ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 2, Issue 8, August 2014

"Analysis and comparison of Bit Error Rate variation with the change in number of antennas in a V-BLAST based MIMO system"

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Abstract: The number of users for applications based on broadband multimedia services like cellular phones, wi-fi, laptop, wireless networking, Bluetooth applications are growing very rapidly. This is the motivational cause for enhancing the tapping of frequency band. The MIMO antenna system can be used for efficient and faster communication. The Bit error rate is a parameter for judging that whether the communication held on transmission channel was appropriate or not. The reduced bit error rate with signal to noise ratio will be the demand of ideal communication system. Different technique are been utilized by communication system to retrive the information from received signal at receiver end. The V-BLAST is a technique developed in Bells labs USA, this technique can be use to design a comparative less complex system with increased efficiency. In this paper a novel information retrieving technology from a noisy phase shift keying modulated signal is discussed and analyzed. Here the effect of change in number of transmitter and receiver end antennas over BER of system is also been analyzed.

Keywords: MIMO, SIC, V-BLAST, ZF.

I. INTRODUCTION

The biggest disadvantage of wired network is that they are complicated and they are also not reconfigurable, mobility is less, if installation of a new wired network is required than it need new interconnections of end user devices, the cost of installation such network some time may be very high. For indoor application a wireless LANs can provide high-speed and cable-free access, thus adding a new node or computing device to an existing wire free local area network will be very easy and quick. In present era number of new portable devices like smart phones, computer notebooks, PDA's and WAP enabled cellular phones gave new hike to growth of wireless networks and associated industry.

The wireless networks are used to packetized digital audio/video signals and they also support high data traffic. The multimedia applications and large number of e-gazettes are communicating with each other in present scenario of business and smart home. With the growth in internet, and mobile users a large transactions of data, while calling from the cellular phones, may result in heavy burden on network.

The new 3G wireless LAN setup as comparison to previously used WLAN was able to provide the data rate up to 54 Mbps, can provide data rates of 2 with limited mobility. The wireless LAN work on the frequency bands whose license was not allocated to anyone. In a urban are many wireless LAN exists and they can be linked together to shape into a dense urban broadband wireless LAN, it will knockout many existing high and slower WANs.

To establish a high-speed wireless network, a extremely high data rate point to point link will require. For this purpose the MIMO system can play an important role in developing such networks. The MIMO system is comprises of multiple antennas placed on one or both end of communication system, a suitable algorithm is used at receiving end to detected the data transmitted from transmitting end, the multipath scattering should be exploited in any wireless channel, , as an alternative of its lessening as is done in conventional wireless systems based on FDM, TDM, and CDM.

An MIMO system can be defined as a system which transmits N signals with the help of N transmit antennas simultaneously on all antennas for this purpose all antennas are feed with same carrier frequency. On the receivers end M number of different antennas are used to receive these N independent transmitted signals.

Multipath scattering act as a source of diversity and it allows the parallel transmission of N independent signals from user. At the receiver end the N simultaneously transmitted signals are to be separated and for this purpose number of space division multiplexing and space time coding methodologies are developed [1-8]. The probability of error in received bit at the receivers end depends on the fading channel utilized between transmitter and receiver, signal to noise ratio, modulation technique used to modulate information signal at transmitter end and the algorithms utilized at receivers end for separating the information signal from the received noisy signal.

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In this present research Phase Shift Keying technique is used at transmitter to modulate data signal, the frequency of carrier signal used is 10^6 Hz taken, the V-Blast algorithism is used at receivers end to extract the information signal from received noisy signal.

II. PHASE SHIFT KEYING

Phase shift keying (PSK) is the process of superimposing the message over carrier signal in which the phase of a transmitted signal is varied according to the information signal. Several types are possible for phase shift keying, the binary phase shift keying (BPSK) is the simplest one. In BPSK modulation method the digital signal, whose information is coded in binary digits form can be imposed over carrier according to the phase of signal. Here 0^0 phase can be utilized to present one binary digit and 180^0 can be used to represent another one. In this method state of each bit can be decide according to the state of preceding bit, like if phase does not change than it concludes that past bit will continue and phase change will identify the change of information bit.

Multiphase shift keying is another sophisticated form of phase shift keying, in this method more than two phases are been utilized to superimpose the information bits over carrier frequency. The biggest benefit of this method is the optimized utilization of frequency band for transferring information between transmitter and receiver.

III. METHODOLOGY INVOLVED

A 1 MHz frequency signal is been engaged for modulation of data bits in proposed method. The phase shift keying modulation process is used for superimposing data bits over carrier wave and demodulating them at receivers end.

