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A Novel Approach Of Performance Analysis Of A Novel ICI Through ICI Self-Cancellation-Scheme In OFDM Systems Using BER

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ABSTRACT
OFDM is a multicarrier modulation technique in which a high rate bit stream is split into N parallel bit-streams of lower rate and each of these are modulated using one of N orthogonal sub-carriers. In a basic communication system, the date is modulated onto a single carrier frequency. The available bandwidth is then totally occupied by each symbol. This kind of system can lead to inter-symbol-interference (ISI) in case of frequency selective channel. The basic idea of OFDM is to divide the available spectrum into several orthogonal sub channels so that each narrowband sub channels experiences almost flat fading. Orthogonal frequency division multiplexing (OFDM) is becoming the chosen modulation technique for wireless communications. A well-known problem of OFDM is its sensitivity to frequency offset between the transmitted and received signals, which may be caused by Doppler shift in the channel, or by the difference between the transmitter and receiver local oscillator frequencies. This carrier frequency offset causes loss of orthogonality between sub-carriers and the signals transmitted on each carrier are not independent of each other. The orthogonality of the carriers is no longer maintained, which results in inter-carrier interference (ICI). The undesired ICI degrades the performance of the system. This paper investigates an efficient ICI cancellation method termed ICI self-cancellation scheme for combating the impact of ICI on OFDM systems.
Keywords - Inter carrier interference, orthogonality, Doppler shift, Self-cancellation, BER etc.., QPSK, QOSTBC (Quasi-Orthogonal Space-Time Block Code)

I. INTRODUCTION

Orthogonal space-time block codes (OSTBC) from orthogonal designs have both advantages of complex symbol-wise maximum-likelihood (ML) decoding and full diversity. However, their symbol rates are upper bounded by 3/4 for more than 2 antennas for complex symbols. To increase the symbol rates, they have been generalized to quasi-orthogonal space-time block codes (QOSTBC) in the literature but the diversity order is reduced by half and the complex symbol-wise ML decoding is significantly increased to complex symbol pair-wise (pair of complex symbols) ML decoding. The QOSTBC has been modified by rotating half of the complex symbols for achieving the full diversity while maintaining the complex symbol pair-wise ML decoding. The optimal rotation angles for any signal constellation of any finite symbols located on both square lattices and QOSTBC has also been modified by Yuen-Guan-Tjhung by rotating information symbols in another way such that it has full diversity and in the meantime it has real symbol pair-wise ML decoding (the same complexity as complex symbol-wise decoding) and the optimal rotation angle for square and rectangular QAM constellations has been found.

In this paper, we systematically study general linear transformations of information symbols for QOSTBC to have both full diversity and real symbol pair-wise ML decoding. We present the optimal transformation matrices (among all possible linear transformations not necessarily symbol rotations) of information symbols for QOSTBC with real symbol pair-wise ML decoding such that the optimal diversity product is achieved for both general square QAM and general rectangular QAM signal constellations. OFDM is emerging as the preferred modulation scheme in modern high data rate wireless communication systems. OFDM has been adopted in the European digital audio and video broadcast radio system and is being investigated for broadband indoor wireless communications.

Orthogonal Frequency Division Multiplexing (OFDM) is a technique in which the total transmission bandwidth is split into a number of orthogonal subcarriers so that a wideband signal is transformed in a parallel arrangement of narrowband ‘orthogonal’ signals. In this way, a high data rate stream that would otherwise require a channel bandwidth far beyond the actual coherence bandwidth can be divided into a number of lower rate streams. Increasing the number of subcarriers increases the symbol period so that, ideally, a frequency selective fading channel is turned into a flat fading one. In other words, OFDM handles frequency selective fading resulting from time dispersion of multipath channels by expanding the symbol duration [1]. Very high data rates are consequently possible and for this reason it has been chosen as the transmission method for many standards from cable-based

Asymmetric Digital Subscriber Line (ADSL), to wireless systems such as the IEEE 802.11a/g local area network, the IEEE 802.16 for broadband metropolitan area network and digital video and audio broadcasting. The fact that the OFDM symbol period is longer than in single carrier modulation, assures a greater robustness against Inter-Symbol Interference (ISI) caused by delay spread. On the other hand, this makes the system more sensitive to time variations that may cause the loss of orthogonality among subcarriers thus introducing cross interference among subcarriers. Other possible causes of this loss may be due to frequency or sampling offsets emerging at the local oscillator, phase noise and synchronization errors the combination of all these factors forms the frequency domain OFDM channel response that can be summarized in an ICI matrix. Estimation of this channel matrix is crucial to maximize performance, but in real world OFDM systems this task can be very tough, since the size of the ICI matrix depends on the number of OFDM subcarriers which can be in the order of hundreds or thousands. Several channel estimation algorithms and methods to obtain ICI cancellation have been reported in the literature in both frequency and time domain: although blind techniques are possible without reduction of Spectrum efficiency, commercial systems include pilot patterns to improve the estimation process. These are exploited for example in where a pilot-symbol-aided estimation in the time domain is proposed

