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Error Rate Analysis of MIMO System Using V Blast Detection Technique in Fading Diversity Environment

Sudhanshu Kumar Chourasia, Prof. Rashmi Pandey
Department of Electronics & Communication Engineering Vedica Institute of Technology, Bhopal
Department of Electronics & Communication Engineering Vedica Institute of Technology, Bhopal

Abstract
Wireless communication system with multi- antenna arrays has been a field of intensive analysis on the last years. The appliance of multiple sending antennas and Receiving Antennas either side will considerably enhance the data rate and rate. The review of the performance limitations of MIMO system becomes vital since it will provide lot ideas in understanding and planning the important life MIMO systems. Vertical Bell Laboratories layered space Time (V-BLAST). The thought behind Multiple Input and Multiple Output system is that the signals on the transmitter antennas at one finish and also the receiver antennas at the opposite finish are correlative in such how that the performance (Bit Error Rate or BER) or the info rate (bits/sec) of the wireless communication system for every MIMO subscriber are improved. During this paper we tend to are proposing a technique that evaluates the performance of V-BLAST MIMO system in several thought of Rayleigh attenuation surroundings to urge higher performance of the system. In V- BLAST MIMO system a number of linear detection techniques will be used for interference cancellation. At this point we are using MMSE-IC for the same. Our expected system provide higher error rate performance with the used of matched filter at receiver aspect .The projected system compared within the presence of AWGN. Now matched filter applied on V-BLAST MIMO with MMSE-IC system in fading diversity surroundings.

Keywords: Bit Error Rate, Fading Diversity, Matched Filter, Multiple Input Multiple Outputs, MMSE-IC, V-BLAST, Symbol Error Rate, and Signal to Noise Ratio.

I. INTRODUCTION

Wireless communication system with multi-antenna arrays has been a field of intensive analysis on the last years. The use of multiple antennas at each the transmitter and therefore the receiver sides will drastically improve the channel capacity and rate [2]. The study of the performance limits of MIMO system [1] becomes vital since it will provide lot ideas in understanding and planning the practical MIMO systems. Vertical-Bell Laboratories layered space-time (V-BLAST) architecture and initial practical implementation of this design on MIMO wireless communications to demonstrate a high spectral potency. Multiple-input– multiple-output (MIMO) technologies are extensively explored and accepted mutually of the leading technology to support needs of the user in future generation. From the angle of the broad band communication state of affairs, the wireless communication technology ought to support a strong, reliable and extremely high speed communication link. Through the intensive analysis it has been extremely recognized that MIMO have the potential to extend the capability of the trendy wireless systems [3] [4] [5]. Wireless communication exploitation MIMO has recently emerged mutually of the foremost important technical breakthroughs in trendy engineering. MIMO systems establish associate degree arbitrary wireless communication a link that the transmission end in addition because the receiving end is provided with multiple antenna parts as illustrated in Fig. 1.