At the receivers end MMSE- SIC algorithms is been used for retrieving the message bits from received signal with maximum efficiently and minimum error rate. A comparative analysis between ZF and MMSE is also been done. The received signal at first antenna can be given by

$$R_1 = H_{11} \times T_1 + H_{12} \times T_2 + N_1 \quad .....(1)$$

Eq (1) in matrix form can be represented as

$$R_1 = [H_{11} \quad H_{12}] \begin{bmatrix} T_1 \\ T_2 \end{bmatrix} + N_1$$

and the received signal at second antenna can be given by

$$R_2 = H_{21} \times T_1 + H_{22} \times T_2 + N_2 \quad .....(2)$$

Eq (2) in matrix form can be represented as

$$R_2 = [H_{21} \quad H_{22}] \begin{bmatrix} T_1 \\ T_2 \end{bmatrix} + N_2$$

Where,

- R_1, and R_2 represent the received signals at first and second antennas of MIMO system.
- T_1 and T_2 are the transmitted signals from first and second antennas of MIMO system
- H_{ij} represents the channel from i^{th} tranmit antenna to j^{th} receiver antenna.

So the cumulative equation between two transmitter and receiver antennas can be given by

$$\begin{bmatrix} R_1 \\ R_2 \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \end{bmatrix} + \begin{bmatrix} N_1 \\ N_2 \end{bmatrix} \quad .....(3)$$

Equivalently,

$$\mathbf{R = HT + N} \quad .....(4)$$

In minimum mean square error method the value of a coefficient W is to be calculated using following relations

$$\mathbf{W = [H^H H + N_0 I]^{-1} x H^H} \quad .....(5)$$

Using MMSE methodology the value of symbol transmitted from transmitter end can be calculated at receivers end by using below given relation.

$$\begin{bmatrix} T_1 \\ T_2 \end{bmatrix} = W \begin{bmatrix} R_1 \\ R_2 \end{bmatrix} + \begin{bmatrix} N_1 \\ N_2 \end{bmatrix}$$

IV. ANALYSIS OF PROPOSED SYSTEM

The BER is analyze for a MIMO system with two transmitter and two receiver antenna over Rayleigh fading channel.

As shown in fig (1) minimum BER rate is achieved for ML and MMSE-SEC as comparison to ZF.

