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Wireless Signal Quality Enhancement by Improving SNR for MIMO Channels Using 64 QAM

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ABSTRACT: High quality multirate data transmission is demanding greater speed and accuracy for reliable and accurate reception. Specially, increasing wireless multimedia applications are infusing high data requirements. Rapidly time varying multi-carrier, multi-user based MIMO channels due to high mobility have inevitably necessitated equalization for the availability of partial or no channel state information at the transmitter and/or receiver which fetch new problems. Additive White Gaussian Noise (AWGN) encapsulates continuous uniform spectrum for the transmitted signal continuously in every channel. Space Time Coding (STC), an extension of the spatial diversity, further enhances the gain by adding the utilization of transmit diversity .The simulations show that as we go for higher order of transceivers, the system structure complexity increases relatively. Convergence of blind algorithms can be difficult to achieve for some channel conditions as well as for differential phase noise.

KEYWORDS-AWGN, BER, MIMO, STBC, QAM

I. INTRODUCTION

Wireless systems allow linking people in almost every place. Twenty first century has begun its footsteps with evolution and revolutionary changes in wireless communication, from an optional convenience to an essential necessity in daily life. Extensive advances have made innovatory changes in digital signal processing, computing and transmission. This change has accelerated wireless technology to jump from just a convenience to inevitability, earthling Generation changes from second to third, fourth and the count began. These technological advancements have also inlaid super highways for data transmission from single antenna to multi antenna called MIMO (Multiple Input Multiple Output) technology.

Distinctive space-time processing techniques have been proposed in works in request to completely exploit possibilities of MIMO systems. The most prominent one is Space-Time Coding, in which the time measurement is supplemented with the spatial measurement inherent to the utilization of numerous spatially- distributed antennas. A surely understood case of theoretically basic, computationally effective and mathematically exquisite space time square coding (STBC) plan has been proposed by Alamouti.

A. Objectives

Interference reduction and avoidance: Exploits spatial dimension sharing time and frequency resources to improve the coverage and range of a wireless n/w.

1. **Spatial multiplexing:** Increases the transmission rate (or capacity) linearly for the same bandwidth and with no additional power expenditure.
2. **Array gain***:* The average increase in the SNR at the receiver that arises from the coherent combining effect of multiple antennas at the receiver or transmitter or both.

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II. LITERATURE REVIEW

MIMO has made a significant technical breakthrough in wireless communications. C. Wang [1] explains spatial multiplexing, the approach to exploit the capacity of MIMO systems, where independent information streams are transmitted from the antennas. These streams are then separated at the receiver by means of appropriate signal processing techniques such as maximum likelihood (ML) which achieves optimal performance or linear receivers like Zero-Forcing (ZF) which provides sub-optimal performance but offers significant computational complexity reduction with tolerable performance degradation.
N. S. Kumar et.al [2], investigated about the three types of equalizer for MIMO wireless receivers. BER performance of ML Equalizer is superior to zero forcing Equalizer and Minimum Mean Square Equalizers. Based on the mathematical modeling and the simulation result, using BPSK modulation, it is inferred that the ML equalizer is the best of the three equalizers.

Sunil Joshi et.al [5], have shown with their results that 16-QAM is more flexible and reliable considering bandwidth (BW) efficiency, noise sensitivity, and data rate compared to QPSK. Also it is shown with the results that MIMO outperforms MISO and SIMO, as SNR increases.
Nidhi Raghav, Veeranna D[6] have investigated that BER and SER (symbol error rate) is least for QAM compared to BPSK, QPSK, and 8PSK modulation techniques for Rayleigh channel.

III. QAM (QUADRATURE AMPLITUDE MODULATION)

Quadrature Amplitude Modulation has fast become the dominant modulation mechanism for high speed digital signals. Quadrature Amplitude Modulation (QAM) is a modulation scheme which is carried out by changing (modulating) the amplitude of two carrier waves. The carrier waves are out of phase by 90 degrees and are called Quadrature carriers hence the name of the scheme

A. Constellation diagram

A constellation diagram is the representation of a digital modulation scheme on the complex plane. The diagram is formed by choosing a set of complex numbers to represent modulation symbols. These points are usually ordered by the gray code sequence. Gray codes are binary sequences where two successive values differ in only one digit. The use of gray codes helps reduce the bit errors. The real and imaginary axes are often called the in-phase and the quadrature. These points are usually arranged in a rectangular grid in QAM, though other arrangements are possible. The number of points in the grid is usually a power of two because in digital communications the data is binary.