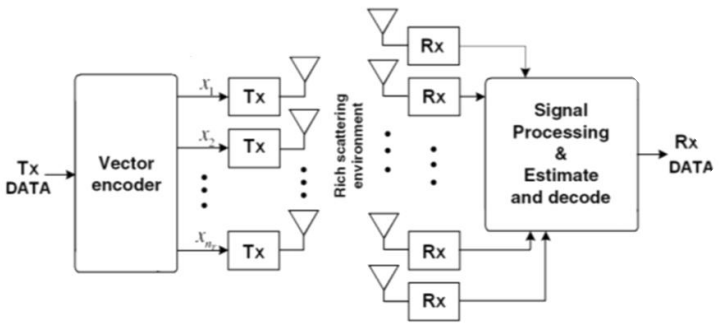

Fig. 1 V-Blast System Model

The idea behind MIMO is that the signals on the transmit (TX) antennas at one finish and therefore the receive (RX) antennas at the opposite end are "combined" in such the simplest way that the standard (Bit Error Rate or BER) or the data rate (bits/sec) of the communication for every MIMO user are going to be improved. Such an advantage are often accustomed increase each the network's quality of service and therefore the operator's revenues considerably. Final goals of the future generation wireless communication system are high data rate, high- performance and optimum utilization of the information measure. MIMO wireless systems facilitate to attain that goal. The realizable capability and performance rely on the channel conditions and on the structure of the transmit signal. So as to attain the goal the look MIMO system design influences the complexness of the transmitter and, notably the receiver. The MIMO committal to writing techniques are often split into three teams such as: space-time coding (STC), house division multiplexing (SDM) and beam forming. an oversized range of low complexness linear MIMO detectors are studied up to now, usually these linear detectors area unit supported minimum mean-square error (MMSE), supported zero- forcing (ZF) and QR Decomposition. However the performance of this detector are often poor, particularly in MIMO systems that use a less range of receiving antenna branches and adequate to transmission antennas. To enhance performance, a therefore known as vertical Bell laboratories stratified reference system (V-BLAST) formula has been introduced; this performs sequent interference cancellations within the applicable order. VBLAST system with sequent Interference Cancellation (SIC) detector helps to attain the high spectral potency with cheap decipherment complexness, in wealthy scattering environments through exploiting spacial dimension and additionally V-BLAST yields higher diversity gains and improves bit error-rate (BER) performance.

In Section II, the system model is represented. In Section III, describe the practicality of planned methodology MMSE-IC and Matched Filter in AWGN channel. In Section IV describe the detection formula employed in MIMO System. The simulation results and conclusion area unit provided in Section V and Section VI, correspondingly.

II. SYSTEM MODEL

A. V Blast Architecture

BLAST stands for Bell Laboratories layered space Time and V stands for Vertical that relates to the blocking structure. V-BLAST is a wireless communication technique that uses multi-element antennas at each transmitter and receiver. It is an additional unremarkably information measure economical approach for wireless networks. Its spectral potency ranges from 20 to 40 bps/Hz whereas potency of ancient wireless communication techniques ranges from 1 to 5 bps/Hz (mobile cellular) to around 10 to 12 bps/Hz (point to point fixed microwave system)[6]. For a V-BLAST system with N_t transmit antennas and N_r receive antennas ($Nr \geq Nt$), a single data stream is split in to N_t parallel sub- streams and each sub-stream is sent through a corresponding transmit antenna. The V-BLAST architecture is illustrated in Fig.2 the received vector with size n_{R1} is modeled by [7]. Multi-antenna (MIMO) systems attract vital attention throughout the previous few years because of an unprecedented high spectral potency they promise. A key a part of the system is that the receiver (Rx) signal process algorithmic rule. The primary planned algorithms were the Diagonal Bell laboratories layered space-time (D-BLAST) and V- BLAST [9-11].

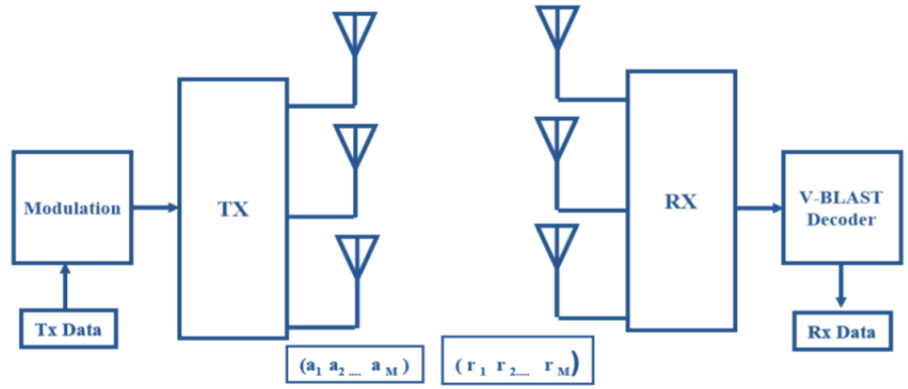

Fig. 2 V Blast Architecture

For convenience, the above equation can be represented in matrix notation as follows:
Equivalently,

$$r = H\,a + n$$

Where H represents the channel matrix with dimension $nR\ nT$ whose elementh_{ij}, represents the complex fading coefficient for the path from transmit j to receive antenna i. These loss coefficients are

modeled by a self-determining zero mean complex Gaussian random variable with variance 0.5 per dimension. A denotes the vector of transmitted symbols with dimension n_{T1}, n represents a complex vector of independent samples of AWGN over each received antenna with zero mean and variance σ_n^2 .

