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STUDY AND ANALYSIS PRECODED ORTHOGONAL FDMA UPLINK SYSTEM

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I. ABSTRACT

This thesis aims to The mobile WiMAX air interface adopts orthogonal frequency division multiple access (OFDMA) as multiple access technique for its uplink (UL) and downlink (DL) to improve the multipath performance. All OFDMA based networks, including mobile WiMAX experiences the problem of high peak-to-average power ratio (PAPR). This thesis presents: Discrete-Cosine transform matrix (DCTM) precoding based random-interleaved OFDMA uplink system, Selecting mapping (SLM) based DCTM precoded random-interleaved OFDMA uplink system and Partial Transmit Sequence (PTS) based DCTM precoded random-interleaved OFDMA uplink system respectively, for PAPR reduction in mobile WiMAX systems. PAPR of the proposed systems is analyzed with the root-raised-cosine (RRC) pulse shaping to keep out of band radiation low and to meet the transmission spectrum mask requirement

I. INTRODUCTION

Since the very genesis of man, communication[1] has been one of the main aspects in human life. Previously various methods like sign languages were implemented for this purpose. As various civilizations started coming into existence, many innovative ideas came to the minds of the people – special birds and human messengers were employed to meet these challenges. As ages rolled by, post system developed and transportation vehicles like trains and ships were used to maintain link between people miles apart. But by the turn of the nineteenth century, a great leap in communication system was observed when wireless communication[1] was introduced

The demand of high data rate services has been increasing very rapidly and there is no slowdown in sight. We know that the data transmission includes both wired and wireless medium. Often, these services require very reliable data transmission over very harsh environment. Most of these transmission systems experience much degradation[2] such as large attenuation, noise, multipath, interference, time variance, nonlinearities and must meet the finite constraints like power limitation and cost factor. One physical layer technique that has gained a lot of popularities due to its robustness in dealing with these impairments is multi-carrier modulation technique. In multi-carrier modulation, the most commonly used techniques Orthogonal Frequency Division Multiplexing (OFDM)[4]; it has recently become very popular in wireless communication

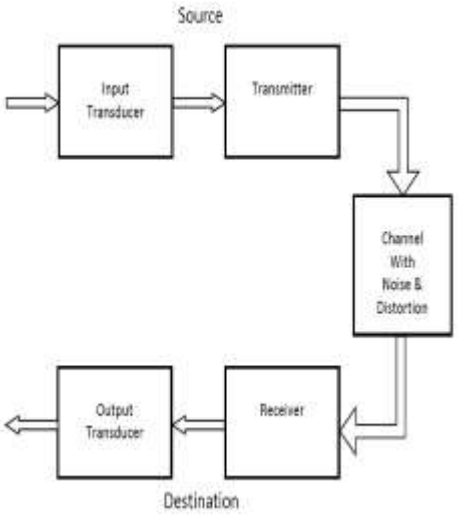


Fig 1 A block diagram representation of electronic communication system

Orthogonal Frequency Division Multiplexing (OFDM) Transmission

Orthogonal frequency division multiplexing (OFDM) transmission scheme is a type of multichannel system which avoids the usages of the oscillators and bandlimited filters for each subchannel. The OFDM technology was first conceptualized with subsequent symbols. This is an unwanted phenomenon as the previous symbols have similar effect as noise, which makes the communication as some sort of unreliable. It is usually caused by multipath propagation or the inherent nonlinear frequency response of a channel causing successive symbols to blur together. The presence of ISI in the system introduces error in the decision device at the receiver output. Therefore, in the design of the transmitting and receiving filters, the objective is to minimize the effects of ISI and thereby deliver the digital data to its destination with the smallest error rate possible.

