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ADAPTIVE MODULATION AND RATE CODING MULTI CARRIER CODE DIVISION MULTIPLE ACCESS TECHNIQUE FOR 4G MOBILE COMMUNICATION SYSTEMS

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ABSTRACT

Future mobile communication requires 100 Mbps data rate, video and audio streaming, asymmetric, multiple access, adaptive modulation and code rate, dynamic packet arrangement, adaptive antenna and IPv6 utilization facility to enhance lossless communication. We propose an Adaptive Modulation and Rate Coding Multi Carrier Code Division Multiple Access (AMRC-MC-CDMA) technique is a promising way to increase the data rate with reliable transmission over wireless channels. In this paper, we present various digital modulation techniques such as BPSK, QPSK and M-ary PSK systems applied to a coded MC-CDMA system in an AWGN channel environment. This method compares the Bit Error Rate Performance of various code rates using MC-CDMA technique and finally choose the best code rate to achieve better BER performance. It is found that the proposed method gives the optimum performance compared to the conventional MC-CDMA system used in fourth generation.

Keywords: adaptive modulation (AM), MC-CDMA, BER, AWGN.

1. INTRODUCTION

The demand of future generation is networked consumer systems with large coverage range. In real life, in a work place or in an entertainment scenario, people want transparent internetworking, which provide information exchange, entertainment and large file transfer. The internetworking should be on-demand with whatever they want regardless of time or location. Due to multipath fading and interference from other users, Signal to Noise Ratio varies with time in wireless communication channel. Adaptation and Diversity techniques are important techniques used to utilize full channel capacity. By adaptation we adjust the modulation technique and coding rates dynamically to maximize the throughput and reduce the Bit Error Rate depending on the channel conditions [1, 2].

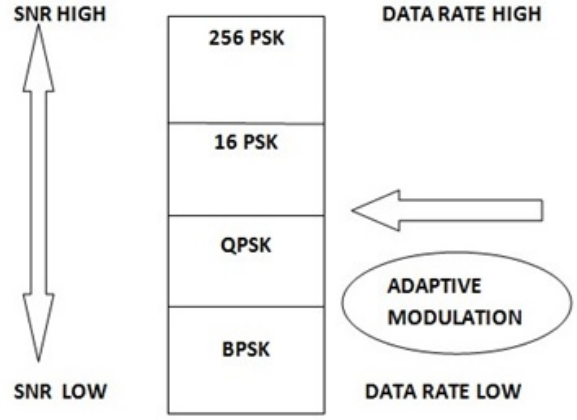

Figure-1. Modulation selection flow diagram.

Figure-1 shows that the estimation of channel is essential for using various digital modulation schemes. The selection of modulation depends on the transmission range. As we increase the transmission range we select the lower rate modulation scheme. However, we use higher rate modulation to increase the throughput when the transmission range is near to the base station

When the channel condition is poor meaning low SNR, we decrease the modulation rate in order to increase the reliability. On the other hand, when the SNR is good, we can increase the modulation rate to improve the data rate. The aim of adaptive method is to increase the operational efficiency and transmission link stability by increasing network capacity over the active communication channel and to reduce the sensitivity to environmental interferences.

Adaptive modulation means dynamically changing the modulation scheme in a lossless manner to maximize the multi path propagation conditions.

The most important an objective of fourth generation systems is to reduce the Inter symbol Interference (ISI) resulting from the high data rates, and to use the accessible restricted bandwidth in a spectrally effective manner. To achieve these objectives there are two important modulation techniques: Orthogonal Frequency Division Multiplexing (OFDM) and Multi Carrier Code Division Multiple Access. The ability of OFDM is to cancel the multipath distortion in a bandwidth efficient manner without using several local oscillators. Future mobile communication systems, based on the hybrid technique uses a combination of multiple carrier OFDM and spread spectrum based technology called Code Division Multiple Access (CDMA) generally known as OFDM-CDMA or MC-CDMA. When such a signal is applied to a wide-range transmission environment it can

reach large average user throughputs. Further to improve the spectral efficiency of the wireless systems, some type of modulations is proposed in paper [1, 3].

