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BER Performance in MIMO OFDM System for Rayleigh Fading Channel

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ABSTRACT: In this paper we show the Channel coding plays a very important role in OFDM systems performance. The structure of OFDM systems makes channel coding more effective in confronting fading channels. Sometimes Coded OFDM is known as COFDM. The role of channel coding in conjunction with frequency and time interleaving is to provide a link between bits transmitted on separated carriers of the signal spectrum, in such a way that the information conveyed by faded carriers can be reconstructed in the receiver. Frequency selectivity, currently known to be a disadvantage, is then turned into an advantage that can be called frequency diversity. Using Channel State Information (CSI), channel coding can yield some additional gain. Channel state information is frequency response of the channel or signal to noise ratio in each carrier.

This paper presents Space-Time Coded OFDM system consisting of two transmitters and a single receiver. Simple space time code is used. 4- PSK modulation is used to modulate the symbols across an OFDM channel. We also proposed a variation of the scheme which tries to spread additional symbols across time frequency attempting to increase the rate of transmission without changing the type of modulation employed or increasing the bandwidth. A Rayleigh frequency selective slow fading channel is assumed throughout the analysis. SER performance of the above systems is carried out with emphasis on the modulation scheme and number of carriers.

Index Terms: MIMO-OFDM, BER, SNR Outage Capacity

I. INTRODUCTION

Now a day's integration of Orthogonal Frequency Division Multiplexing (OFDM) technique with Multiple Input Multiple Output (MIMO) systems has been an area of interesting and challenging research in the field of broadband wireless communication. Multiple input multiple output (MIMO) systems using multiple transmit and receive antennas are widely recognized as the vital breakthrough that will allow future wireless systems to achieve higher data rates with limited bandwidth and power resources, provided the propagation medium is rich scattering or Rayleigh fading. wireless link layer as some of the applications e.g., video conferencing, and home audio/visual networks require data rates nearing 1 Gb/s. Moreover WLANs are faced with demands of providing higher data rates due to the increase in rich media content and competition from 10 Gb/s wired LANs. Designing very high speed links that offer good range capability on the wireless channel is a hard problem for several reasons. The wireless channel is a harsh time-varying propagation environment. A signal transmitted on a wireless channel is subject to interference, propagation path loss, and delay spread, Doppler spread, shadowing and fading. While it is possible to increase data rates by increasing the transmission bandwidth or using higher transmit power, both spectrum and transmit power are very constrained in a wireless system. The bandwidth, or spectrum, is prohibitively expensive. Increasing transmit power adds interference to other systems and also reduces the battery life-time of mobile transmitters. Multiple antennas have been used to increase diversity to combat channel fading. Hence, a MIMO system can provide two types of gains: spatial multiplexing or capacity gain and diversity gain. However, the capacity and diversity benefits of MIMO systems depend strongly on what kind of fading the channels undergo; whether the fades associated with different transmit and receive antennas are correlated; and whether the channel state information (CSI) is available at the transmitter. This paper presents the progress we have made towards determining the capacity and benefits of multiple antennas under different assumptions about the underlying channel. Wireless technology is the foundation for the much anticipated ubiquitous communication networks that will allow people and machines to transfer and receive information on the move, anytime and anywhere. This technology will enable an endless array of applications such as wireless phones, wireless Internet access, wireless local area networks (WLAN), automated highways, distance learning, video conferencing, and home audio/visual networks. There are many technical challenges that must be overcome in order to make this vision a reality. One of the toughest challenges faced by wireless engineers and system designers is the bottleneck presented.

II. SYSTEM MODEL

A model of MIMO-OFDM system with NTx transmit antennas and N Rx receive antennas is depicted in the Figure 1. Let, xi , yi and ri be the transmitted signal, received signal and the Additive White Gaussian Noise for sub-carrier respectively and the system uses frequency selective channel. Then the received signal can be given as

yi = Hi si + ri ; 0 ≤ i ≤ N S ..(1)

In Eq. (1), Ns represent the number of sub-carriers Hi is the channel response matrix of ith sub-carrier that is of size NTx *N Rx

The Hi is a Gaussian random matrix whose realization is known at the receiver and it is given as

$$Hi = \sum_{l=0}^{L-1} hl \exp(-j*2\pi*i*l/Ns) \quad \ldots(2)$$

In Eq. (2) hl is assumed to be an uncorrelated channel matrix where each element of the matrix follows the independently and identically distributed (IID) complex Gaussian distribution and L represents the tap of the chosen channel (i.e. L-tap frequency selective channel) .It is assumed that a perfect channel state information (CSI) is available at the receiver but not at the transmitter. The total available power is also assumed to be allocated uniformly across all space-frequency sub-channels. In MIMO-OFDM system Ergodic Capacity is define as this is the time-averaged capacity of a stochastic channel.