Upon reception of the signal, the demodulator examines the received symbol and chooses the closest constellation point based on Euclidean distance. It is possible to transmit more bits per symbols by using a higher-order constellation QAM, but this is more susceptible to noise because the points are closer together, resulting in a higher BER.

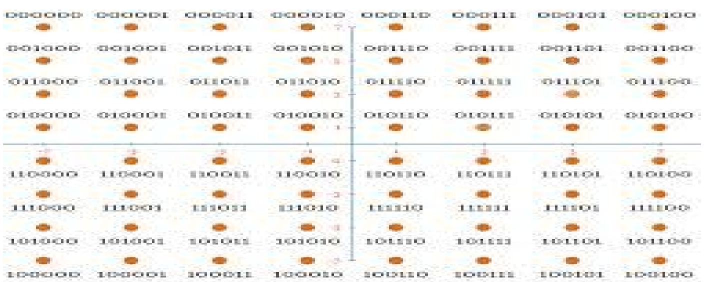

Figure 2.1: 64-QAM constellation diagram

IV. MIMO WIRELESS COMMUNICATION SYSTEM

MIMO (multiple input multiple output) is an antenna technology for wireless communications system. In a MIMO system there are M transmit and N receive antennas as shown in figure3.1, the transmitted data signals pass through multiple paths to get to the receiving antennas. The antennas at each end of the communications circuit are combined to

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minimize errors and optimize data speed.Though not shown on the diagram, but there is also noise that interferes with the data signals along the paths.

A. MIMO Multiplexing Technique

B. Space Time Block Coding (STBC)

Space-time block coding is a simple yet ingenious transmit diversity technique in MIMO technology. STBC is a technique used in wireless communications to transmit multiple copies of a data stream across a number of antennas and to exploit the various received versions of the data to improve the reliability of data-transfer. The fact that transmitted data must traverse a potentially difficult environment with scattering, reflection, refraction and so on as well as can be corrupted by thermal noise in the receiver means that some of the received copies of the data will be better than others. This redundancy results in a higher chance of being able to use one or more of the received copies of the data to correctly decode the received signal. Space–time coding combines all the copies of the received signal in an optimal way to extract as much information from each of them as possible.

C. Alamouti Scheme for MIMO systems

Historically, the Alamouti code is the first STBC that provides full diversity at full data rate for two transmit antennas. A block diagram of the Alamouti space-time encoder is shown in Figure. 3.1

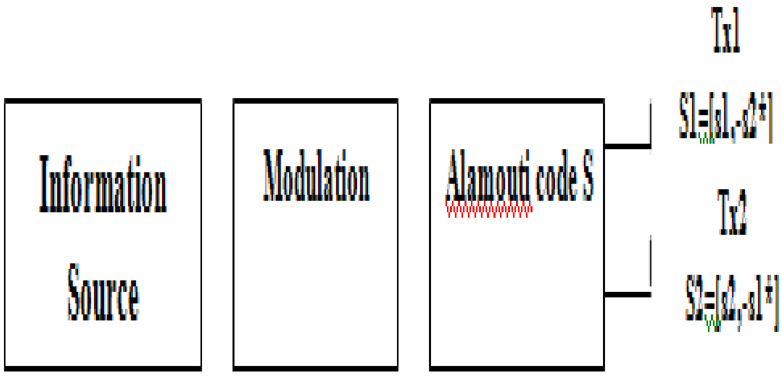

Figure 3.1 a block diagram of the Alamouti space-time encoder.

The information bits are first modulated using an M-ary modulation scheme. The encoder takes the block of two modulated symbols S_1 and S_2 in each encoding operation and hands it to the transmit antennas according to the code matrix

V. METHODOLOGY

The advancement in the technology is a continuous process of research on small factors to improve the performance of the system. The concept of making wireless MIMO channel based system with end to end reliability of information is achievable using the space time coding techniques in addition with the efficient modulation techniques that helps to shield the signals from unwanted noise attacks and interferences.
The system is equipped with the Almouti STBC coding and 64 QAM Modulation technique and applying moving average filter at the receiver side to reduce the effect of distortions and interferences.

A. Flow chart

The below mentioned flow chart is the step by step flow of computer algorithm implemented on simulation tool.

