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BER Performance Comparison of Various Modulation Schemes using MMSE on MIMO System over Various Fading Channel

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Abstract- In MIMO-OFDMA (multiple input multiple output-orthogonal frequency division multiplexing access) when signals are transmitted from the transmitter to receiver different types of error detection techniques are used for calculating the BER (bit error rate), which is an important factor in characterizing the data channel. Among various modulation schemes techniques, MMSE (minimum mean square error) is a versatile technique in which it is not necessary to calculate, explicit the posterior probability density function. In MMSE, we calculate the BER on previously known parameters and no need to assume random variables as a result among all estimators and the accuracy rate is higher. MMSE to reduce BER uses "MINIMUM MEAN SQUARE ALGORITHM" that is MMSE algorithm which is pre-owned to minimize the error and achieved the optimal performance at a cost of high computational complexities.

Keywords: MIMO-OFDM, MMSE, ML, ZF, BER.

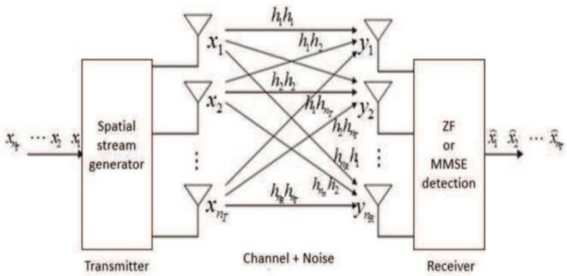
I. INTRODUCTION

In the present 4g network, when signals are transmitted from the transmitter to receiver different types of distortion take place. To overcome from these distortions we use different types of techniques, one of them is "MIMO". MIMO (multi-input and multi-output) as the name indicate it uses several transmitter and receivers in transmission. MIMO is used to minimize the error and amend the data speed whereas OFDMA in MIMO is used to improve the system spectral efficiency and minimize the problem of fading and inter-symbol interference. Hence, the combination of MIMO-OFDMA is in voguish. In MIMO-OFDMA different fading channels are used these are Rayleigh fading, RICIAN, and AWGN and these channels are implemented by using distinct equalization techniques i.e. ZF (zero forcing), MMSE (Minimum Mean Square Error), ML (Maximum Likelihood). Among these techniques MMSE techniques are more popular because of their ease of use and accuracy. MMSE detection technique calculates the noise power despite the Abandon of users. In this technique, we already know the previously values which helps us to estimate the parameters whereas in other techniques we have to randomly pick the values and then the comparison is to be performed where the probability of error is maximum. In other techniques, Parameter are assumed because we don't know about these parameters previously or if we know then we have to calculate the complex calculations like multidimensional integration done in Monte Carlo methods. MMSE detection techniques used an algorithm i.e. "MINIMUM MEAN SQUARE ALGORITHM" (where channel matrix is a known matrix as shown in equation (1) in system model) that is pre-owned to minimize the error. In this paper, section II shows the system model of MMSE and section III shows the table which contains a literature review and their compared analysis is shown in section IV. Section V contains the conclusion obtained by these papers.

II. SYSTEM MODEL

MIMO system model uses multiple transmitters and multiple receivers. In MIMO-OFDM technology, the radio signal is split into a large number of sub-channels to achieve greater spectral efficiency. As a result throughput and capacity of the system increases.

Here, the number of transmitting antennas is denoted by "x" and receiving antennas are denoted by "y" in fig. [a].



Figure[a]

For the system shown in figure (a) the received signal is:

$$Y=H_C X+N \qquad \text{.......... (1)}$$

Here, H_c in equation [1] denotes the channel matrix which is in the form of H_{ij} where "i" is the number of transmitted antenna and "j" is the number of received antenna. I.e.

$$H_c = \begin{bmatrix} h_{11} & h_{12} & \cdots & h_{1n_T} \\ h_{21} & h_{22} & \cdots & h_{2n_T} \\ \vdots & \vdots & \cdots & \vdots \\ h_{n_R1} & h_{n_R2} & \cdots & h_{n_Rn_T} \end{bmatrix}$$

