Analysis of BER for MIMO-STBC with Different Modulation Techniques

Pooja Sawant, Snehal Parande, Shweta shelke

Abstract— **To meet the requirements of very high data rates for wireless communications such as Internet and Multimedia services, multiple transmitting and multiple receiving antennas have been proposed. Multiple-input multiple-output (MIMO) with space-time codes remove effect of fading significantly enhance the channel capacity. This is efficient solution for the future wireless communication systems. They provide higher data rates and longer transmission range within limited bandwidth and transmitted power. The multiple antenna allow MIMO systems to perform pre-coding, diversity coding means space time block coding and spatial multiplexing.**

MIMO diversity is one technique which mitigates the effect of fading by taking advantages of multipath taking by the signal. MIMO technique increases the strength of the signals. Space-time block codes (STBC) is one technique of the MIMO which improve the performance by increasing diversity gain.

In this paper space time block codes for two transmit antennas and two receive antennas with different digital modulations such as BPSK (Binary Phase Shift Keying), QPSK (Quadrature Phase Shift Keying) are studied. This study is done on the basis of Bit Error Rate (BER), Signal to Noise Ratio for each scheme. Also the BER for basic modulation techniques in Rayleigh fading channel is calculated. The comparison of BER curves for these different schemes is done in order to choose the best one. All these techniques are implemented in the MATLAB.

Index Terms— **BER, BPSK, MIMO, QPSK, Rayleigh Channel, SNR, STBC**

I. INTRODUCTION

Communication technologies have become a very important part of human life because Wireless communication systems have opened new dimensions in communications. Nowadays around 700 million people subscribe to existing second and third generation. Over the next years it is expected to move towards 100Mbps-1Gbps range and to subscriber numbers of over two billion.

The research community has generated many solutions for improvements in system performance. One of the most significant solutions is multi antennas at the transmitter and at the receiver known as MIMO stands for multiple-input multiple-output. The idea behind this is antennas at the both ends are 'combined and connected' in such a way that the quality for each user is improved. The core idea in MIMO transmission is space-time signal processing in time is complemented by signal processing in the spatial dimension by using multiple, spatially distributed antennas at both transmitter and receiver.

Because of properties of MIMO such as efficiency and gain, MIMO is important part of modern communication such as IEEE 802.11, Wi-Fi, 4G and HSPA.

A. Motivation:

One essential problem in wireless is fading, which occurs as signal follows multiple paths between transmitter and receiver antennas. So, sometimes the arriving signals will add up destructively, reducing the received power to near zero. In such case no reliable communication is possible.

Fading can be avoided by diversity which means that the information is transmitted number of times, hoping that at least one of the replicas will not undergo severe fading. These Different signal paths can be modeled as a number of separate independent fading channels.

Several transmission schemes has been proposed that utilize the MIMO channel in different ways, such as spatial multiplexing, space-time coding. In space time coding no. of transmitted code symbols per time slot are equal to the no. of transmit antennas. Space time block codes is one method of space time coding technique which proposed by Alamouti. This gives full diversity and full data rate in case of two transmit antennas. The main issue in this scheme is to achieve high reliability, high efficiency and high performance gain.

B. Objective:

The study involves procedures of encoding, channel modeling, simulations of the STBC transmission system, digital transmission system and computation and comparison of BER. We will study and identify multiple input multiple output (MMO) technology that gives best Bit Error Rate performance for different digital modulation schemes such as BPSK, QPSK using MATLAB simulation. Also we study the transmission characteristics for these above schemes by plotting their BER Versus SNR curves.

The comparison of the simulated BER and BER for BPSK in AWGN (Adaptive white Gaussian noise) is done on the receiver side.

II. SYSTEM MODEL:

A. BLOCK DIAGRAM

The information to be transmitted is modulated & fed to the Space Time Encoder. It consist of transmit antennas as part of the multiple input multiple output technologies. Each transmitting & receiving antenna pair as a channel, represented by different channel coefficients. These channel coefficients play an important role in the design of system.

In the decoder the received signal is fed to the Space Time Decoder where signal is detected. This detected signal is then fed to the demodulator which gives the original information

Manuscript received April 04, 2015.

Pooja Sawant, BE (Electronics and Telecommunication), Vidya Pratishthan's college of engineering, Baramati.

