Development of Efficient Evaluation of Channel Estimation using MIMO Diversity and Detection Combining

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Abstract - In this paper we are proposing channel estimation of wireless system which is used for high data rate systems. Channel estimation was performed using various methods; some of them shown good results. Here we are looking forward for another linear algorithm with which estimation of channel in wireless system can be performed efficiently. So in this context we are using MRC, EGC and SC which is a linear detection combining algorithm to estimate the channel, and this proposed approach is giving efficient results than previous methods.

Keywords - MRC, EGC, SC, MIMO, SISO, Diversity, Channel Estimation, BER.

I. INTRODUCTION

During the last few decades, wireless communication systems have been under major development. The requirements have shifted from the low data rate voice services to real time video transmissions. Support for higher data rates has become more essential and the development towards more advanced wireless systems is still ongoing. Multiple antennas are currently included in many of the wireless standards to achieve the required data rates. This increases the complexity of signal processing algorithms in the receiver. However, the complexity and power consumption of the wireless device should be moderate. This poses challenges in developing algorithms and architectures for the mobile receiver.

Broadband Wireless Communications:

Nowadays, wireless broadband communications can provide its users with radio access to broadband services based on public wired networks, with data rates exceeding 2 Mbps [10]. However, multimedia and computer communications are playing an increasing role in today's wireless services, which are presenting new challenges to the development of wireless broadband communication systems. The next generation of broadband wireless communication systems such as 4G is therefore anticipated to provide wireless subscribers with high quality wireless services such as wireless television, high speed wireless Internet access and mobile computing. The pressure of rapidly growing demand for these services is enormous which is driving communication technology towards higher data rates, higher mobility, and higher carrier frequencies for reliable transmissions over mobile radio channels.

Depending on the quality-of-service (QoS) requirements and different applications, many broadband wireless communication approaches have been proposed recently. Their target is to achieve the required high transmission rate while maintaining a certain QoS in macro cellular, Pico cellular and indoor environments.

II. MIMO COMMUNICATIONS

The explosion of interest in MIMO systems dates from the middle of the 1990s. However, what is not widely known is the fact that eight years before Telatar's work, another paper was written by Winters [15]. This research showed that with appropriate signal processing in the transmitter and the receiver, the channel capacity (a theoretical upper bound on system throughput) for a MIMO system is increased as the number of antennas is increased, proportional to the minimum number of transmit and receive antennas, which implies that the possible transmission rate increases linearly. This basic finding in information theory is what led to an explosion of research in this area [6].

Nowadays, MIMO technology has attracted the most attention in wireless communications, since it can offer significant increase in data throughput and link range without additional bandwidth or transmit power. It achieves this by higher spectral efficiency (more bits per second per Hertz of bandwidth) and link reliability through diversity gain (reduced fading). Because of these properties, MIMO is a current key theme of international wireless research. A baseband framework for a general MIMO system is presented in Fig 1shows

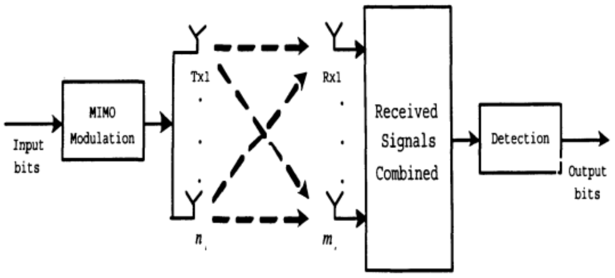

Fig 1: MIMO technologies using multiple antennas both at a transmitter and a receiver

and it shows that a MIMO system consists of nt transmit (Tx) and m r receive (Rx) antennas. All the Tx antennas can send their signals simultaneously in the same bandwidth of a radio channel. Each Rx antenna receives the superposition of all the transmit signals disturbed by the noise in the radio channel.

