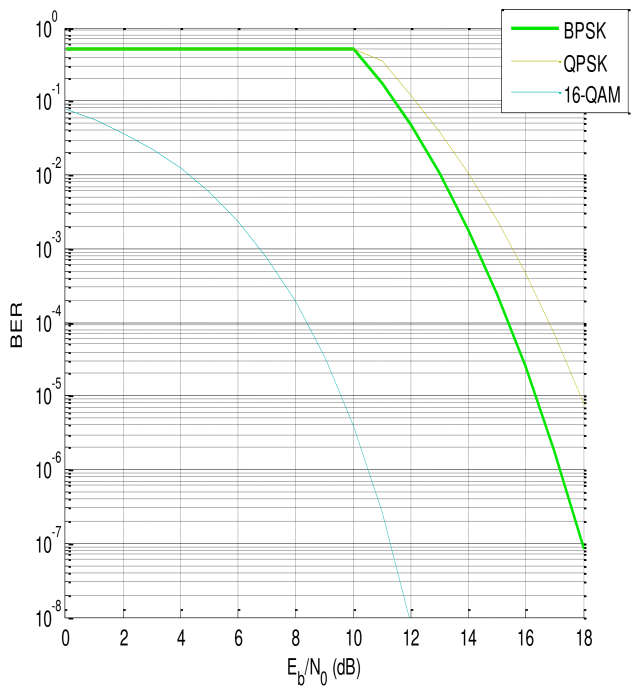

Figure 4: Plot of BER V/S E_B/N_O for convolutional coding with different modulation technique

5.2 RESULT OF SECOND SIMULATION

Table 2: Performance evaluation of CC-OFDM with 16-QAM modulator

S.NO	E_b/N_o(dB)	16-QAM
1.	1(dB)	**0.5016**
2.	2(dB)	**0.4982**
3.	3(dB)	**0.4979**
4.	4(dB)	**0.4743**
5.	5(dB)	**0.4678**
6.	7 (dB)	**0.3753**
7.	10(dB)	**0.0571**
8.	12(dB)	**0.0022**
9.	15(dB)	**0.0**
10.	18(dB)	**0.0**

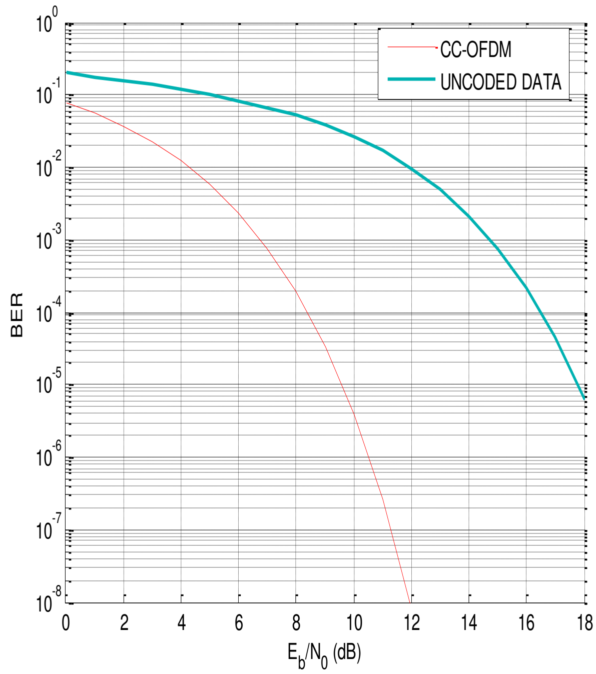

Figure 5: Plot of BER V/S E_B/N_O for convolutional code of 16-QAM modulation

6. CONCLUSIONS

The tremendous worldwide demand for high-speed mobile wireless communications is rapidly growing. OFDM technology promises to be a key technique for achieving the high data capacity and spectral efficiency requirements for wireless communication systems of the near future. In this dissertation, convolutional coding based OFDM system is analyzed under different modulation schemes. CC-OFDM is a powerful modulation technique to achieve higher bit rate and long range data access. So, the CC-OFDM is chosen for high speed digital communications like Wi-Fi, Wi-MAX, etc. Quality of an OFDM system is improved because it minimizes the probability of Error. It solves real life issues e.g. system complexity, cost of implementation, low transmission power required (SNR), minimum bandwidth etc. Performance analysis of BER evaluation of normal OFDM is poor than that of CC-OFDM. BER performance of the CC-OFDM with hard decoding method with QAM modulation has been observed the better than the normal OFDM system.

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