The main advantages of MC-CDMA include efficiency and flexibility in spectrum usage. Other users are allowed to use the spectrum or subcarriers in the MC-CDMA design if it is not used by the current user. This technique is robust to frequency selective fading because the symbol period is larger than the delay spread resulting in reduced Inter symbol Interference.

Table-1: Classification of generation

The different parameters used in second generation, third generation and fourth generation are given in the following Table-1.

Table-1. Classification of 2G, 3G and 4G.

PARAMETERS	GSM-2G	3G	4G
ACCESS METHOD	TDMA/FDMA	W-CDMA	OFDM,MC-CDMA
DATA RATE	9.6--19.2kbps	115--384 kbps	100 Mbps
FREQUENCY	1850-1990MHz	1800-2400MHz	2-8GHz
RADIO TRANSMISSION TECHNIQUE	CIRCUIT SWITCHED	PACKET SWITCHED	PACKET SWITCHED

Combination of Walsh coded MC-CDMA with adaptive modulation rate technology for fourth generation mobile communications is analyzed in this paper. Adaptive modulation based BPSK, QPSK, M-ary PSK systems applied to Walsh coded MC-CDMA system in an AWGN channel has been investigated and compared the BER performance of all these modulation schemes. The rest of the paper describes the basics of adaptive modulation technique, channel information and MC- CDMA system. Section 3 describes the model of the MC-CDMA system and the different system parameters adopted for simulation. The results and discussion are given in section 4. Finally section 5 present the conclusion and future scope of work.

2. RELATED WORKS

a) Adaptive modulation scheme

In wireless communication systems, the radio channels vary continuously with time due to high mobility of the users. During transmission, the information signals take multiple paths to reach the receiver and while doing this various speeds of phase rotation caused by the Doppler spread. Thus results in rapid change in the wireless channels [4].

Due to multipath fading these time varying wireless channels show different values of SNR at different instances of time. In fixed modulation scheme, the system is to be designed so as to take care of the poor signal condition of the channel to offer acceptable Bit Error Rate. Moreover the fixed modulation system is spectrally not efficient because it will choose higher order modulation for good channel conditions. Adaptive modulation is used to adapts the transmission technique to the current channel condition to achieve robust and bandwidth efficient communication over multipath fading channels. The adaptive system changes the transmission or any other mixture of these parameters according to the estimation of channel condition [5, 9].

The goal of adaptive modulation is the allocation of more number of bits to carriers with high SNR during transmission, whereas few bits to carriers with low SNR. The most important system requirements of adaptive system are given below.

a) Channel quality assessment

A reliable prediction of channel estimation during the next timeslot is necessary for transmission. The channel estimator estimates the SNR of the channel through mean and variance calculation. The average received power is calculated by taking the square of mean of magnitude of the received signal. The noise power will be calculated by variance calculation on the received signal. The use of channel power prediction will improve the performance of the link adaptation [6, 12].

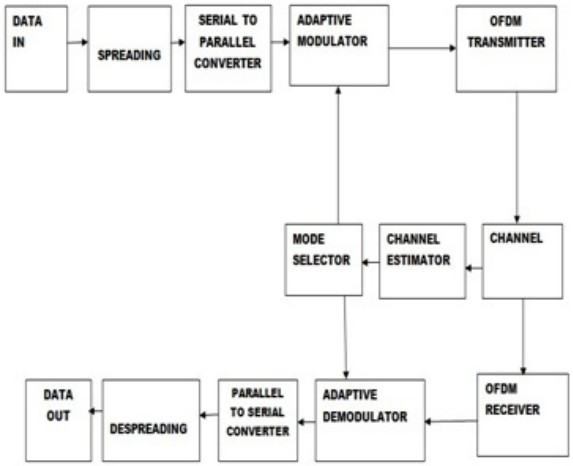

Figure-2. Schematic of adaptive multi carrier CDMA.

