Performance Comparison of Uncoded & Coded Adaptive OFDM System over AWGN Channel

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Abstract

Adaptive OFDM (AOFDM) is the important approach to fourth generation of mobile communication. Adaptive modulating scheme is employed according to channel fading condition for improving the performance of OFDM. This gives improved data rate, spectral efficiency & throughput. OFDM is flexible to adapt modulation schemes on subcarriers according instantaneous signal-to-noise ratio (SNR). In this paper, we compare Bit Error Rate (BER),Mean Square Error(MSE), Spectral Efficiency, Throughput performance of uncoded & coded adaptive OFDM with BPSK,QPSK & QAM modulation over AWGN channel.

Keywords: *AOFDM,BER , FFT,MSE, OFDM,SNR,* Spectral Efficiency, Throughput

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is the most popular modulation technique for wireless communications. OFDM is a digital multicarrier modulation scheme which uses a large number of closely spaced orthogonal subcarriers [2]. OFDM signals are generated using the Fast Fourier transform. Each individual carrier, commonly called as subcarrier. Each subcarrier is modulated with a conventional modulation scheme at a low symbol rate, maintaining data rates similar to conventional single carrier modulation schemes in the same bandwidth. OFDM is a logical next step in broadband radio evolution. It is applied in IEEE standards like IEEE 802.11(Wi-Fi) and 802.16(WiMAX). OFDM is flexible to adapt modulation schemes on subcarriers according to instantaneous SNR. Adaptive OFDM (AOFDM) is the important approach to fourth generation of mobile communication. Adaptive modulation scheme is employed according to channel fading condition to improve OFDM performance. This improves data rate, spectral efficiency & throughput.

In this paper, we analyze Bit Error Rate (BER), Mean Square Error (MSE), Spectral Efficiency, Throughput performance of coded adaptive OFDM with BPSK,QPSK & QAM modulation over AWGN channel.

II. SYSTEM MODEL :

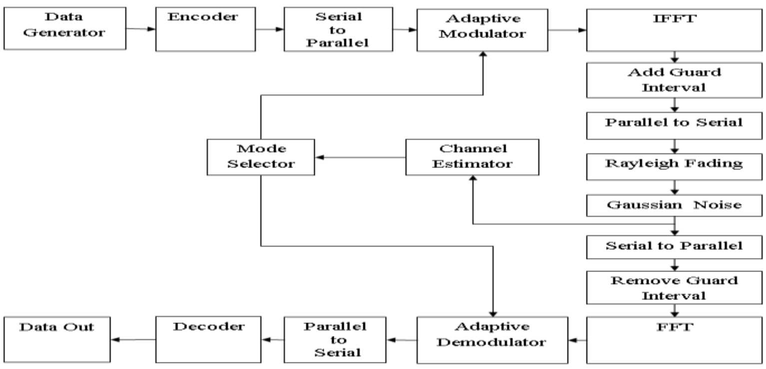

Figure 1. Adaptive OFDM system

The system model for Adaptive OFDM system is as shown in "Fig.1".The data is generated with the help of data generator. It is represented by a code word that consists of prescribed number code elements. The transmitter first converts this data from serial stream to parallel sets. Each set of data contains one symbol, Si, for each subcarrier . For example, a set of four data would be [S0 S1 S2 S3]. The flexibility to rigorous channel conditions can be further improved if information about the channel is sent over a return channel. Based on this feedback information adaptive modulation & channel coding may be applied across all subcarriers or individually to each subcarrier.

An inverse Fourier transform (IFFT) converts the frequency domain data set into samples of the corresponding time domain representation. Specifically IFFT is useful for OFDM because it maintains orthogonality between subcarriers. Since the duration of each symbol is long it is feasible to insert a guard interval between the OFDM symbols. Thus eliminating intersymbol interference. Parallel to serial block creates the OFDM signal by sequentially outputting the time domain samples. At receiver guard interval is removed. FFT is applied to have frequency domain signals. Adaptive demodulator does the reverse of modulator.

The channel estimator is used to estimate the instantaneous SNR of the received signal. Based on the instantaneous SNR the best mode will be selected for next transmission frame. This task is done by the mode selector block [1].The channel estimation and mode selection are done at the receiver side and the information is sent to the transmitter using a feedback channel [4]. In this model the adaptation is done frame by frame. At the transmitter the adaptive modulator block consists of different modulators which are used to provide different modulation modes. The switching between these modulators will depend on the instantaneous SNR. This system model is used to describe three types of modulation schemes as BPSK, QPSK & QAM.

III. SYSTEM PARAMETERS:

Table1. System Parameters

Parameter	Value
IFFT size	512
Number of subchannels N	512
Number of subband	32
Number of subcarriers per subband	16
SNR	0-30dB
Guard interval N/4	128
Pilot interval	8
Modulation scheme	BPSK, QPSK, QAM
Channel length L	16
Number of pilots(P= N/8)	64

OFDM system parameters considered here to analyze the Bit Error Rate (BER),Mean Square Error, Spectral Efficiency, Throughput performance of uncoded & coded adaptive OFDM with BPSK,QPSK & QAM modulation over AWGN channel are mentioned in Table1.