The Minimum Mean Square Error (MMSE) approach tries to find a coefficient W which minimizes the criterion,

$$E\{[W_{y-x}][W_{y-x}]^{\mathrm{H}}\}$$

Solving,

$$W = [H^H H + N_0 I]^{-1} H^H$$

When comparing to the equation in Zero Forcing equalizer, apart from the $N_0 I$ expression both the equations are comparable. Infect, when the noise expression is zero, the MMSE equalizer reduces to Zero Forcing equalizer.

B. Rayleigh Fading Model

The part of each path can change by 2π radian when the delay $\tau_n(t)$ changes by $1/f_c$. If f_c is large, relative little motions in the medium can reason change of 2π radians. Since the space between the devices are much better than the wavelength of the carrier frequency, it s practical to assume that the phase is uniformly distributed between 0 and 2π radians and the phases of every path are independent. When there is large number of paths, applying Central Limit Theorem, every path can be modeled as circularly symmetric complex Gaussian random variable through time as the variable. This model is well-known as Rayleigh fading channel model. A circularly symmetric complex Gaussian random variable is of the form,

$$Z = X + jY$$

Where real and imaginary parts are zero mean Independent and Identically Distributed (IID) Gaussian random variables. For a circularly symmetric complex random variable Z,

$$E[Z] = E\left[e^{j\theta} Z\right] = e^{j\theta} E[Z]$$

The information of a circularly symmetric complex Gaussian random variable is completely specified by the variance

$$\sigma^2 = E[Z^2]$$

The magnitude $|Z|$ which has a probability density,

$$p(z) = z/\sigma^2 \, e^{-z^2/2\sigma^2}, z \geq 0$$

is known a Rayleigh random variable.

This model, called Rayleigh fading channel model, is reasonable for an environment where there is large number of reflectors.

III. PROPOSED METHODOLOGY

V-BLAST (Vertical-Bell Laboratories layered Space- Time) is a detection algorithmic rule to the receipt of multi- antenna MIMO systems. Its principle is sort of easy, 1st it detects the foremost powerful signal (Highest SNR), then it regenerates the received signal from this user from offered call. Then, the signal regenerated is subtracted from the received signal and with this new sign; it payoff to the detection of the second user's most powerful signal, since it has already cleared the primary signal then forth. Techniques accustomed exploit the high-capacity nature of a MIMO system include stratified coordinate system architectures, particularly Diagonal Bell Laboratories stratified space-time (DBLAST) and Vertical Bell Laboratories layered space-time (V-BLAST). V-BLAST MMSE IC algorithmic rule is shown in fig. 3 by this diagram during which N no. of signals are transmitted through N no. of Transmitters. Information is acknowledged by N no. of receiver at the output side.

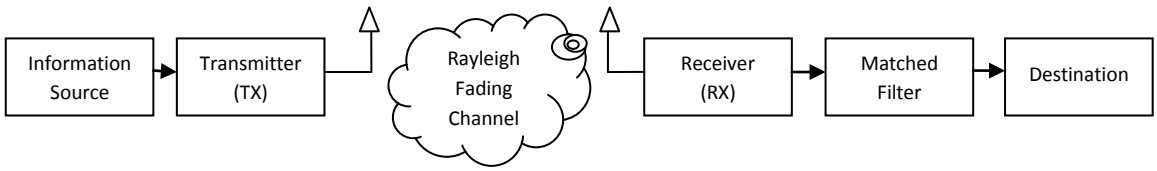

Fig. 3 Block Diagram of MIMO V Blast Model

This V-BLAST diagram shows a performance of system in Rayleigh fading environment by exploitation Matched Filter so BER and SER are diminished and system performance can increase as our system can proceed. So, this can give high system performance by Matched Filter in fading Diversity surroundings in MIMO configuration.