The adaptive modulated MC-CDMA system consists of adaptive modulation switch. The input serial binary data stream is formatted into word size depending on the modulation type required for transmission. At the front end of the receiver the SNR is determined and this information is directly fed to the mode selector through channel estimator. Based on these information the mode selector selects the modulation scheme, which satisfies the switching threshold.

3. RESULT AND DISCUSSION

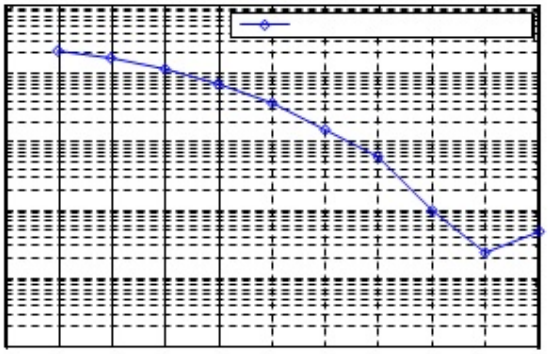

Figure- 3. Adaptive rate of 4 users.

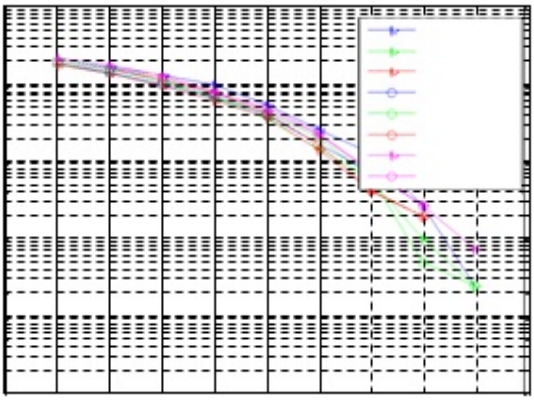

Figure-4. Comparison of code rates for 4 users.

Figure-3 shows the adaptive rate of transmitted signal using MC-CDMA technique which gives 10-3.9 Bit Error Rate for 9 dB SNR, and 10-3 BER for 8 dB SNR. Figure-4 shows BER Vs SNR of all possible code rates from 0.2 to 0.9.From this the proposed technique, we choose the optimum code rate as 0.3.

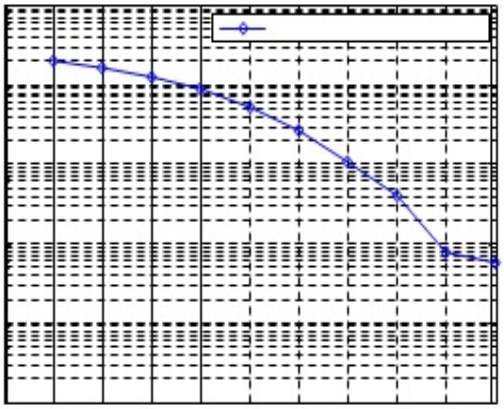

Figure-5. Adaptive rate of 5users.

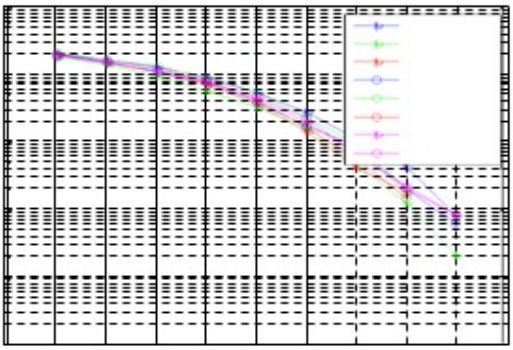

Figure-6. Comparison of code rates for 5 users.

Figure-5 shows the adaptive rate of transmitted signal of MC-CDMA technique which gives 10-3.3 Bit Error Rate for 9 dB SNR and 10-2.7 BER for 8 dB SNR. Figure-6 shows BER Vs SNR of all possible code rates for 5 users from 0.2 to 0.9.From this proposed technique, we choose the optimum code rate as 0.2.