IV. RESULTS & DISCUSSIONS:

Here we analyzed the the Bit Error Rate (BER),Mean Square Error, Spectral Efficiency, Throughput performance of uncoded & coded adaptive OFDM with BPSK,QPSK & QAM modulation over AWGN channel. Here we used Cyclic coding. “Fig.2” & “Fig.3” shows BER performance of uncoded & coded adaptive OFDM respectively. It is observed from “Fig.2” that for SNR is in between 0 dB - 3dB, highest modulation scheme i.e.64QAM is used. For SNR is between 3dB - 6dB, 32QAM is used. When SNR is in between 6dB - 9dB modulation scheme 16 QAM is used. For SNR in between 9dB - 12dB, 8QAM is used. For SNR is between12dB- 15dB lower modulation scheme i.e. QPSK is used & for SNR is from 12dB-18dB lowest modulation scheme i.e. BPSK is used. For value of SNR above 18dB signal is not transmitted. Thus adaptation is achieved on the basis of instantaneous SNR. BER performance of coded AOFDM is similar to uncoded for SNR upto 9dB, for higher SNR value it degrades.

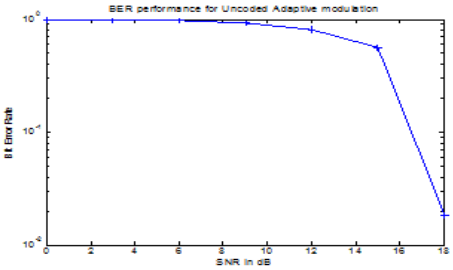

Figure 2. BER Performance of Uncoded AOFDM with BPSK,QPSK,QAM

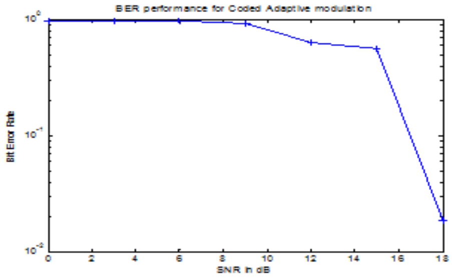

Figure 3. BER Performance of Coded AOFDM with BPSK, QPSK,QAM

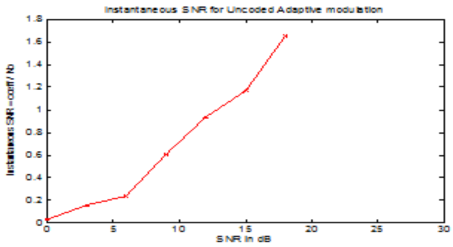

Figure 4. Instantaneous SNR of Uncoded AOFDM with BPSK, QPSK,QAM

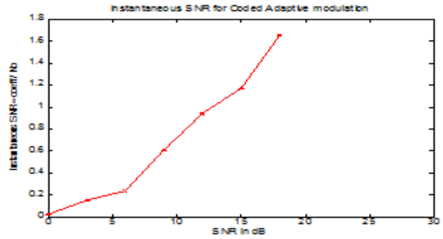

Figure 5. Instantaneous SNR of Coded AOFDM with BPSK, QPSK,QAM

Instantaneous SNR of uncoded & coded adaptive OFDM is shown in “Fig. 4” & “Fig. 5”. It increases with SNR value.

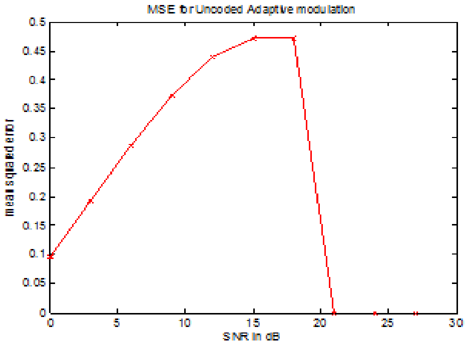

Figure 6. Mean Square Error of Uncoded AOFDM with BPSK, QPSK,QAM

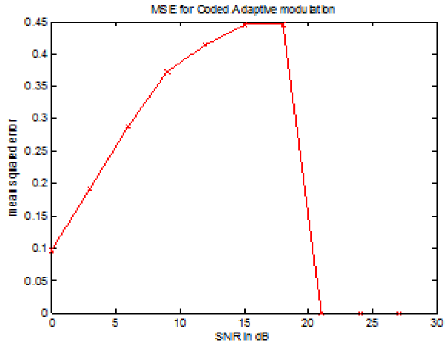

Figure 7. Mean Square Error of Coded AOFDM with BPSK, QPSK,QAM

It is observed from “Fig.6” & “Fig.7” that Mean Square Error (MSE) of uncoded & coded adaptive OFDM with BPSK,QPSK,QAM increases from 0.1 to 0.47& 0.1 to 0.45 respectively for SNR value from 0dB to 18dB. After that it decreases & becomes 0 at & above SNR 21dB due to no transmission.