Spatial Diversity (SD) :

Spatial diversity is a part of antenna diversity techniques in which multiple antennas are used to improve the quality and reliability of a wireless link. Usually in densely populated areas, there is no clear Line of Sight (LoS) between the transmitter and the receiver. As a result, multipath fading effect occurs on the transmission path [7]. In spatial diversity several receive and transmit antennas are placed at a distance from each other. Thus if one antenna experiences a fade, another one will have a LoS or a clear signal. Figure 6 shows the basic principle of Spatial Diversity.

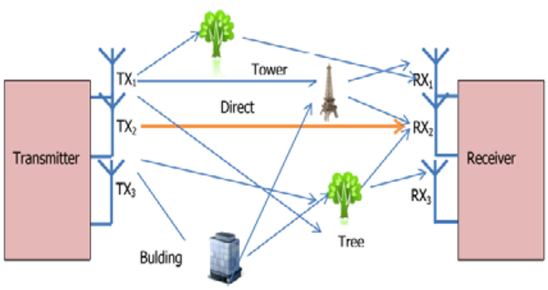

Fig 2: Spatial diversity

Selection Diversity :

In multiple input and single output systems, selection diversity selects the branch providing the largest magnitude of log-likelihood ratio (LLR). The LLR for BPSK signals in fading channels is found to be proportional to the product of the fading amplitude and the matched filter output after phase compensation. Channel state includes statistics information such as fading amplitudes, phases and delay. In selection diversity technique, none of these channel information is required. Selection diversity uses one receiver antenna which greatly reduces the complexity of the wireless systems. Here, the receiver simply looks at the outputs from each fading channel and selects the one with the highest signal-to-noise ratio (SNR). In this case, the strongest signal is picked up and other signals that have undergone deep fades are unlikely to be picked by the receiver, which can avoid the deep fading effect. Therefore, the more the channels are, the more accurate the recovered would be. There is also no need for any addition of the fading channel outputs, which further decreases the complexity. Since Selection diversity does not require any knowledge of the phases, it is usually used in non coherent or differential coherent modulation schemes. The structure of selection diversity is shown in Figure 4.1: the signals from the transmitter antenna are sent through multiple channels, selected by the detector system and finally received by the receive antenna.

Selection diversity can be viewed as the practical methods to reduce the implementation complexity of MIMO systems while still taking benefit of the use of multiple antennas. The performance of the BPSK signals in slow, Rayleigh channel with additive white Gaussian noise using one transmit antenna, two transmit antennas and four transmit antennas, respectively, and one receive antenna in all cases are calculated.

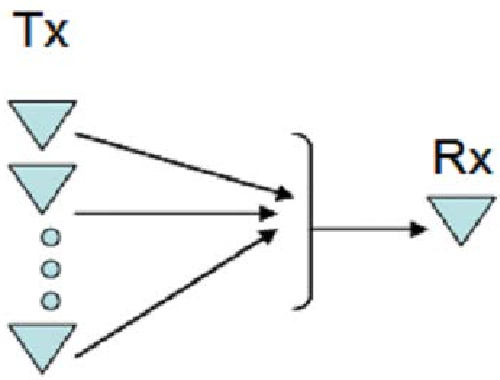

Fig 3: the basic structure of transmit selection diversity.

III. PROPOSED METHODOLOGY

The block diagram shows the proposed methodology. The Space Diversity with EGC, MRC and SC detection combining in Fig. 3.1. In the proposed methodology EGC, MRC and SC modulation with multiple input multiple output (MIMO) has been used to minimize the error rate against SNR. The Block Diagram in the transmitter side the data is modulated by QPSK modulator the antenna diversity with 1, 2, 4, and 8 is used. In receiver side detection combining techniques EGC, MRC & SC is used for efficient performance of system.