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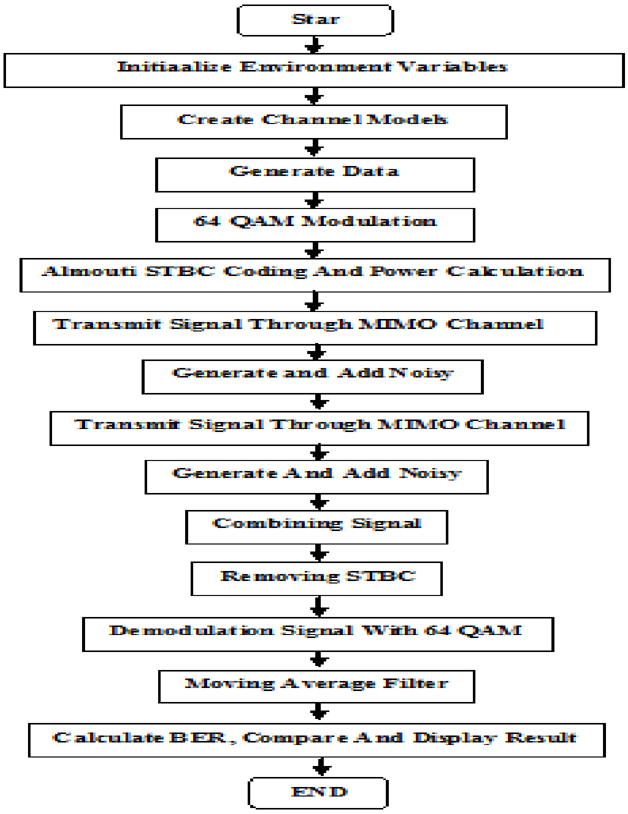

Figure 4.1 Flow chart of implemented simulation model of proposed system

The above mentioned algorithm gives the results by which the outcomes of the proposed methodology.

B. Simulation results

The study involved developing a scheme for implementing a link with the channel following Raleigh fading model with modulation techniques such as 64-QAM for the following conditions

1. Without using any error correction codes or multiple access scheme.
2. Using Alamouti's STBC technique with ZF equalizer receiver.

C. Simulation results without using any error correction codes or multiplexing scheme.

The simulated result for modulation techniques are as shown in figure and Table indicates the performance of the system by taking the value of SNR for fixed BER i.e., for 10^{-4} from the.

Table 4.1: Comparison table for 10^{-4} BER without using STBC

Modulation techniques	~SNR(dB) for 10^{-4}BER
BPSK	31
QPSK	32
16 QAM	34
64-QAM	40

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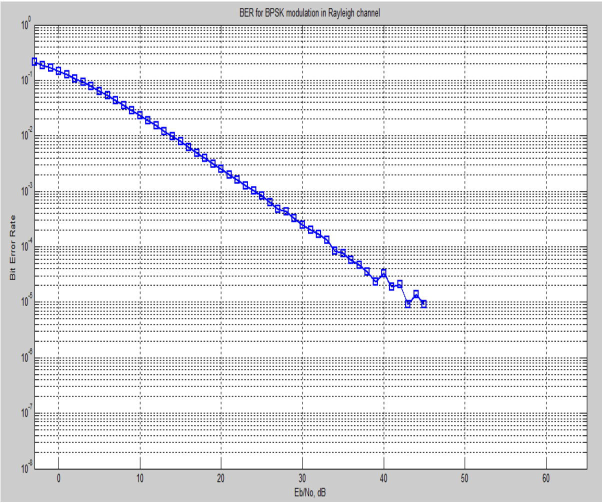

