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REDUCTION OF BER IN RECEIVERS FOR WIRELESS COMMUNICATION USING MIMO OFDM

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Abstract - Time varying channels destroy the orthogonality among subcarriers in orthogonal frequency division multiplexing (OFDM) systems, and introduce intercarrier interference (ICI). Lots of efforts have been devoted to mitigate ICI in OFDM systems, with different frame structures and channel models, but the computational complexity of the methods is usually very high. In multiple-input multiple-output (MIMO) systems, the complexity is even higher. In this paper, a low-complexity ICI mitigationmethod is proposed for MIMO-OFDM systems under the assumption of linear time-varying channels.We are proposing a method for decreasing the Bit Error Rate(BER) in order to increase the efficiency of the system.

Keywords - MIMO, OFDM, MCCDMA

I. Introduction

Recently a worldwide convergence has occurred for the use of Orthogonal Division Frequency Multiplexing as an emerging technology for high data rates. In particular, the wirelesslocal network systems such as WiMax, WiBro, WiFi etc., and the emerging fourth-generation mobile systems are all OFDM based systems. OFDM is a digital multi- carrier modulation scheme, which uses a large number of closely-spaced orthogonal sub-carriersthat is particularlysuitable for frequency-selective channels and high data rates. This technique transforms a frequency selective wide-band channel into a group of non-selective narrow-band channels, which makes its robust against large delay spreads by preserving orthogonality in the frequency domain. Moreover, the introduction of a so-called cyclic prefix at the transmitter reduces the complexity at receiver to FFT processing and one tap scalar equalizer at the receiver. The simplified equalization at receiver, however, requires knowledge of the channel over which the signal is transmitted. To facilitate the estimation of the channel in an OFDM system (such as WiMax, WiBro, WiFi, and 3.9/4G), known signals or pilots could be inserted in the transmitted OFDM symbol. Different methods can then be applied to estimate the channel using these known pilots. The focus of this report is to investigate performance of different channel estimators for an OFDM-based 3.9Gsystem.The outcome of the report is to recommend a channel estimation method for implementation and future study. There are several modulation methods which basically related to FDMA concept used in wireless communication.

Working:

In wire-line communication, the data transmission is primarily corrupted by statistically independent Gaussian noise, as known as the classical additive white Gaussian noise (AWGN). In absence of interference, the primary source of performance degradation in such wire-line channels is thermal noise generated at the receiver. Reliable communication in wireless or radio channels, however, becomes a difficult task as the transmitted data is not only corrupted by AWGN, but also suffers from inter-symbol interference (ISI), in addition to (large-scale and small-scale) fading as well as interference from other users. To master the art of wireless communications, one must understand the propagation characteristics of a radio channel. The fading in radio propagation can be classified into two groups; large-scale fading and small-scale fading. Large-scale fading manifests itself as the average signal power attenuation or path loss due to motion over large areas.Small-scale fading refers to the dramatic changes in the signal amplitude and phase that occur due to small changes in the spatial separation between the transmitter and the receiver.

Proposed Method:

In this Paper, we investigate pilot-based non-adaptive channel estimation methods.

Different possibilities exist for allocating pilots in the time-frequency domain of an OFDM system. We discuss three such possibilities.

1. An entire OFDM symbol may be allocated as pilot. Such an allocation will be highly beneficial for channel estimation in highly frequency-dispersive and low Doppler channels at the expense of sacrificing data rate. It will show that the raw channel estimate in an all frequency pilot is indeed the least-squares solution to channel in frequency domain.

2. Pilots may be transmitted on individual sub-carriers during the entire transmission period. Such a strategy will be advantageous in moderately frequency-selective and

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high Doppler channels.

3. Pilots may be allocated in spaced intervals in time and frequency. Depending upon the time- frequency pilot spacing and channelproperties, such an allocation strategy will work well in both high frequency-selective and high Dopplerchannels.

Channel EstimationMethods:

Channel estimation methods, 2-D or 1-D dimensional, can be characterized into three types

1. Simple linearinterpolation

2. Generalized linear network models based on orthogonal polynomials (least-squares method)

3. Wiener filtering using second-order statistics of the channel (LMMSEmethod)

The focus of this report has been on 1-D methods, where we apply channel estimation in frequency domain first, and later use temporal interpolation by either linear interpolation or simple averaging between two pilot positions. We note that channel estimate could also be done in reverse order i.e., time-domain estimation followed by frequency-domain estimation. This method was not investigated since it causes delay in the decoding of an OFDM symbol.