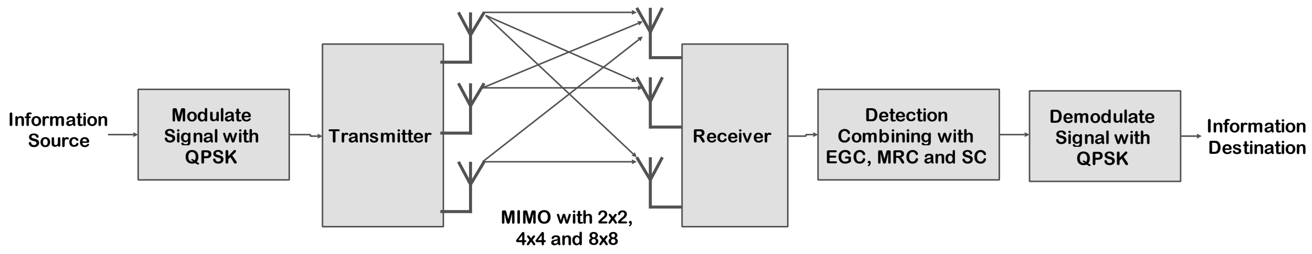

Fig. 3.1 Block Diagram of Proposed System

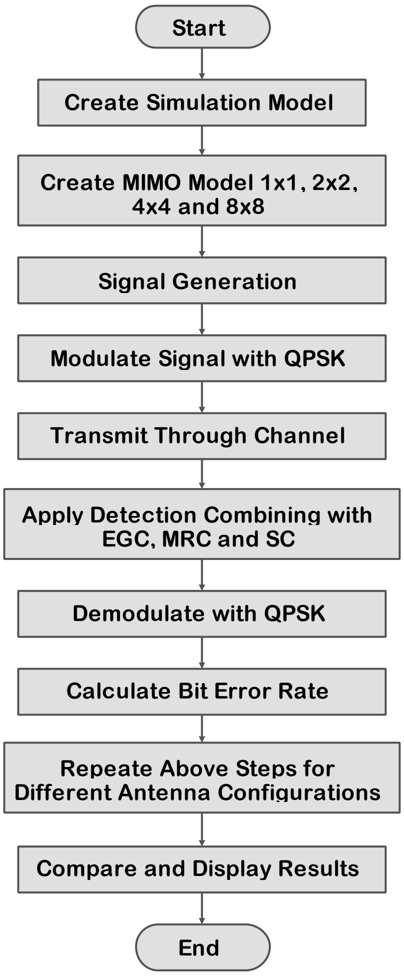

Fig. 3.2 Flow Chart of Proposed Methodology

The flow chart of proposed methodology is shown in Fig. 3.2, it shows the step by step execution of proposed program. When the simulation starts it is need to create environment first which is created with the help of variable in simulation tool. Than we configure system for multiple antennas at transmitter and receiver both. After that the data is generated and converted into signal QPSK modulation is applied.

After complete preparation of signal it is transmitter through wireless channel where signal encountered with noises and get corrupted. Due to these noises and interferences we have to use effective combining techniques. After application of combining technique which significantly reduces the effect of noises. Then demodulate with QPSK. and repeat with different antenna configurations and calculate bit error rate(BER) and display results.

IV. SIMULATION OUTCOMES

This section explains the results of proposed methodology after simulation. The simulation of proposed system is under 3 MIMO configurations i.e. when one antenna at receiver and one at transmitter, similarly 2, 4, and 8 antennas both side. For enhancing the performance of the system integrate with combining techniques (EGC, MRC and SC) is also compared.

