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Performance optimized of MIMO transmission link

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Abstract: Wireless communication using Multiple-Input Multiple-Output (MIMO) links has emerged as one of the most significant breakthroughs in modern communications because of the huge capacity and reliability gains promised even in worst fading environment. In this paper, the performances of MIMO physical layer multipath rayleigh channel has been optimized using different equalization techniques considering 2 transmit 2 receive antenna case and the modulation technique is BPSK.

Key Words: MIMO, Fading Channel, equalizer

1. INTRODUCTION

Modern radio communication systems have to provide higher and higher data rates. As conventional methods like using more bandwidth or higher order modulation types are limited, new methods of using the transmission channel have to be used. Multiple antenna systems (Multiple Input, Multiple Output – MIMO) give a significant enhancement to data rate and channel capacity. Introduction to basic MIMO concepts and terminology and explains how MIMO is implemented in different radio communications standards. In this thesis work, different equalization approach called Minimum Mean Square Error (MMSE) equalization will be discussed. The channel as a flat fading Rayleigh multipath channel and the modulation as BPSK will be taken. Taking about today's engineering world spatial multiplexing techniques makes the receivers very complex, and therefore it is typically combined with Orthogonal frequency-division multiplexing (OFDM) or with Orthogonal Frequency Division Multiple Access (OFDMA) modulation, where the problems created by multi-path channel are handled efficiently. MIMO technology can be used in non-wireless communications systems. One example is the home networking standard ITU-T, which defines a power line communications system that uses MIMO techniques to transmit multiple signals over multiple AC wires (phase, neutral and ground). The key advantage of employing multiple antennas is to get reliable performance through diversity and achievable higher data rates through multiplexing. In MIMO system same information can be transmitted and receive through multiple antennas simultaneously. A Minimum Mean Square Error (MMSE) estimator is a method in which it minimizes the mean square error (MSE), which is a common measure of estimator quality. Minimum mean-square error equalizer, which does not usually eliminate ISI completely but instead, minimizes the total power of the noise and ISI components in the output. For which equalizers are used. Equalizers are the essential building blocks of a communication system in broadband applications where ISI is a critical factor. In many such systems data transmitted in packets. Where each packet consists of a known training sequence followed by unknown data. There are different equalization techniques used for MIMO systems like Zero forcing, maximum ratio combining and Minimum mean square error (MMSE) techniques are used.

2. OVERVIEW Equalizer

An equalizer is usually implemented at the baseband or at IF in a receiver. Since the baseband complex envelope expression can be used to represent band pass waveforms, the channel response, demodulated signal and adaptive equalizer algorithms are usually simulated and implemented at the baseband.

Equalizers can be classified as either linear or non-linear. For each type of equalizer, there can be a structure, and corresponding to the structure there are algorithms. The main

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structures and the fundamental algorithms are illustrated in Figure 1. The review material presented in this chapter is taken principally from the Proakis textbook.

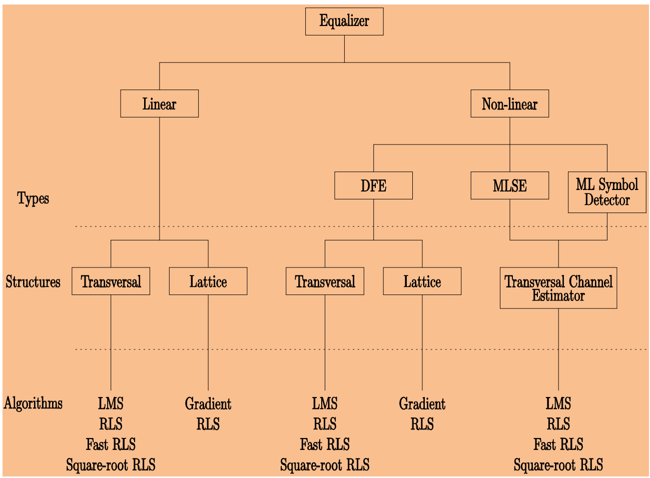

Figure 1: Equalizer types, structure and algorithms.

The general modes of operation of an equalizer involve training and tracking. In the training mode, a fixed length, pre-determined sequence is sent from the transmitter to the receiver to enable the equalizer to minimize a cost function. When an equalizer is properly trained, it is said to have converged. Once the equalizer is trained, the user data is transmitted and the equalizer employs an algorithm to track the changing channel and update the equalizer coefficients.