II. Transmitter Section Block diagram

MIMO-OFDM is a key technology for next-generation cellular communications, as well as wireless LAN, wireless PAN and broadcasting. In MIMO-OFDM Wireless Communications with MATLAB, the authors provide a comprehensive introduction to the theory and practice of wireless channel modeling, OFDM, and MIMO, We consider channel-coded multi-input multi-output (MIMO) orthogonal frequency-division multiplexing (OFDM) transmission and obtain a condition on its signal for it to attain the maximum diversity and coding gain. As this condition may not be realizable, we propose a suboptimal design that employs an orthogonal transform and a space-frequency inter leaver between the channel coder and the multi-antenna OFDM transmitter

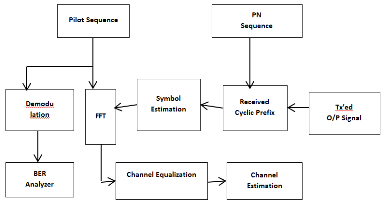


Fig 1:Transmitter section block diagram

We propose a corresponding receiving method based on block turbo equalization. Attention is paid to some detailed design of the transmitter and the receiver to curtail the computational complexity and yet deliver good performance. Simulation results demonstrate thatthe proposed transmission technique can outperform the conventional coded MIMO OFDM and the MIMO block single-carrier trans- mission with cyclicprefixing.

Orthogonal frequency-division multiplexing (OFDM) with multiple transmit and receive antennas has drawn much recent attention inresearch on high-speed transmission over multi- path fading channels. To exploit more fully the inherent diversity under multi-input multi-output (MIMO) OFDM in fading channels, one usually needs to employ space-time and/or space- frequency coding. There is now abundant literature on space-time/frequency coding. Taking space-time coding as an example, the approaches can be divided into two broad categories: The coding approach (as represented by space-time trellis coding and space-time block coding) and the linear preprocessing approach (as represented by linear constellation precoding for signal space diversity.The input data stream is split into N parallel low bandwidth modulated data streams. Due to orthogonality of subcarriers they do not interfere with one another. Each subcarrier has a low symbol rate. But the combination of subcarriers carrying the information in parallel allows for high data rates. Low symbol rate is used to reduce the problem of intersymbol interference (ISI).

III. Reciever Section Block diagram

To improve efficiency of the spectrum we uses MIMO. Multiple antennas at the transmitter side and multiple antennas at the receiver side are being used in this technique. By using spatial multiplexing and space time block code we can implement MIMO. International Journal of Emerging Technology and Advanced Engineering

A.**Space Time Block Code**: For transmission with two antennas Alamouti has discovered space time block coding scheme. STBC scheme supports maximum likelihood (ML) detection based only on a linear processing at the receiver. The linear processing and the simple structure of the Alamouti construction makes it attractive scheme. It is used in the application where higher order diversity is needed.

B. Spatial Multiplexing: A high rate bit stream is decomposed into three independent 1/3 rates bit sequences which are then transmitted simultaneously, using multiple antennas,thus consuming one third of the nominal spectrum. It is similar as a three unknowns resolved from a linear system of three equations. Separation of bit stream is possible only ifequations are independent which can be interpreted by each antenna "seeing" a sufficiently different channel in which case the bit streams can be detected and merged together to yield the original high rate signal. In receiver stage generation of OFDM signal takes place by using fast Fourier transform (FFT). C. OFDM

Specification: Parameters of Specification Description N=64 FFT size or total number of subcarriers(used+unused) Nsp=4 Number of pilot subcarriers are 4 Nsd=48 Number of data subcarriers are 48 Derived Parameters OFDM Bandwidth=20*10^6 Bandwidth of OFDM ΔF=OFDM BW/N Bandwidth for each subcarrier include all used and unused subcarriers. Tfft=1/ ΔF IFFT or FFT period=3.2µsTgi=Tfft/4Guard interval duration – duration of cyclic prefix-1/4th portion of OFDM symbols Tsignal=Tgi+Tfft Total duration of OFDM symbol=Guard time+FFT period Ncp=N*Tgi/Tfft Number of symbols allocated to cyclic prefix Nst=Nsd+Nsp Number of total used subcarriers nBitsPerSym=Nst For QPSK number of bits per symbol D. Multiple Input Multiple Output: Frequency reuse is the main function of the MIMO.