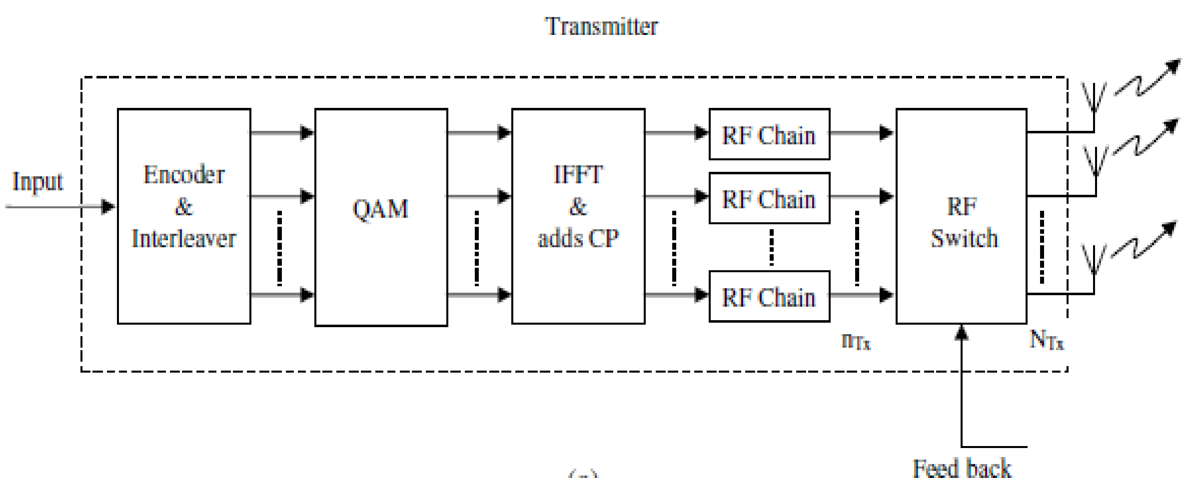
It is found by taking the mean of the capacity values obtained from a number of independent channel realizations. And Outage Capacity is define as the q% outage capacity Cout,q is defined as the capacity that is guaranteed for (100 – q) % of the channel realizations. Ergodic Capacity is define by equation

$$C = E\left(\frac{1}{N_S}\sum_{i=0}^{N_S-1}\log\left(\left|I_{N_{Rx}} + \gamma.Q\right|\right)\right) \quad \ldots(3)$$

$$\gamma = \rho / nTx \quad \ldots(4)$$

$$Q = H_i H_i^H \quad \ldots(5)$$

In above equation E(.) denotes Ergodic Capacity NRx is identity matrix of NRx* NRx..ρ is SNR per sub carrier,nTx no of transmit antenna.fig no 1 shows the block diagram of mimo ofdm system. We use QAM (Quaderature Amplitude Modulation) for transmission. CP (Control Programming) is an operating system originally created for 8 bit processor. FFT is an efficient algorithm to compute the discrete Forier transform and its inverse.RF switch generally called Radio Frequency switch. PIN Diode is generally used to make it operate at very high frequency. In this switch input signal is fed at one end then this signal is split in no of output signal by demux.



(a)

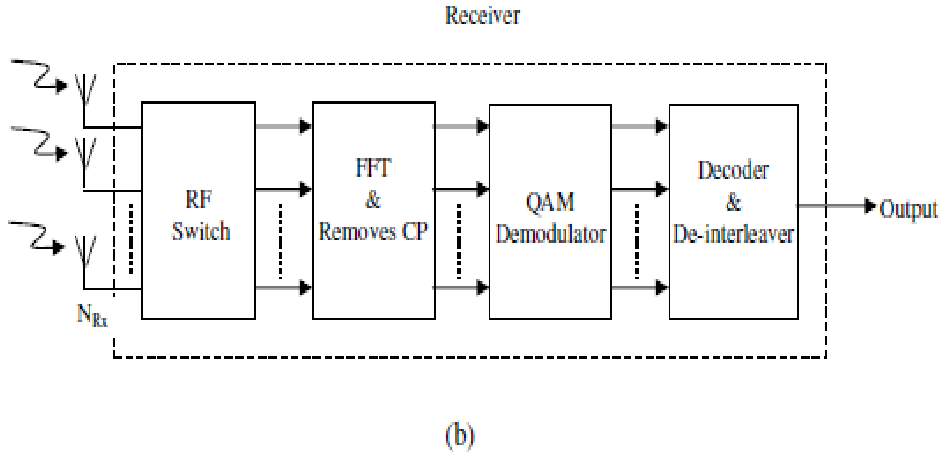


Fig. 1. Block Diagram of MIMO-OFDM system, (a) Transmitter and (b) Receiver.