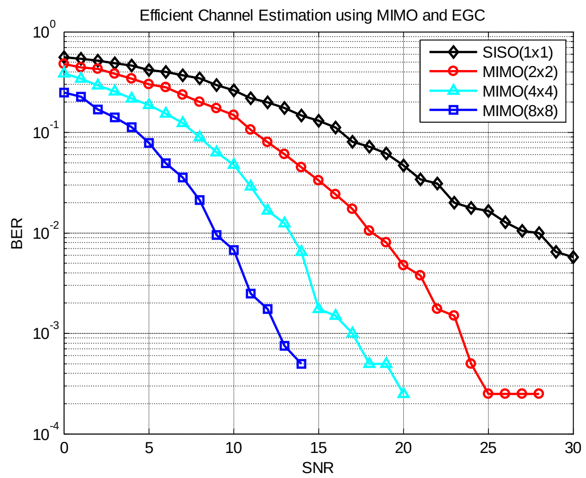

Fig. 4.1 Channel Estimation Performance of MIMO Wireless System using EGC Detection Combining

The simulation of proposed system with equal gain combining(EGC) is shown in the Fig. 4.1 and the outcome with different MIMO communication that, when we use 8x8 antennas with this combining technique we will get the better results than less number of antennas.

The simulation of proposed system with Maximal Ratio Combining(MRC) is shown in the Fig. 4.2 and the outcome with different MIMO communication that, when we use 8x8 antennas with this combining technique we will get the better results than less number of antennas.

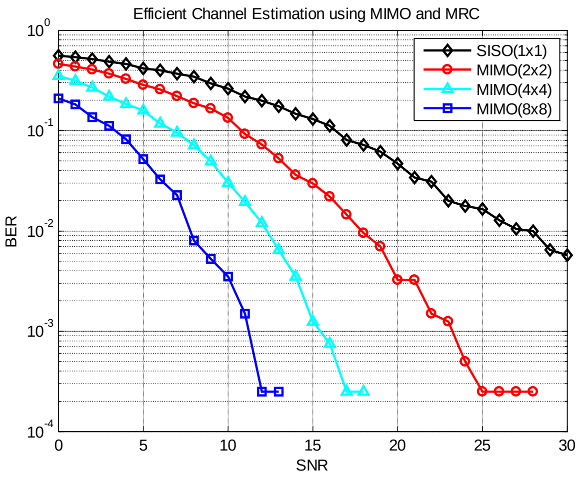

Fig. 4.2 Channel Estimation Performance of MIMO Wireless System using MRC Detection Combining

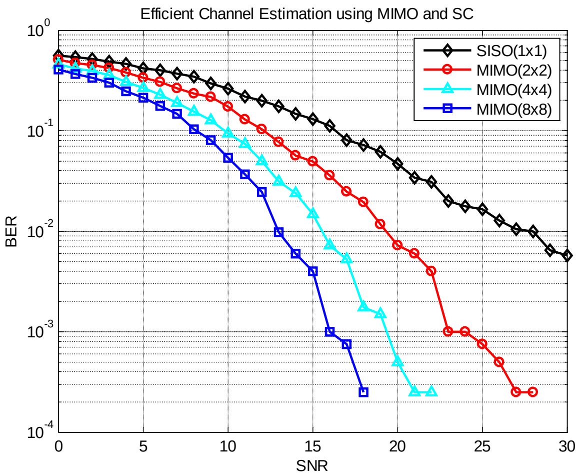

Fig. 4.3 Channel Estimation Performance of MIMO Wireless System using SC Detection Combining

The simulation of proposed system with Selection Combining(SC) is shown in the Fig. 4.3 and the outcome with different MIMO communication that, when we use 8x8 antennas with this combining technique we will get the better results than less number of antennas.

V. CONCLUSION AND FUTURE SCOPE

Channel Estimation done in this work has been done efficiently and the proposed approach is implementing different detection combining techniques that are EGC, MRC and SC. The system utilizes QPSK modulation and the system has analyzed with SISO and MIMO diversities where MIMO configurations are 2x2, 4x4 and 8x8 antennas on transmitter as well as receiver side. Bit error rate calculated for different antennas are improved with increase in antennas because the number of transmitter antenna deliver more power and receives more power, which significantly increases the chances of recovering more information than less number of antennas, but utilization of antennas are limited with having different factor like cost and space etc. But still there is a scope to further enhance the performance with equalization techniques like ML, ZF or MMSE and complex modulation technique to immune signal against noises and interferences.

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