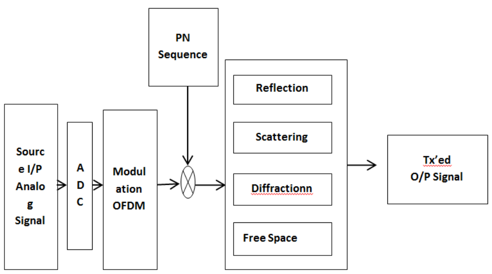
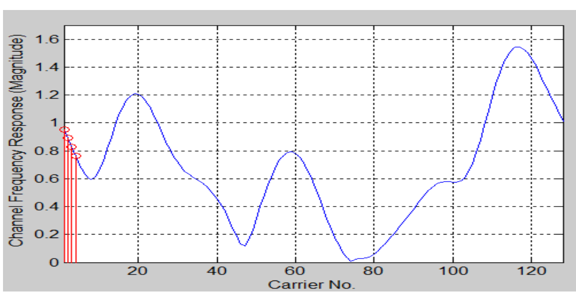


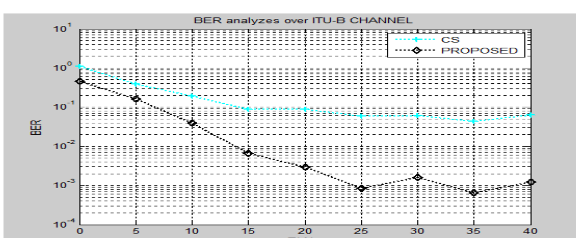
Fig 2: Receiver section block diagram

IV. Results

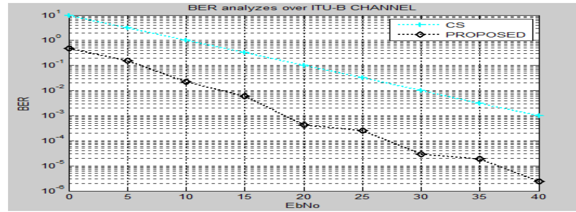
Channel Response



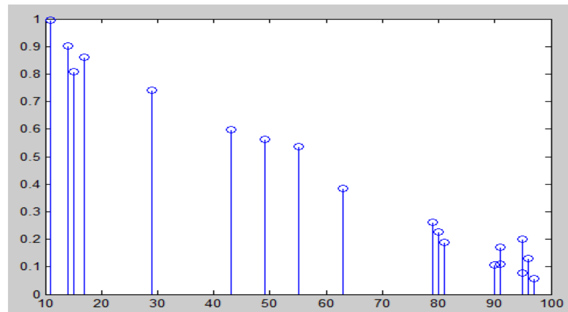
BERAnalyzer (GI=2)



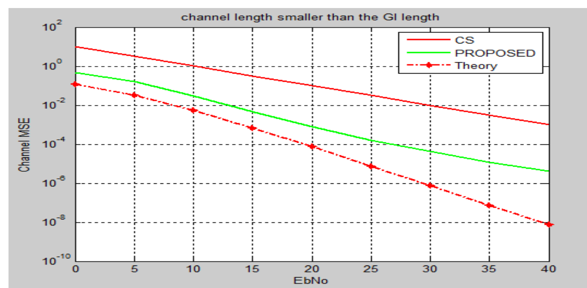
BERAnalyzer (GI=20)



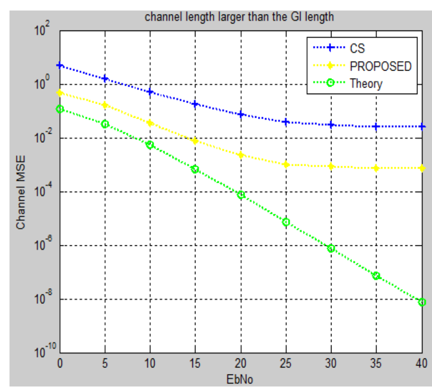
Delay output



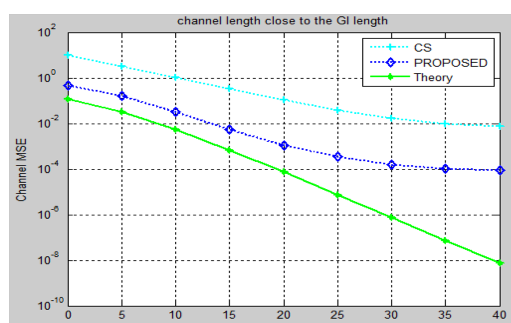
Channel length smaller than the GI length