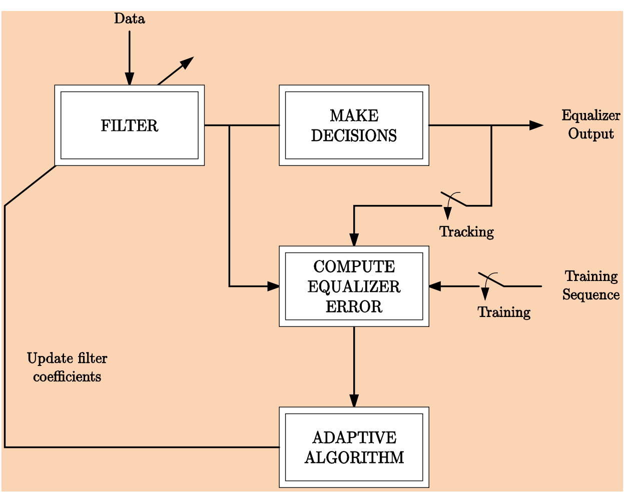

Figure 2: The equalization process- filtering and updating equalizer coefficients.

Furthermore, either of the operating modes can be divided into two stage processes. The first stage is filtering while the second is updating the filter coefficients as shown in Figure 2. The choice of adaptive algorithm, therefore, governs the performance of an equalizer and its ability to track channels. Other factors that should be considered when choosing an algorithm include numerical stability, implementation complexity and robustness [17].

3. MULTIPLE ANTENNA SYSTEM

Several different diversity modes are used to make radio communications more robust, even with varying channels. These include time diversity (different timeslots and channel coding), frequency diversity (different channels, spread spectrum), and also spatial diversity. Spatial diversity requires the use of multiple antennas at the transmitter or the receiver end. Multiple antenna systems are typically known as Multiple Input, Multiple Output systems (MIMO). Multiple antenna technology can also be used to increase the data rate (spatial multiplexing) instead of improving robustness. In practice, both methods are used separately or in combination, depending on the channel condition.

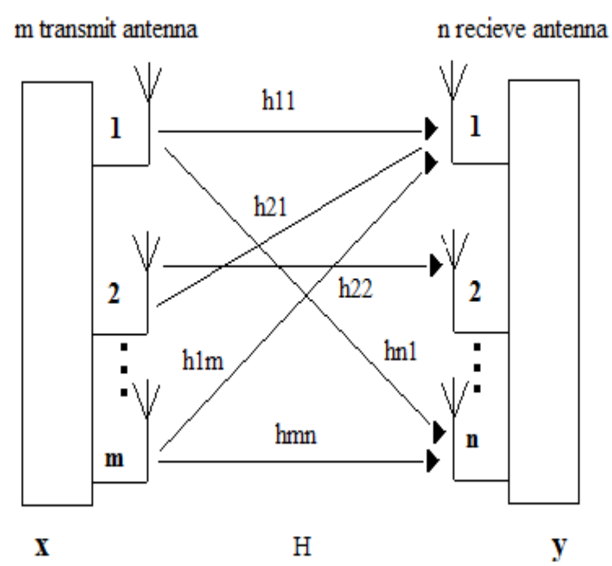

Figure 3 Multiple transmission in MIMO system.

Multiple antennas can be used for increasing the amount of diversity or the number of degrees of freedom in wireless communication systems. We propose the point of view that both

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types of gains can be simultaneously obtained for a given multiple-antenna channel, but there is a fundamental tradeoff between how much of each any coding scheme can get. For the richly scattered Rayleigh-fading channel, we give a simple characterization of the optimal tradeoff curve and use it to evaluate the performance of existing multiple antenna schemes. Figure 3 shows
Multiple transmission in MIMO system.
In MIMO wireless communication, an equalizer is employed which is a network that makes an attempt to recover a signal that has suffers with an Inter symbol Interference(ISI) and proves the BER characteristics and maintains a good SNR. A Minimum Mean Square Error (MMSE) estimator is a method in which it minimizes the mean square error (MSE), which is a common measure of estimator quality. Minimum mean-square error equalizer, which does not usually eliminate ISI completely but instead, minimizes the total power of the noise and ISI components in the output

4. SIMULATIONS

Equalization Techniques are of enormous importance in the design of high data rates wireless systems. They can combat for Inter symbol Interference even in mobile fading channels with high efficiency Zero forcing Equalizer performs well only in theoretical assumptions that are when noise is zero. This also helps to achieve data rate gain, Minimum Mean Square Equalizer uses LMS (least mean square) as a criterion to compensate ISI..