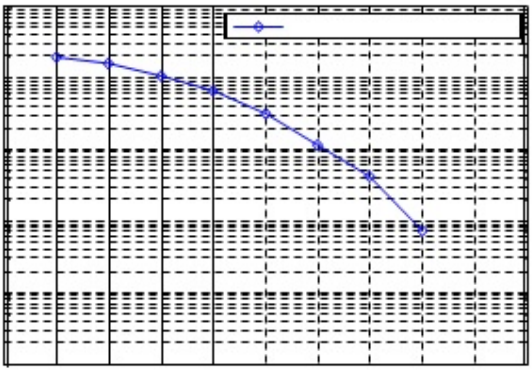

Figure-7. Adaptive rate of 6users.

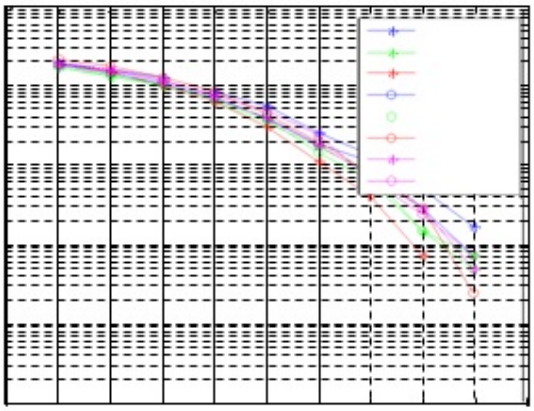

Figure-8. Comparison of code rates for 6 users.

Figure 7 shows the adaptive rate of transmitted signal of MC-CDMA technique which gives 10-3.3 Bit Error Rate for 8 dB SNR. In figure 8 shows BER Vs SNR of all possible code rates from 0.2 to 0.9. From this

the proposed technique we choose the optimum code rate as 0.4.

From the above discussion, we find that the code rate depends on the number of users.

a) Comparison of different code rates for MC-CDMA

Table-2 shows the BER Vs SNR for different number of users. The bit error rate is 10-3.9 for 9dB SNR when the number of user is 4.When we increase the number of users to 5, the bit error rate become 10-3.4.Thus the proposed technique achieves a better BER performance for minimum number of users and also finds the best code rate.

Table-2. Comparison of different PAPR reduction methods.

OPTIMUM CODE RATE	0.3	0.2	0.4
NUMBER OF USERS	4	5	6
SNR (dB)	BER	BER	BER
1	$10^{-0.9}$	$10^{-0.9}$	$10^{-0.9}$
2	$10^{-0.95}$	$10^{-0.95}$	$10^{-0.95}$
3	10^{-1}	10^{-1}	10^{-1}
4	$10^{-1.2}$	$10^{-1.2}$	$10^{-1.3}$
5	$10^{-1.7}$	$10^{-1.6}$	$10^{-1.8}$
6	$10^{-1.9}$	$10^{-1.8}$	10^{-2}
7	$10^{-2.4}$	10^{-2}	$10^{-2.7}$
8	10^{-3}	$10^{-2.7}$	$10^{-3.3}$
9	$10^{-3.9}$	$10^{-3.4}$	-

b) Simulation specifications

Table-3 shows the simulation parameters for Adaptive Multi Carrier CDMA system using MATLAB software.

Table-3. Simulation parameters.

IFFT SIZE	256
TOTAL WORDS	1024
CHANNEL	AWGN
SPREADING CODE	WALSH HADAMARD CODE
MODULATION SCHEMES	BPSK,QPSK,16 PSK,256 PSK

5. CONCLUSIONS

We have proved in this paper that the proposed method of Adaptive Modulation and Rate Coding Multi Carrier CDMA system gives better result by choosing appropriate modulation and optimum code rate as shown in Table-2. In future, the adaptive antenna with this technique can be used to improve the system performance.

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