Figure 4.2 Simulation for BPSK in Rayleigh channel

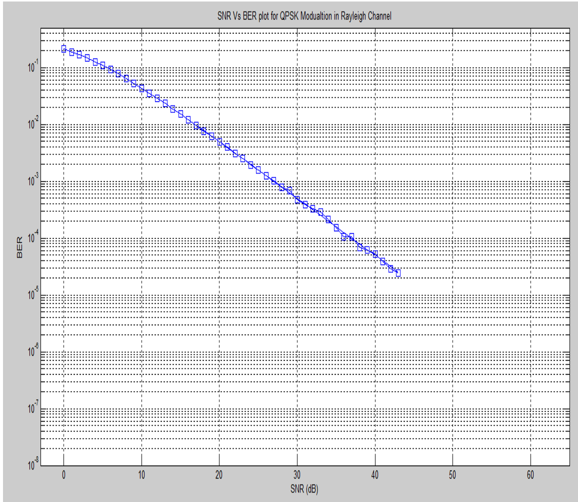

Figure 4.3 Simulation for QPSK in Rayleigh channel

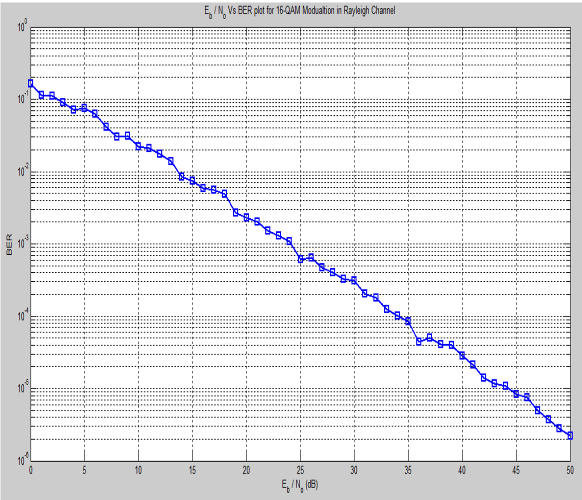

Figure 4.4 Simulation for 16 QAM in Rayleigh channel

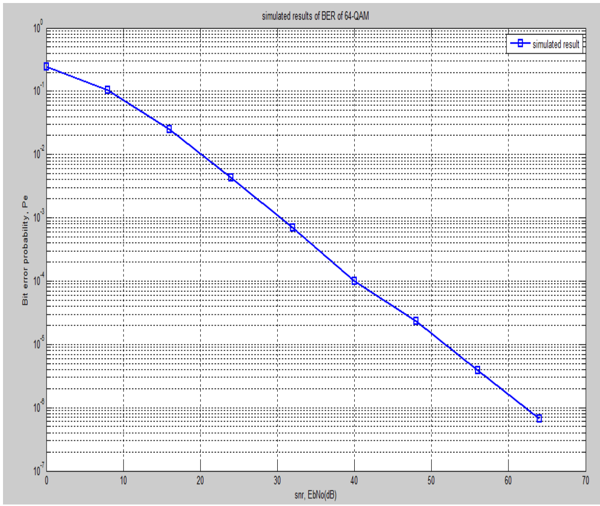

Figure 4.5 Simulation for 64-QAM in Rayleigh channel

From the results obtained it is seen that the performance of 64-QAM is better than other modulation techniques, however the higher data transmission capacity and lower bit error rates comes at the price of higher circuit complexity and costs.

4.4 Simulation results using Alamouti STBC

To analyze the performance of a MIMO system, a channel was simulated and the data coded using Alamouti STBC for different digital modulation techniques, the obtained results are plotted as shown in below figures. Fig. 4.6a, Fig.4.6b and Fig.4.6.c, that represent the performance of 2x2, 2x4, 2x6 MIMO systems respectively for 64-QAM, with ZFE at the receiver.

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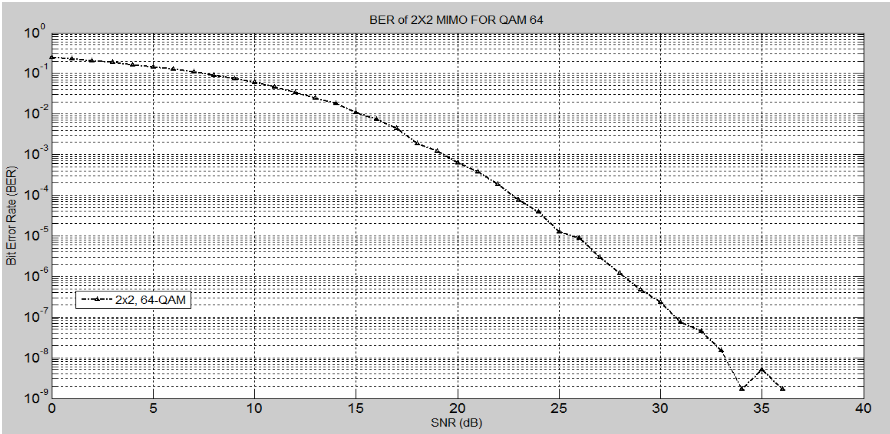