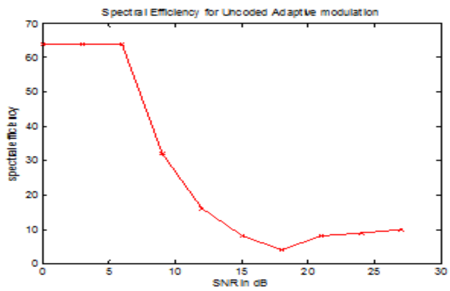

Figure 8. Spectral efficiency of Uncoded AOFDM with BPSK, QPSK,QAM

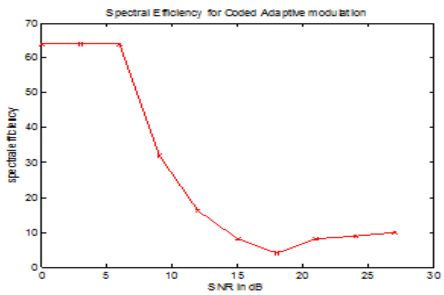

Figure 9. Spectral efficiency of Coded AOFDM with BPSK, QPSK,QAM

Spectral efficiency of uncoded & coded adaptive OFDM with BPSK,QPSK,QAM is shown in “Fig.8” & “Fig.9” respectively .It is same for the both. For SNR 0dB to 6 dB both shows better Spectral efficiency as about 64% .As SNR is still increasing accordingly Spectral efficiency decreases .

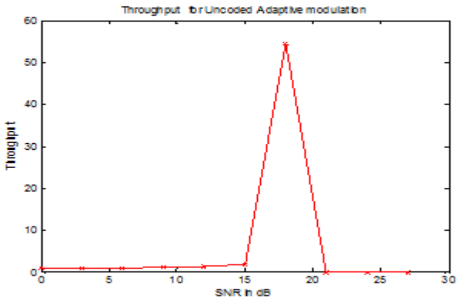

Figure 10. Throughput of Uncoded AOFDM with BPSK,QPSK, QAM

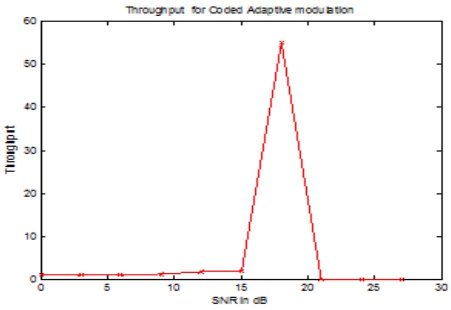

Figure 11. Throughput of Coded AOFDM with BPSK,QPSK, QAM

"Fig.10" & "Fig.11" shows Throughput of uncoded & coded adaptive OFDM with BPSK,QPSK,QAM respectively . Throughput of coded AOFDM is the same as that of uncoded for SNR up to 9dB.Above 9 dB it gradually increases & becomes maximum as 54.97 in comparison with 54.47 at SNR 18 dB. So for SNR up to 12 dB Throughput of both is less due to higher modulation schemes . As SNR increases above 12dB lower level modulation schemes as QPSK & BPSK are employed so Throughput increases. Throughput is maximum for SNR values 18 dB. After SNR above 18 dB it decreases. For SNR values in between 21dB to 27 dB Throughput is minimum i.e. 0 due to no transmission.

V. Conclusion:

In this paper, we have evaluated Bit Error Rate (BER), Mean Square Error (MSE), Spectral Efficiency, Throughput performance of uncoded & coded adaptive OFDM with BPSK,QPSK & QAM modulation over AWGN channel. It is observed that according to instantaneous SNR suitable modulation scheme is employed. If SNR is from 0dB to 3dB & 3dB to 6dB spectrally efficient modulation schemes such as 64 QAM & 32 QAM are used respectively. BER performance of coded AOFDM is similar to uncoded for SNR upto 9dB, for higher SNR value it degrades. MSE of uncoded & coded adaptive OFDM increases from 0.1 to 0.47& 0.1 to 0.45 respectively for SNR value from 0dB to 18dB. After that it decreases & becomes 0 at & above SNR 21dB due to no transmission. Spectral efficiency is same for the both. For SNR 0dB to 6 dB both shows better Spectral efficiency as about 64% .As SNR is still increasing accordingly Spectral efficiency decreases . Throughput of coded AOFDM is the same as that of uncoded for SNR up to 9dB.Above 9 dB it gradually increases & becomes maximum as 54.97 in comparison with 54.47 at SNR 18 dB i.e. for SNR up to 12 dB Throughput of both is less & becomes maximum at 18dB. Thus coded AOFDM gives better Throughput than uncoded one. Also Adaptive modulation achieves a good tradeoff between spectral efficiency and overall BER .

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