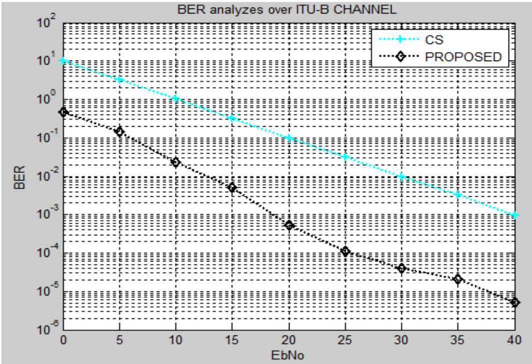
Channel length close to the GI length



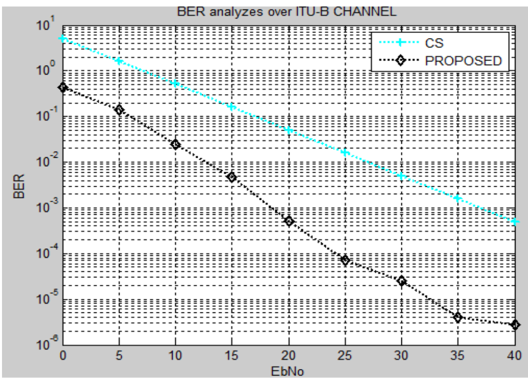
Channel length larger than the GI length



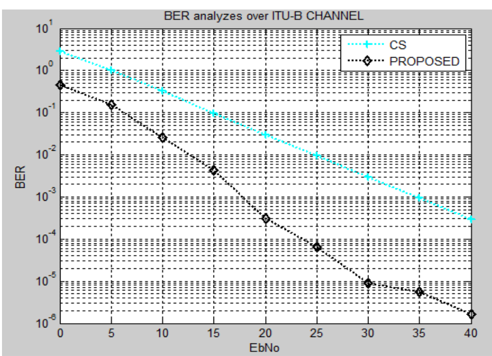
Proposed method output



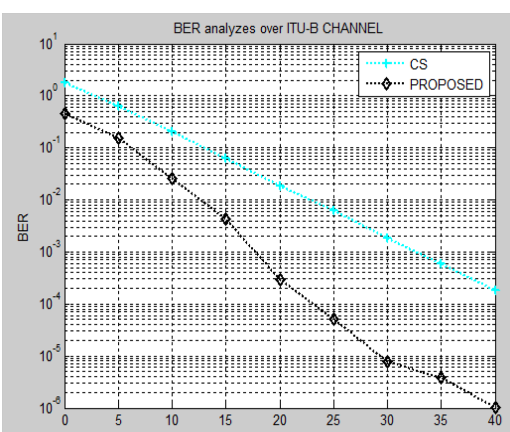
Modulation index m =4



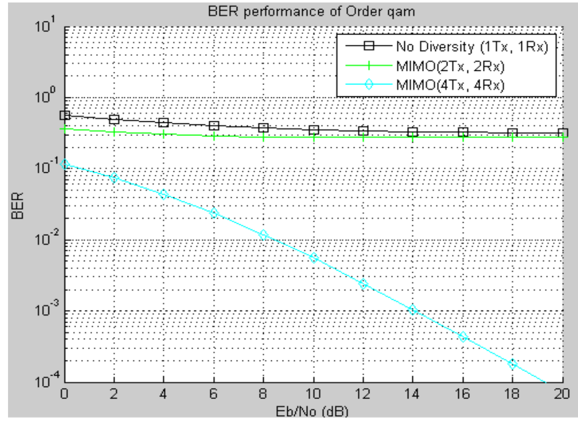
Modulation index m=8



Modulation index m=16



MIMO Output



Comparisions:

S. No.	Channel and GI Lengths	BER
1	Channel Length is < GI	High
2	Channel Length is > GI	Low

Table 1 : Comparison for different channel &GI length.

s no	gi	ber at ebno at 0		ber at ebno at 20		ber at ebno at 40	
		Cs	Proposed	cs	Proposed	cs	Proposed
1	2	1	<1	0.1	$<10^{-2}$	<0.1	10^{-5}
2	20	10	<1	<0.1	$<10^{-3}$	10^{-3}	<10-5
3	25	10	<1	0.1	$<10^{-3}$	10^{-3}	<10-5

Table 2 : Comparison of BER for Different GI

IV. Conclusion:

In this we presented an introduction of OFDM systems in high mobility channels, specifically, the topics of the channel, OFDM, ISI, and ICI over cyclic prefix. Mathematical descriptions of the channel, OFDM, and cyclic prefix and auxiliary information retrieval for estimations were given as well as MATLAB simulations to verify, illustrate concepts, or present a practical implementation. The MSE performance of this method out performs the conventional schemes and is close to the theoretical simulations by simultaneously exploiting the time-domain PN sequence and frequency-domain pilots. Simulation results show that the proposed scheme has a good MSE performance in both static and mobile scenarios and can well support the 64 QAM, especially when the maximum channel delay spread is fairly close to or even larger than the GIlength.

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