Snehal Parande, BE (Electronics and Telecommunication), Vidya Pratishthan's college of engineering, Baramati.

Shweta shelke, BE (Electronics and Telecommunication), Vidya Pratishthan's college of engineering, Baramati.

transmitted. Then comparison of transmitted signal & received signal is carried out.

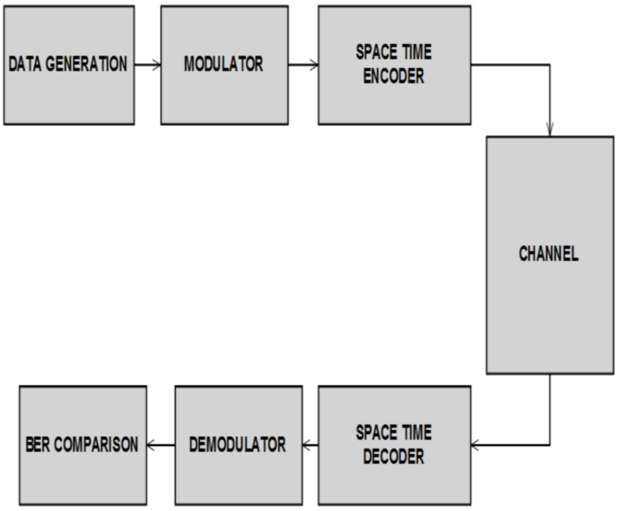


Figure1. Block diagram of system

B. *DIGITAL MODULATION*

a) M-ary coding

This word is derived from the word Binary; M simply denotes the number of conditions, levels or possible conditions for given binary variables. For example, digital modulation with four possible conditions is an M-ary system where

$$M=4.$$

The number of bits necessary to produce a given number of conditions is expressed mathematically as

$$N=\log_2 M$$

Where

N= number of bits necessary

M=number of conditions, levels or combinations.

Above equation can be simplified and rearranged as

$$2^N=M$$

For example, with one bit, only $2^1=2$ conditions are possible.

b) Binary phase shift keying

BPSK is a M-ary encoding scheme where M=2. A BPSK signal is binary signal, to produce two different levels such as 0 and 1. Therefore, with BPSK, each binary digit generates one of two the possible output phases (0^0or 180^0).

c) Quadrature phase shift keying

QPSK is a M-ary encoding scheme where N=2 and M=4 (hence, the name "quaternary" meaning "4"). A QPSK modulator is a binary (base 2) signal, to produce four different input combinations like 00, 10, 01, and 11.

Therefore, with QPSK, the binary input data are combined into groups of two bits, called di-bits. In the modulator, each di-bits code generates one of the four possible output phases ($+45^0$, $+135^0$, -45^o, -135^0).

C. *SPACE-TIME*

BLOCK CODING:

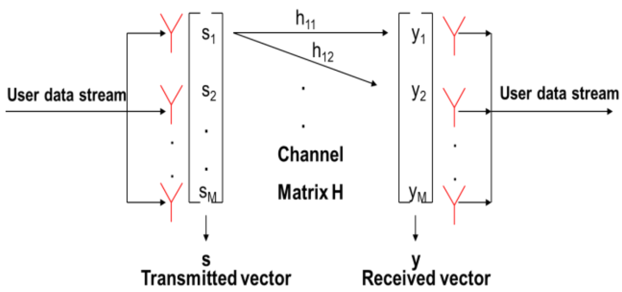


Figure2.Shows a simple representation of STBC system with Sm transmits antennas and Ym receives antennas.

A MIMO system can be represented as

$$H = \begin{pmatrix} h_{11} & h_{12} & \cdots & h_{1Sm} \\ h_{21} & h_{22} & \cdots & h_{2Sm} \\ \cdot & \cdots & \cdots & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ h_{Ym1} & \cdots & \cdots & h_{YmSm} \end{pmatrix}$$

In the encoding and transmission sequence, at a given symbol period, signals are transmitted through two antennas. The signal transmitted through first antenna is denoted by x1 and signal transmitted from other antenna is denoted by x2. During the next symbol period, -x2* is transmitted from the first antenna and x1 *is transmitted from second antenna. In this system, * is the complex conjugate operation. The rows of each coding scheme represent different time slots, while column represent the symbol transmitted through different antennas. In this case, the first and second rows represent the transmission at the first and second time instants respectively.