Here in the COFDM simulation model first random data is generated and is passed through a channel coder. From there it is passed to a OFDM modulator and then passed to a channel. Next the reverse process is performed at the receiver side. After channel coding is undone BER is calculated to estimate the performance of COFDM system. Here, in channel coder Space Time Trellis Code(STTC) coding techniques are used to estimate the performanceof COFDM system. The simulation environment is shown in the following table OFDM simulation parameters used At the beginning and end of each frame, the encoder is required to be in state 0. The encoding algorithm then loops through each pair of input symbols and determines the output for each antenna based on those current inputs and the current state. We use 32 QAM, 4PSK along with 128 point FFT, which result in the reduction of BER and improvement in SNR.

The basic aim of our work is to reduce the Bit error Rate(BER) approx. to 'Zero'.

- We are trying to improve the signal-to-noise ratio in the proposed algorithm.
- The OFDM technology we changed was designed by 32-QAM mapping for BER
- reduction and 128-points FFT/IFFT blocks.
- Implementation of the above OFDM transceiver designed for BER reduction carried out over MATLAB 7.8.0.
- Implementation details are as follows:
- We randomly generate the data using "randint" function provided in MATLAB
- for the random generation of data.
- Encoding of data is carried out by "Trellis Encoding"
- Insert the Interleaving Bits by using "matintrlv" function.
- QAM modulation/4PSK is done of 32 QAM.
- After the cyclic prefix inserted data, we designed a channel for transmission;
- channel is prepared using "AWGN" function.
- At the receiver side for the decoding purpose "Viterbi Detector "is used.
- Bit Error Rate is calculated using the formula:
- BER = Error Bits / Length of Data.

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Table 1 : OFDM simulation parameters used.

No. of transmitter antenna	2
No. of receiver antenna	2
Modulation Type	32 QAM,4PSK
Channel type	AWGN
Decoder type	Viterbi Decoder
No. of iteration	1000

Table 2 : BER, SER result for various iteration.

BER	SER	PEP	FER
0.2506	0.3421	0.5435	0.9980
0.1845	0.2503	0.4101	0.9790
0.1213	0.1636	0.2783	0.8890
0.0692	0.0913	0.1610	0.6730
0.0321	0.0421	0.0767	0.3920
0.0152	0.0200	0.0364	0.1980
0.0071	0.0092	0.0172	0.0990
0.0029	0.0039	0.0070	0.0380
0.0011	0.0014	0.0027	0.0170
0.0004	0.0004	0.0008	0.0060
0.0002	0.0003	0.0005	0.0030
0.0000	0.0001	0.0002	0.0020

III. STTC ENCODER

The space-time encoder maps the raw information bits into space-time symbols based on the trellis diagram, as described below. The encoder takes L = 130 symbols (one frame) from the MPSK signal constellation and encodes them into an (L x n) matrix of complex symbols where n is the number of transmit antennas. This mapping procedure is accomplished through the encoder structure.

At the beginning and end of each frame, the encoder is required to be in state 0. The encoding algorithm then loops through each pair of input symbols and determines the output for each antenna based on those current inputs and the current state. Then the next state is determined based on the current input.

IV. SIMULATION ANALYSIS

For the simplification of performing simulation analysis, we consider a system which consists of two transmitting antennas and one receiving antennas. Simulation parameters: the number of transmitting antenna and receiving antenna are 2 and 1 respectively. Modulation type is QPSK. The number of states and simulation symbols are four and four hundred, figure are Bit Error Rate-Signal

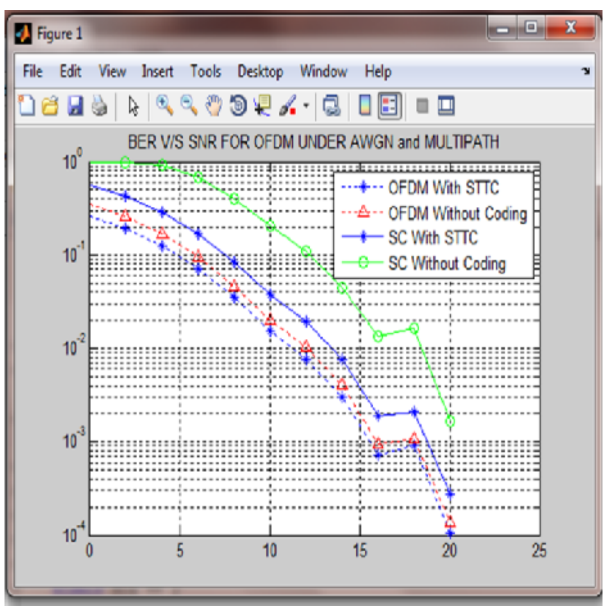

Fig. 2. BER vs SNR for various coding schemes.