II. SYSTEM MODEL:

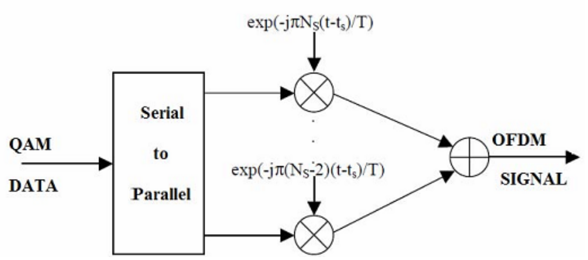


Figure 1: Process of our System Model with QAM/ QPSK

In an OFDM system, the input bit stream is multiplexed into N symbol streams, each with symbol period T, and each symbol stream is used to modulate parallel, synchronous sub-carriers. The sub-carriers are spaced by 1 in frequency, thus they are orthogonal over the interval (0, T).

A typical discrete-time baseband OFDM transceiver system is shown in Figure 1. First, a serial-to-parallel (S/P) converter groups the stream of input bits from the source encoder into groups of log2M bits, where M is the alphabet of size of the digital modulation scheme employed on each sub-carrier. A total of N such symbols, X(m) are created. Then, the N symbols are mapped to bins of an inverse fast Fourier transform (IFFT). These IFFT bins correspond to the orthogonal sub-carriers in the OFDM symbol. Therefore, the OFDM symbol can be expressed as

$$X(n) = \frac{1}{N}\sum_{m=0}^{N-1} X(m)\exp\left(\frac{j2\pi nm}{N}\right)$$

Where the X(m)'s are the baseband symbols on each sub-carrier. The digital-to-analog (D/A) converter then creates an analog time-domain signal which is transmitted through the channel. At the receiver, the signal is converted back to a discrete N point sequence y(n), corresponding to each sub-carrier. This discrete signal is demodulated using an N-point fast Fourier transform (FFT) operation at the receiver. The demodulated symbol stream is given by

$$Y(m) = \sum_{m=0}^{N-1} y(n)\exp\left(\frac{-j2\pi nm}{N}\right) + W(m)$$

where , W(m) corresponds to the FFT of the samples of w(n), The high speed data rates for OFDM are accomplished by the simultaneous transmission of data at a lower rate on each of the orthogonal sub-carriers. Because of the low data rate transmission, distortion in the received signal induced by multi-path delay in the channel is not as significant as compared to single-carrier high-data rate systems. For example, a narrowband signal sent at a high data rate through a multipath channel will experience greater negative effects of the multipath delay spread, because the symbols are much closer together. Multipath distortion can also cause inter-symbol interference (ISI) where adjacent symbols overlap with each other. This is prevented in OFDM by the insertion of a cyclic prefix between successive OFDM symbols

III. ANLYSIS OF INTER CARRIER INTERFE-RENCE

The main disadvantage of OFDM, however, is its susceptibility to small differences in frequency at the transmitter and receiver, normally referred to as frequency offset. This frequency offset can be caused by Doppler shift due to relative motion between the transmitter and receiver, or by differences between the frequencies of the local oscillators at the transmitter and receiver. In this the received signal is given by

$$Y(n) = X(n)\exp\left(\frac{j2\pi n\epsilon}{N}\right) + W(n)$$

IV. ICI SELF-CANCELLATION SCHEME

ICI self-cancellation is a scheme that was introduced by Yuping Zhao and Sven-Gustav Haggman in 2001 to combat and suppress ICI in OFDM. Succinctly, the main idea is to modulate the input data symbol onto a group of subcarriers with predefined coefficients such that the generated ICI signals within that group cancel each other, hence the name self- cancellation.

V. 1. ICI CANCELLING MODULATION

The ICI self-cancellation scheme shown in figure 4.1 requires that the transmitted signals be constrained such that X(1)= -X(0), X(3)= -X(2),---- X(N-1)= -X (N-2), Using (3.3), this assignment of transmitted symbols allows the received signal on subcarriers k and k + 1 to be written as