$$x = \begin{pmatrix} x_1 & x_2 \\ -x_2^* & x_1^* \end{pmatrix}$$

The encoding is done using space time block coding. The received signal in case of this system is given as

$$y= Hx + n$$

Where,

$$H = \begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix}$$

$$y_1 = h_{11}x_1 + h_{12}x_2 + n_1$$
$$y_2 = -h_{11}x_2^* + h_{12}x_1^* + n_2$$
$$y_3 = h_{21}x_1 + h_{22}x_2 + n_3$$
$$y_4 = -h_{21}x_2^* + h_{22}x_1^* + n_4$$

Where H is the channel matrix and n_1, n_2, n_3, n_4 are complex random variables represent noise and interference.

D. *Rayleigh Multipath channel*

A simple statistical multipath channel model is called Rayleigh fading channel model. It is reasonable model when there is many objects in the environment that scatter the signal before it arrives at the receiver. The central limit theorem says that if there is sufficiently much scatter, the channel impulse response will be well modeled as a Gaussian process irrespective of the distribution of the individual components. Rayleigh fading is based on the well-studied distribution with special properties. The Rayleigh fading channel itself can be modeled by generating the real and imaginary parts of complex number according to independent normal Gaussian variables.

E. Receiver

In the STBC decoder received signals were combined by and detected by detector. Demodulator converts the received signal to the original transformed bits. The demodulator is used for decision rules with the goals of making a decision about which bit “zero” or “one”, was send.

III. SIMULATIONS:

Simulations are done in the MATLAB using Rayleigh channel model. We simulate basic modulation techniques BPSK and QPSK to obtain their BER curves. Also we simulate system of STBC for two transmit antennas and two receive antennas using BPSK and QPSK respectively. At last all simulated results are compared with one reference BER curve to find the best scheme among all.
For each sample, blocks of 10^6 symbols are simulated until at least 100 bits errors are obtained. The simulation is stopped when SNR reached 25dB.

From result one; we observed that simulated BER is not ideal one. For both BPSK and QPSK in Rayleigh channel we got higher BER.
From result two; we observed that we got minimum BER for BPSK and QPSK with Alamouti STBC scheme.
In last result; comparison of above techniques is done on the basis of BER curves. Comparison is done in order to find best scheme to implement practically.

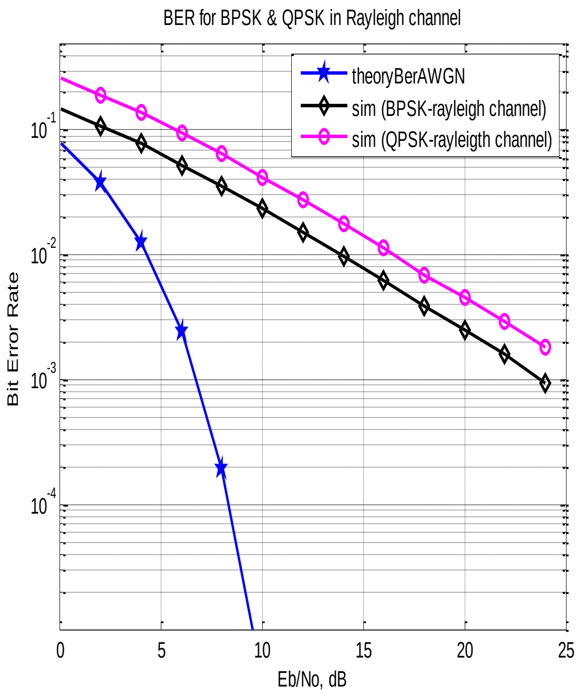
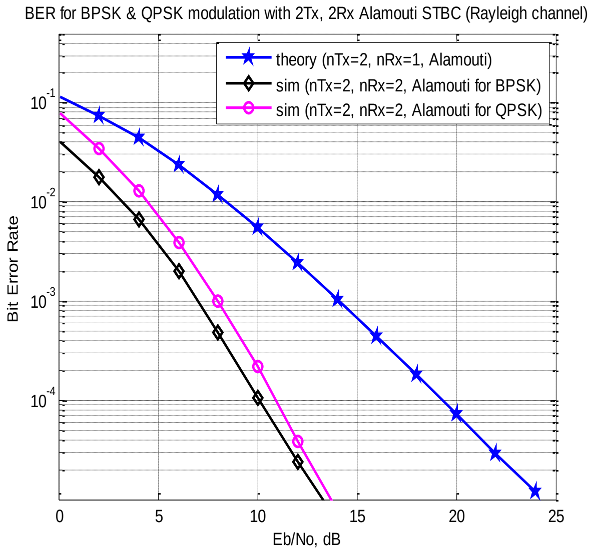


Figure3. RESULT ONE.