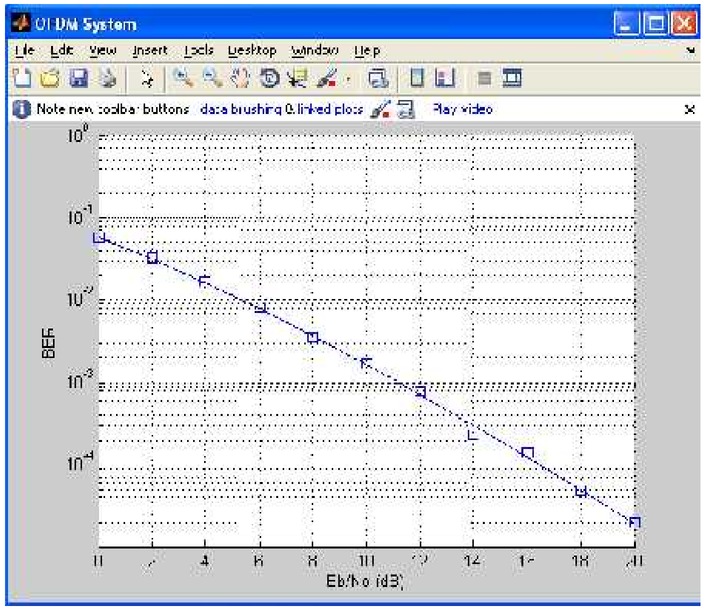

Fig. 3. BER vs SNR performance of proposed scheme with 32QAM.

V. CONCLUSION

The work undertaken in this thesis primarily discusses coded OFDM systems and SFC OFDM system. The implementation of OFDM model is presented. The capability of OFDM in Rayleigh faded channels have been analyzed. This thesis analyzes OFDM system and the effect of channel coding in reducing BER. Along with this soft decoding and decoding with CSI is also studied. Here OFDM and SC are compared and analyzed in Multipath and AWGN environments. We found that without coding both OFDM and SC performs average but as the coding is applied with OFDM technique it shows the reduction in Bit Error Rate We presented architecture of Coded OFDM with the help of 32-QAM and 128-IFFT/FFT which can easily reduce the Bit Error Rate (BER) and improves the performance of Signal-to-Noise Ratio. Reduction in BER found to be satisfactory when compared with previous work In our results it can be seen that as Signal-to- Noise Ratio increases the Bit Error Rate (BER) decreases.

REFERENCES

[1]. Khalida Noori and Ahmed Haider 2007,"A Layered MIMO-OFDM System With Channel Equalization,"*Journal Of Digital Information Management*, Vol. **5** No.6,pp.361-363.

[2] Mohamed Salim Alouini and Andrea J Goldsmith Member IEEE,"Capacity Of Rayleigh Fading Channel Under Different Adaptive Transmission And Diversity-Combining Techniques".

[3] Ergodic Capacity, Capacity Distribution and Outage Capacity of MIMO Time-Varying and Frequency-Selective Rayleigh Fading Channels Chengshan Xiao and Yahong R. Zheng Department of Electrical & Computer Engineering University of Missouri, Columbia, MO 65211, USA.

[4] M. Habib Ullah and A. Unggul Priantoro, 2009. "A Review on Multiplexing Schemes for MIMO Channel Sounding," *International Journal of Computer Science and Network Security*,Vol.9, No.6, pp. 294-300.

[5] Y. Wang, G. S. Liao, Z. Ye and X. Y. Wang, 2008. "Combined Beam forming With AlamoutiCoding Using Double Antenna Array Groups For Multiuser Interference Cancellation," In proceedings of *Progress in Electromagnetics Research Symposium*, pp. 213–226.

[6] Fang Shu, Li Lihua, and Zhang Ping, 2007. "A General Stochastic Spatial MIMO Channel Model for Evaluating Various MIMO Techniques," *International Journal of Applied Science, Engineering and Technology*, Vol. **3**, No. 3, pp. 152-156.

[7] Jishu DasGupta, Karla Ziri-Castro and Hajime Suzuki, 2007. "Capacity Analysis of MIMO OFDM Broadband Channels In Populated Indoor Environments," in proceedings of *IEEE International Symposium on Communications and Information Technologies*, Oct. 17-19, Sydney, pp.273-278.

[8] On the Capacity of OFDM-Based Spatial Multiplexing Systems Helmut Bölcskei, *Member, IEEE*, David Gesbert, *Member, IEEE*, and Arogyaswami J. Paulraj, *Fellow, IEEE*.