IV. DETECTION ALGORITHM

To decrypt the transmitted symbols of the primary layer, the receiver has to estimate the channel matrix exploitation pilots. During this simulation, the fading channel characteristics are assumed to be familiar perfectly at the receiver. The transmitter consists of a binary random creator, a QPSK baseband modulator and a vector encoder. The binary random producer generates the transmitted bits. These bits square measure modulated within the QPSK modulator exploitation the complicated envelope kind. It assumed that every image has a perfect rectangular pulse form and should be sampled with one purpose per image. The vector encoder maps the symbols to every antenna. Within the channel block, the transmitted symbols endure

Rayleigh fading and additive noise. Rayleigh fading channel coefficients are generated among two independent Gaussian random variables with unit variance. Fig.4 describes simulation diagram for V-BLAST theme.

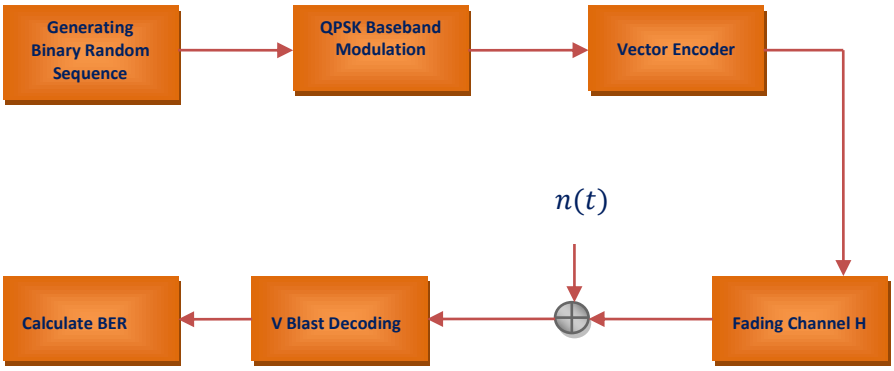

Fig 4: Simulation Process of V-BLAST

Steps for V-BLAST detection

1. *Ordering: choosing the most excellent channel.*
2. *Nulling: by ZF, MMSE, and ML.*
3. *Slicing: construction of a symbol decision*
4. *Canceling: subtracting the detected symbol*
5. *Iteration: going to the first step to detect the next symbol [8].*

V. SIMULATION RESULTS

In our Simulation result we have compared our projected methodology with three completely different surroundings that is relay fading environment, frequency selective relay fading environment & weakening diversity. All the Simulation performed on numerous configurations of transmitter & receiver as a result of it is a MIMO system. In V- Blast MIMO MMSE-IC system perform differently in several environments. Here we have thought-about relay fading surroundings for simulation & it is different type. The performance of projected system is best in weakening diversity however if we have a tendency to use matched filter in existing system. The performances additionally vary wherever we have a tendency to used completely different no of transmitter & receiver configuration. A procedure & execution of projected work on MATLAB simulation tool is described. In projected work the V-BLAST algorithmic program is employed for MIMO configuration for increasing the system performance MMSE-IC and modulation scheme 64-QAM. Within the diagram first off some environmental variables are initialized for simulation afterward value of SNR are tested up to 35 dB (SNR≤35dB) if SNR but 35dB then simulation method is reached to finish however if SNR larger than 30dB then within the next step SNR are inflated by 5dB. Once this no. of frames are tested (Frames≤ 4000 times). If frames are larger than set fundamental quantity then this goes back to previous stage (SNR≤35dB) and if frames are but set fundamental quantity then it goes to consequent stage their knowledge is generated so apply fading diversity with V-BLAST algorithmic program and Modulator with 64 QAM once this Noise (AWGN) is additional there after V-BLAST MMSE IC detects the signal with Matched filter and within the last the BER is calculated until 4000 times frame repetition.

Simulation Model

The Matlab writing performs the following

- Create random binary sequence of +1′s and -1′s.
- Grouping them into pair of two symbols and send two symbols in one time slot
- Multiply the symbols through the channel and after that additive white Gaussian noise.
- Match the received symbols
- Achieve hard decision decoding and count up the bit errors
- Repeat for multiple values of E_B/N_o and plot the simulation and theoretical results. Below Simulation result are performed on 5x5, 6x6, 7x7, 8x8, & 9x9.