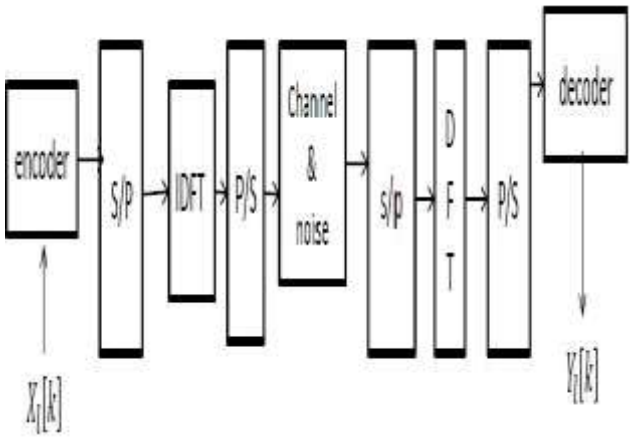


Figure2:OFDM Transmission Scheme

MODULATION & DEMODULATION IN OFDM SYSTEMS

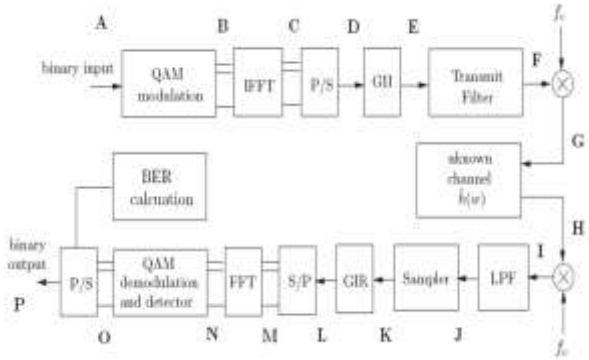


Fig. 3 OFDM Block Diagram

Modulation

Modulation[1] is the technique by which the signal wave is transformed in order to send it over the communication channel in order to minimize the effect of noise. This is done in order to ensure that the received data can be demodulated to give back the original data. In an OFDM system, the high data rate information is divided into small packets of data which are placed orthogonal to each other. This is achieved by modulating the data by a desirable modulation technique (QPSK). After this, IFFT is performed on the modulated signal which is further processed by passing through a parallel – to – serial converter. In order to avoid ISI we provide a cyclic prefix to the signal.

Demodulation

Demodulation is the technique by which the original data (or a part of it) is recovered from the modulated signal which is received at the receiver end. In this case, the received data is first made to

pass through a low pass filter and the cyclic prefix is removed. FFT[2] of the signal is done after it is made to pass through a serial – to – parallel converter. A demodulator is used, to get back the original signal.

DESIGN ANALYSIS

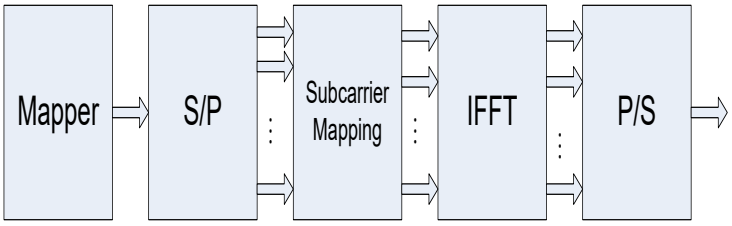


Fig 4 Random-Interleaved OFDMA uplink system

Proposed Models

Discrete cosine transform (DCT) and discrete cosine transform matrix (DCTM)

DCT (Ahmed et al., 1974) can be defined as:

$$X_k = \sum_{n=0}^{N-1} x_n \cos\left[\frac{\pi}{N}(n+\frac{1}{2})k\right]$$

The first requirement ensures that every output symbol has the same amount of information of very input data. The second requirement preserves the power at the precoder output. Finally, the third requirement ensures the recovery of the original data at the receiver. The kernel of the DCTM is defined in the below equation For $N=L\times L$ and $j=\sqrt{-1}$, the DCTM kernel D, of size $N=L\times L=L^2$