Figur4. RESULT TWO.

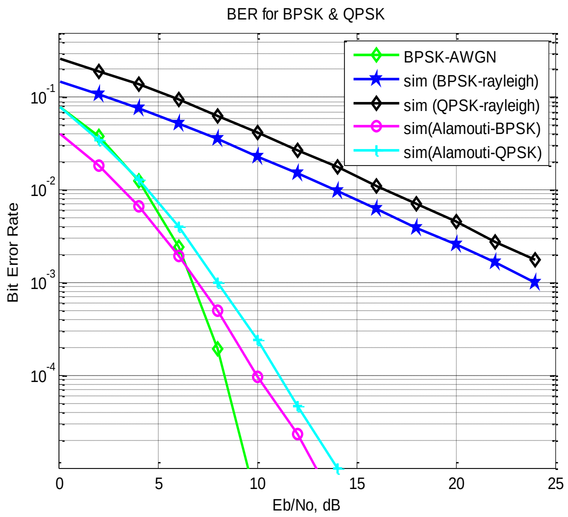


Figure5. RESULT THREE.

IV. CONCLUSION:

In this paper, we studied the multiuser space-time block codes was provided by presenting Alamouti’s scheme that allow low complexity. We discussed block codes with code rate of 2 by 2. We optimized rate one design to achieve minimum BER for Rayleigh fading channel realization when the information symbols are drawn from BPSK and QPSK digital modulation technique. Also, we plot the BER curves for BPSK and QPSK modulation in Rayleigh fading channels without using STBC. We observed that BER reduces as no. of antennas are increases but it reduce the energy per receive antenna. Finally, we conclude that BPSK Modulation gives sharp waterfall curve with trade-off of one bit per symbol. Whereas QPSK modulation transmit two bits per symbol bit gives steady BER curve.

V. ACKNOWLEGEMENT

The authors are grateful to Prof. Shrihari Muttagi (Vidya Pratishthan’s college of Engineering, Baramati) for guidance in every difficulty. Author would like to thank to the Principal Dr. Deosarkar and also Head of department Prof. V. U. deshmukh(Vidya Pratishthan’s college of Engineering, Baramati) for providing good environment.

REFERENCES

[1] S. Alamouti, "A simple transmit Diversity technique for wireless communications,"IEEE Journal on selected areas in communications, vol. 16, no.8, pp. 1451-1458, 1998.
[2] Vahid Tarokh, A. Robert Calderbank, Hamid Jafarkhani," Space–Time Block Coding for Wireless Communications: Performance Results,"IEEE Journal on selected areas in communication, vol. 17, no. 3, March, 1999.
[3] V. Tarokh, N. Seshadri, A. R. Calderbank, "Space –Time codes for high data rate wireless communication", IEEE Transaction on information theory, Vol. 44, No. 2, pp. 744-765,1998
[4] Hamid Jafarkhani, "Space-Time coding theory and practice".
[5] G. Raleigh, J. M. Cioffi, "Spatial-temporal coding for wireless communications", in Proc. IEEE GLOBECOM96, pp. 18091814.
[6] A. Wittenden, "Base station modulation diversity for digital SIMULCAST", in Proc. IEEE VTC, May, 1993, pp. Yan, Q. Blum, R. S. Improved space-time convolutional codes for quasi-static fading channels. IEEE Trans. On wireless Communications,1(4): Oct. 2002, 56371.

Pooja Sawant, BE (Electronics and Telecommunication), Vidya Pratishthan's college of engineering, Baramati.

Snehal Parande, BE (Electronics and Telecommunication), Vidya Pratishthan's college of engineering, Baramati.

Shweta shelke, BE (Electronics and Telecommunication), Vidya Pratishthan's college of engineering, Baramati.