Figure 4.6.a Simulation for 2x2 using 64-QAM in Rayleigh channel

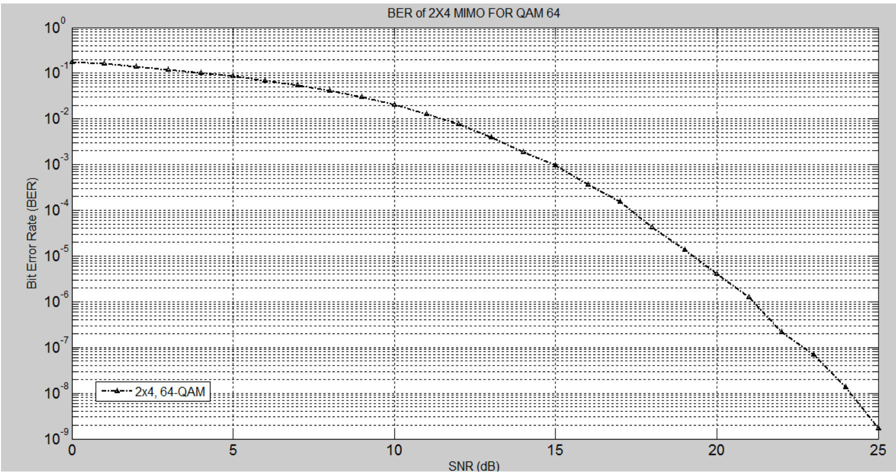

Figure 4.6.b Simulation for 2x4 using 64-QAM in Rayleigh channel

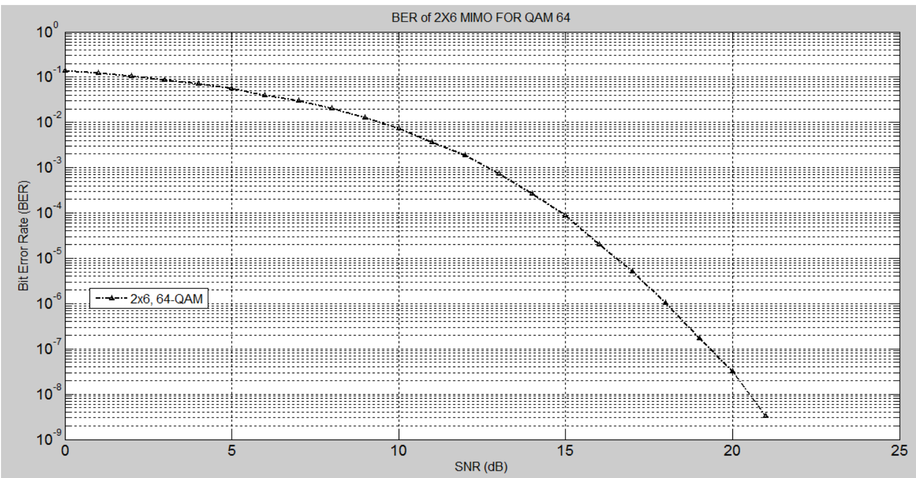

Figure 4.6.c Simulation for 2x6using 64-QAM in Rayleigh channel

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Table 4.2 Comparison table for 10^{-4}BER using STBC

Modulation techniques	SNR(dB) for 2x2	SNR(dB) for 2x4	SNR(dB) for 2x6
64-QAM	21	17	15

Table 4.2 gives a detailed explanation for the obtained result for 2x2, 2x4, 2x6 MIMO systems for 64-QAM using Alamouti STBC multiplexing technique. It is observed that 64-QAM achieves better SNR value for BER of 10^{-4}, It may be noted that. From these results it is concluded that 2x2 is better than 2x4 and 2x6.It is evident that the overall performance has decreased by increasing the number of transmitters and receivers of MIMO system. however considering that the power transmitted is shared by two transmitters the overall performance has increased beyond

VI. CONCLUSIONS AND FUTURE SCOPE

The study of the performance of the MIMO system for a modulation techniques such as 64-QAM with STBC (for 2, 4 and 6 receivers and 2 transmitters) and for uncoded and coded-OFDM (with hard and soft decision decoders) was successfully simulated in MATLAB®R2013a environment.As expected the STBC schemes with added advantage of spatial diversity ensure robust data transmission with low error rates but at the cost of considerable power consumption that is as expected. The increase in number of receiver/transmitter antennas however surprisingly does not bring down the SNR

A. FUTURE SCOPE

The study can be further enriched by incorporating:

1. Further research can be carried out by increasing the number of antennas on both transmitter and receiver side to increase bandwidth efficiency, SNR and capacity.
2. MIMO transceiver provides meaningful way for cross layer trade off. This motivates further research in cross layer design for MIMO ad hoc networks that leverages the inherent multiplexing gain in each MIMO transceiver.

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