DCTM precoding based random interleaved OFDMA system a DCTM precoding based random-interleaved OFDMA uplink system. In this system, a DCT precoding matrix D of dimension $N=L\times L$ is applied to the constellation symbols to lower the autocorrelation of input

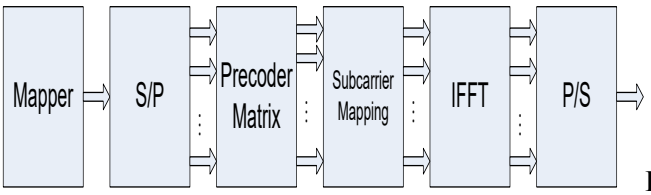
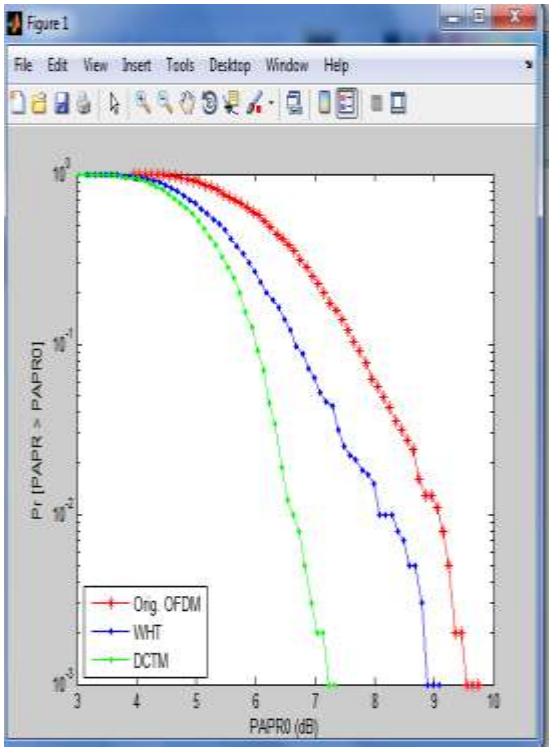


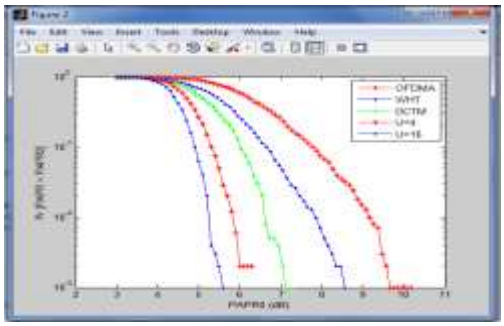
Fig 5 DCTM Precoding based Random Inter In the DCTM precoding based random-interleaved OFDMA systems, baseband modulated data is passed through S/P convertor which generates a complex vector of size M that can be written as follows:

$$X = [X_0, X_1, X_2, \ldots X_{M-1}]^T$$

Simulation Results



CCDF Comparison of PAPR of the DCTM precoded random-interleaved OFDMA



CCDF Comparison of PAPR of the DCTM precoded random-interleaved OFDMA

CONCLUSION

In this paper, the precoding based systems: DCTM precoded random-interleaved OFDMA uplink system, SLM based DCTM precoded random-interleaved OFDMA uplink system and PTS based DCTM precoded random-interleaved OFDMA uplink system[10] have been proposed for PAPR reduction in mobile WiMAX systems. Computer simulation shows that, the PAPR of the both proposed uplink systems have low PAPR than the WHT precoded random-interleaved OFDMA uplink systems and conventional random-interleaved OFDMA uplink systems. Proposed systems are also efficient, signal independent, distortionless and do not require any complex optimizations. Additionally, these uplink systems also take the advantage of the frequency variations of the communication channel and can also offer substantial performance gain in fading multipath channels. Thus, it is concluded that proposed DCTM precoding based uplink systems are more favorable than the WHT precoded random-interleaved OFDMA uplink systems and conventional random-interleaved OFDMA uplink systems for the mobile WiMAX systems.

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