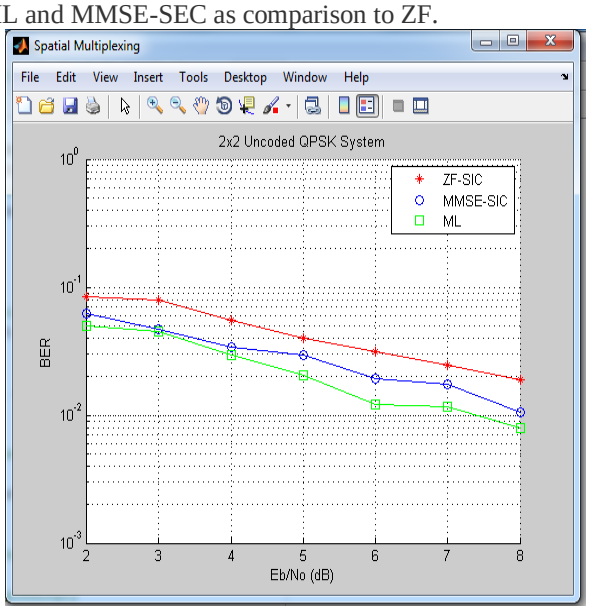

Fig (1) Analysis for 2X2 MIMO System

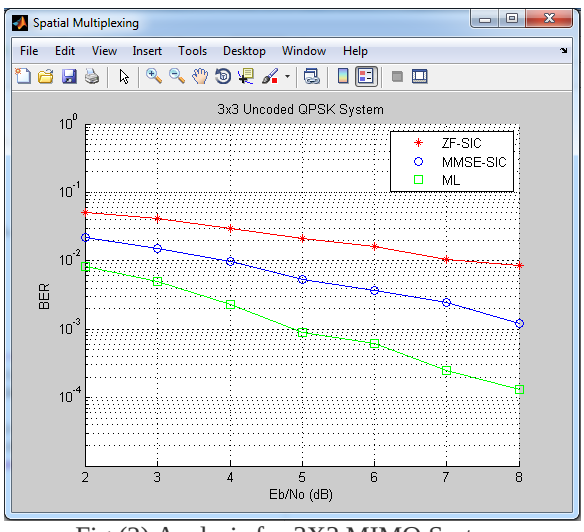

Fig (2) Analysis for 3X3 MIMO System

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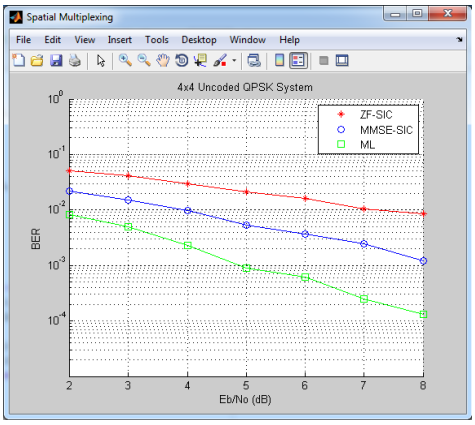

Fig (3) Analysis for 4X4 MIMO System

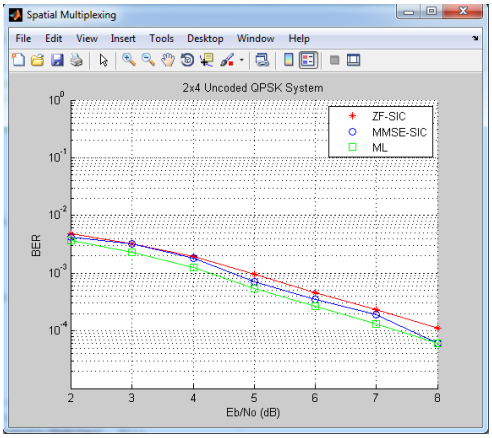

Fig (4) Analysis for 2X4 MIMO System

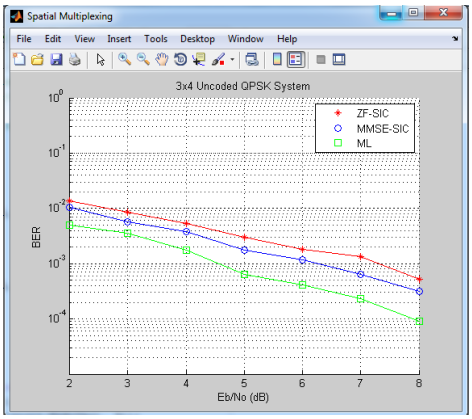

Fig (5) Analysis for 3X4 MIMO System

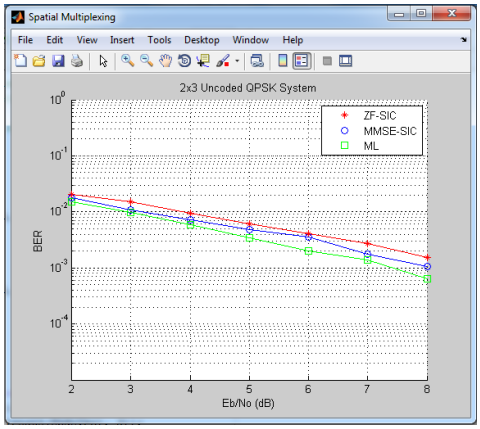

Fig (6) Analysis for 2x3 MIMO System

Table - 1

Algorithms Used	Tx X Rx	E_b / N_o	BER
ZF	2 X 2	4	6×10^{-1}
	3 X 3	4	8×10^{-1}
	4 X 4	4	9×10^{-1}
	2 X 4	4	10^{-3}
	3 X 4	4	8×10^{-2}
	2 X 3	4	5×10^{-2}
MMSE-SIC	2 X 2	4	8×10^{-1}
	3 X 3	4	6×10^{-2}
	4 X 4	4	8×10^{-2}
	2 X 4	4	3×10^{-2}
	3 X 4	4	9×10^{-2}
	2 X 3	4	7×10^{-2}
MMSE-ML	2 X 2	4	8×10^{-1}
	3 X 3	4	4×10^{-2}
	4 X 4	4	10^{-3}
	2 X 4	4	10^{-3}
	3 X 4	4	3×10^{-3}
	2 X 3	4	8×10^{-2}

V. CONCLUSION

From the analysis of results of simulation held for 2x2, 3x3, 4x4, 2 x 4, 3 x 4, and 2 x 3 transmitter and receiver antenna system it can be easily concluded that as the number of antennas are increasing in the system, it is leading to the betterment of the performance of the system. But the optimum improvement is achieved for the combination of 3 transmitter and 4 Receiver antenna system. It is clearly indicate that odd combination of transmitter and receiver antenna may lead to great improvement in BER to SNR.

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