$$Y'(k) = \sum_{l=0,l=even}^{N-2} x(l)\,[s(1-k) - s(1+1-k)] + n_k$$

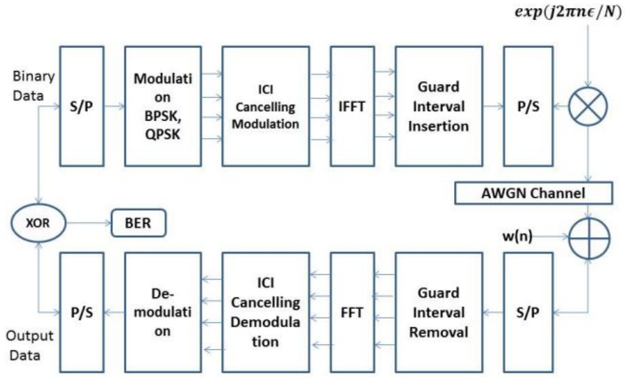
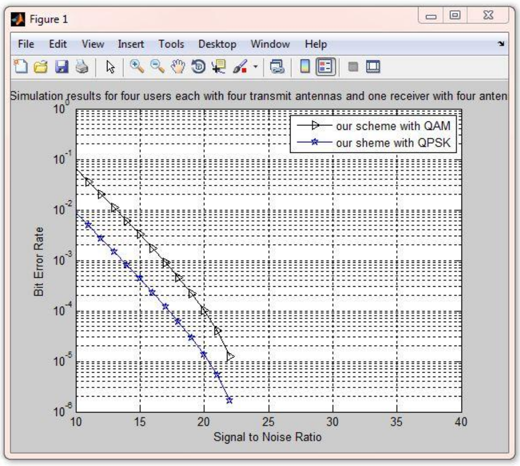


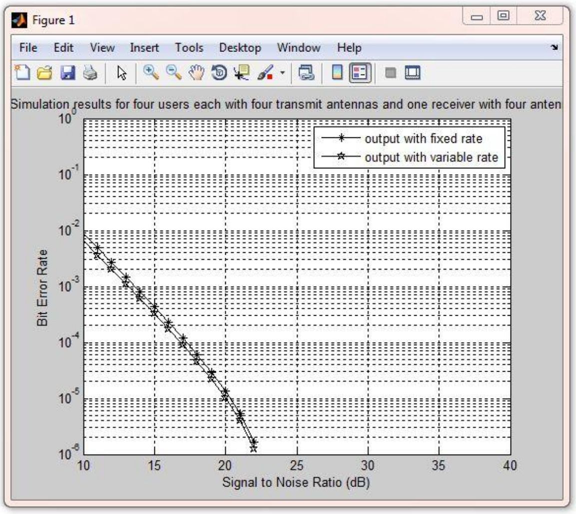
Figure 4.1: Self cancellation with OFDM System.

VI. SIMULATION RESULTS

1. The bellow graph identifies the performance of BER and SNR



2. The bellow graph identifies the difference between variable rate & fixed rate



VII. CONCLUSION

In this paper, the performance of OFDM systems in the presence of frequency offset between the transmitter and the receiver has been studied in terms of the Carrier-to-Interference ratio(CIR).Inter-carrier interference (ICI) which results from the frequency offset degrades the performance of the OFDM system. One of the main disadvantages of OFDM is its sensitivity against carrier frequency offset which causes attenuation and rotation of subcarriers, and inter carrier interference (ICI). Orthogonality of the sub-carriers in OFDM helps to extract the symbols at the receiver without interference with each other. This work investigates an ICI self-cancellation scheme for combating the impact of ICI on OFDM systems for different frequency offset values. Different modulation techniques are considered for ICI reduction and compared with each other for their performances. It is also suitable for multipath fading channels.

REFERENCES

[1] *Z.Yuping and S.-G. Haggman, "Intercarrier interference self-cancellation scheme for OFDM mobile communication systems," IEEE Trans. On Commun ., vol. 49, no. 7, pp. 1185-1191, 2006.*

[2] *J.-D. Kim, Y.-S. Byun, "A New Inter-Carrier Interference Cancellation Using CP-ICA Sc heme in OFDM Systems," IEEE 65th Vehicular Technology Conference, 2007. VTC2007-Spring, Dublin (Ir), 22-25 April 2007, pp. 2369 - 2373..*

[3] *Lorenzo Favalli, Pietro Savazzi, Anna Vizziello "Frequency Domain Estimation and Compensation of Inter carrier Interference in OFDM Systems" 2008 IEEE.*

[4] *Sharifah Kamilah Syed Yusof and Anis Izzati Ahmad Zamani"Intercarrier Interference Self-Cancellation for Space-Time-Frequency*

MIMO OFDM System " 2008 ieee international rf and microwave conference proceedings december 2-4, 2008, kuala lumpur, malaysia .

[5] *5. K. Raghunath and A. Chockalingam, Senior Member, IEEE "SIR Analysis and Interference Cancellation in Uplink OFDMA with Large Carrier Frequency/Timing Offsets " ieee transactions on wireless communications, vol. 8, no. 5, may 2009*