In this fig 5.1 shown a performance comparison of V- BLAST MIMO MMSE-IC system in numerous attenuation environment for 5x5 transmitter & receiver configuration. in figure we have seen that a good performance of V- BLAST MMSE-IC system using matched filter by that bit error rate is reduced in system and & performance can increase that is shown by green characteristics in result and it provides BER $10^{-1.3}$ at 0 dB SNR, $10^{-3.8}$ at 30 dB SNR.

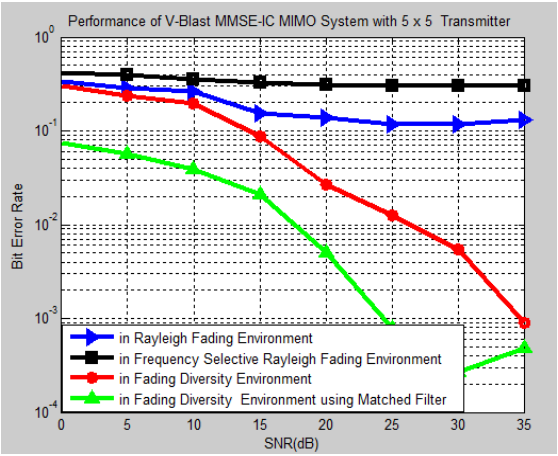

Fig 5.1: Performance Comparison of V-Blast MIMO MMSE IC System in Different Fading Environments for 5x5 Tx & Rx configuration

In this fig 5.2 shown a performance comparison of V- BLAST MIMO MMSE-IC system in numerous attenuation environment for 6x6 transmitter & receiver configuration. in figure we have seen that a good performance of V- BLAST MMSE-IC system using matched filter by that bit error rate is reduced in system and & performance can increase that is shown by green characteristics in result and it provides BER $10^{-1.2}$ at 0 dB SNR, 10^{-4} at 35 dB SNR.

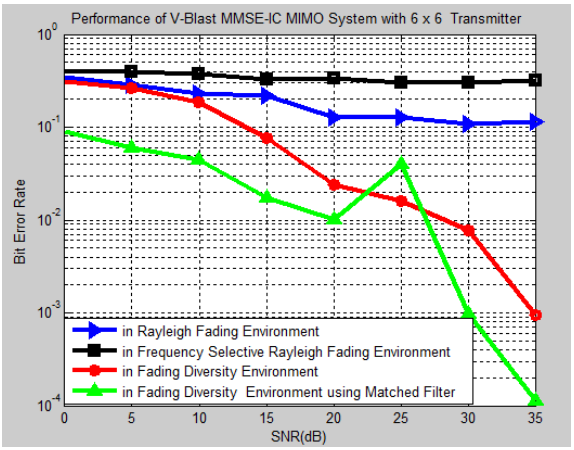

Fig 5.2: Performance Comparison of V-Blast MIMO MMSE IC System in Different Fading Environments for 6x6 Tx & Rx configuration

In this fig 5.3 shown a performance comparison of V- BLAST MIMO MMSE-IC system in numerous attenuation environment for 7x7 transmitter & receiver configuration. in figure we have seen that a good performance of V- BLAST MMSE-IC system using matched filter by that bit error rate is reduced in system and & performance can increase that is shown by green characteristics in result and it provides BER $10^{-1.2}$ at 0 dB SNR, $10^{-6.7}$ at 35 dB SNR.