Minimum Mean Square Equalizer not only eliminates ISI components but also minimizes the total power of noise as compared to Zero Forcing Equalizer the results in lowering the chances of incorrect decisions resulting in enormous interference cancellation and there is a less improvement in the Bit Error Rate

The simulations were carried out at MATLAB which means keeping the transmitter and receiving antenna 2X2 and different equalizer technique MRC, ZF & MMSE, results show in Table 1and figure 4

Table-1 BER and Eb/No dB values for MMSE,MRC and ZF Equalizer in (2×2) MIMO system

	BER Values for MMSE,MRC and ZF Equalizer in (2×2)MIMO system		
Eb/No	MRC	ZF	MMSE
1	0.0581	0.1464	0.0925
2	0.0441	0.1267	0.0783
3	0.0328	0.1085	0.0654
4	0.0238	0.0919	0.0541
5	0.0169	0.0771	0.0449
6	0.0118	0.0642	0.0367
7	0.0081	0.0530	0.0297
8	0.0055	0.0435	0.0242
9	0.0037	0.0355	0.0194
10	0.0024	0.0288	0.0155
11	0.0016	0.0233	0.0126
12	0.0013	0.0187	0.0100
13	0.0011	0.0151	0.0080
14	0.0009	0.0121	0.0064

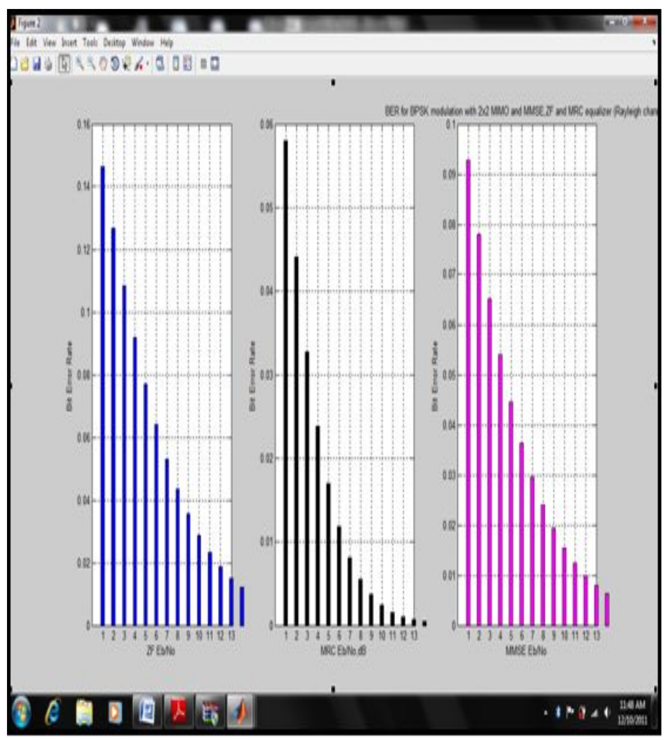

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Figure 4 Bar graph plot for BER and Eb/No for MMSE, MRC and ZF Equalizer in Rayleigh Channel for (2×2) MIMO system.

The simulations were carried out at MATLAB which means keeping the transmitter antenna as two and vary the number of antennas in the receiver side as shown in figure 5.

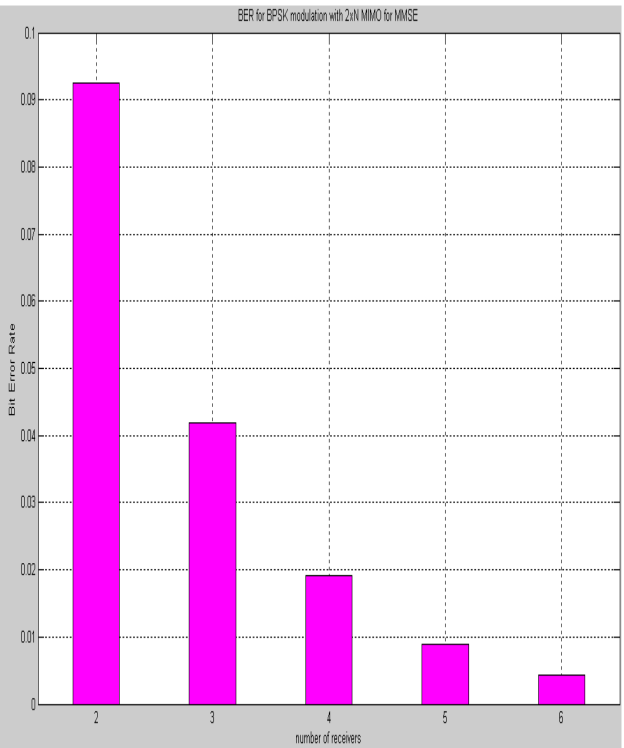

Figure.5 Bar graph plot for BER and Eb/No for MMSE for different number of receivers

5. CONCLUSION:

Simulation analysis of MIMO antenna configuration and comparision of the performance with the three types of equalizer based receiver namely MRC, MMSE and ZF has been performed. The MRC equalizer gives minimum BER values for corresponding Eb /No values. So BER performance of MRC Equalizer is superior then MMSE Equalizer. Similarly now the antenna configuration is varied namely 2×n as shown in figure 5, as the number of receivers (n) is increased keeping the number of transmitters (m=2) as constant, The Bit Error rate decreases in MMSE equalizer with increase in receivers.

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