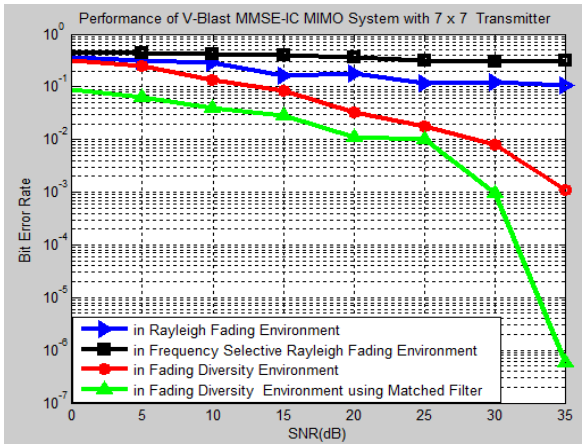

Fig 5.3: Performance Comparison of V-Blast MIMO MMSE IC System in Different Fading Environments for 7x7 Tx & Rx configuration

In this fig 5.4 shown a performance comparison of V- BLAST MIMO MMSE-IC system in numerous attenuation environment for 8x8 transmitter & receiver configuration. In
figure we have seen that a good performance of V- BLAST MMSE-IC system using matched filter by that bit error rate is reduced in system and & performance can increase that is shown by green characteristics in result and it provides BER $10^{-1.2}$ at 0 dB SNR, $10^{-3.9}$ at 30 dB SNR.

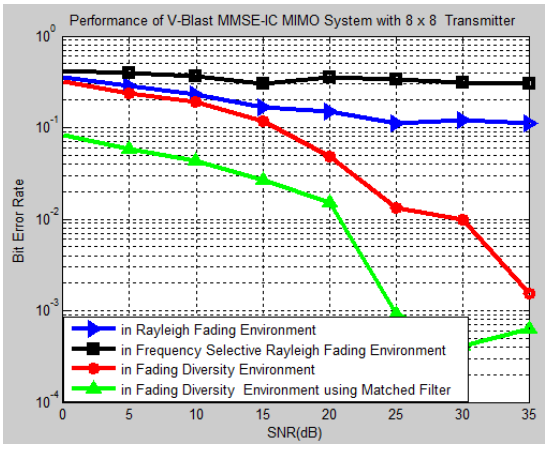

Fig 5.4: Performance Comparison of V-Blast MIMO MMSE IC System in Different Fading Environments for 8x8 Tx & Rx configuration

In this fig 5.5 shown a performance comparison of V- BLAST MIMO MMSE-IC system in numerous attenuation environment for 9x9 transmitter & receiver configuration. in figure we have seen that a good performance of V- BLAST MMSE-IC system using matched filter by that bit error rate is reduced in system and & performance can increase that is shown

by green characteristics in result and it provides BER $10^{-1.2}$ at 0 dB SNR, $10^{-3.9}$ at 30 dB SNR.

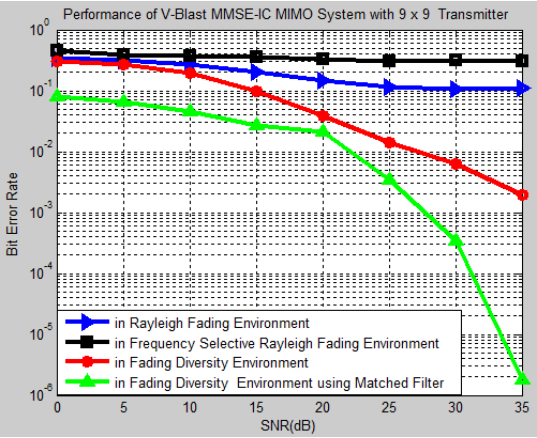

Fig 5.5: Performance Comparison of V-Blast MIMO MMSE IC System in Different Fading Environments for 9x9 Tx & Rx configuration

VI. CONCLUSION

In this paper, a new detection algorithm with MMSE- IC is planned for the V-BLAST System which may be achieved by the Matched Filter. Because it is shown within the simulation results and also the quality moreover as bit error rate and symbol error rate reduced by our approach in MIMO configuration. what is more we will attain totally different exchange between Relay fading environment, in frequency selective Relay fading atmosphere, in attenuation Diversity and fading diversity environment using Matched Filter. Based on bit error rate, we have a tendency to show the performance of those receiver schemes indicates that the detector based receiver with MMSE-IC combined with symbol cancellation and best ordering to boost the performance with lower quality and compare the machine quality of those schemes. The various modulation schemes positively facilitate in analyzing these detection algorithms.

VII. ACKNOWLEDGMENTS

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