Here, value of x is $[x_1, x_2, x_3 \ ..... \ x_{nT}]^T$; Y is $[y_1, y_2 \ ..... \ y_{nT}]^T$ and N denotes the Gaussian noise $[n1, n_2 \ ... \ n_{nT}]^T$. so, the channel matrix in equation [1] can be written as:

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_{n_R} \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & \cdots & h_{1n_T} \\ h_{21} & h_{22} & \cdots & h_{2n_T} \\ \vdots & \vdots & \cdots & \vdots \\ h_{n_R1} & h_{n_R2} & \cdots & h_{n_Rn_T} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_{n_T} \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_{n_R} \end{bmatrix}$$

III. LITERATURE SURVEY

IN MIMO-OFDM two techniques are used at transmitter and receiver side. Pre-coding in the transmitter side and post-coding on the receiver side. According to Purnima k. Sharma et al. [1] Pre coding is a technique that is accustomed to predict the channel condition at the transmitter side using the beam-forming techniques for achieving the transmission diversity. Pre coding techniques eliminate the deterioration fading effects and improve the performance of the system whereas the linear, as well as the non-linear codes, execute on the receiver ends.

Madalina-Georgiania Berceanu et al. [2] proposed that Non- linear techniques are versatile than linear decoding technique due to its BER performance like SIC (successive interference cancellation) when the number of antennas is fluctuated from 10 up to 50.

Shubhangi R. Chaudhary et al. [3] In this paper, the linear techniques are preferred in comparison to non-linear because of the intricacy on non – linear techniques.BER performance is compared using different equalization techniques and stimulations are carried using the Rayleigh frequency flat fading channel.

According to Zenitha Rehman et al. [4] STBC enhances the transmission energy and provides high reliability in which a major consideration is ALAMOUTI codes where the BER is reduced, without reducing the data. Brijesh Kumar Yadav et al. [5] this paper deals with STBC and V-BLAST. STBC is used for channel capacity maximization and diversity gain, to detect the suppression the interference in MIMO system V-BLAST (vertical – bell labs layered space-time) techniques are better than the conventional methods.

According to Supraja Eduru et al. [6] mainly two different fading channels are considered i.e. Rayleigh fading channel and RICIAN fading channel to broadcast the info over the air in a cellular network. Rayleigh fading is better for non- line of sight of communication, at the BER 10^{-3}, Minimum Mean Square Error provides about 10-15 dB channel gain when collating with the Zero Forcing.

Ambika Verma et al. In RICIAN the fountain codes [7] are better in broadcast and multicast purposes then convolution codes where the better quality of the system is desired in MIMO-OFDM.

In [8] Kamaljit Kaur Gill et al. NAKAGAMI – M faded channel matrix is produced by the gamma random variables. The wireless power antenna has distinctive frequencies which clarify the charge-less, investigation and examination is associated based on RF frequencies in terms of MIMO [9].

Lusekelo Kibona et al. [10] estimated the BER performance, closed-form expressions for SINR (signal interference noise ratio) are derived and different parameters are analyzed by the MONTO CARLO simulated using MATLAB under imperfect CSI(channel state information).

Table [1] literature review

AUTHOR	PAPER TITLE	MAJOR FINDINGS	RESEARCH METHODOLOGY	RESEARCH PROSPECTS
Brijesh Kumar et al	Analysis of efficient and low complexity MIMO-OFDM using STBC and V-BLAST	V-BLAST along with different techniques is surpassing	BER/SNR comparison is performed in forms of graphs with or without the using V-BLAST techniques	V-BLAST is elitist than STBC when BER and spectral efficiency considered
Shubangi R Chaudhary et al	BER performance analysis of MIMO-OFDM using different equalization techniques	BER is improved by various detection techniques	Different equalization techniques outputs are organized in terms of BER /SNR	ML equalizer technique performed very well with or without OFDM
Ambika Verma et al	Performance evaluation of fountain codes for MIMO-OFDM	Fountain coded MIMO-OFDM coding gain is conflicting with	Standard test images are considered in image processing and their quality is compared between	Where preference is high quality, fountain codes are satisfactory

	system over RIACIAN faded channel	convolution coded MIMO-OFDM system	fountain and convolution codes	
Himankashi Grover et al	Performance analysis of MMSE equalizer and time-frequency block code for MIMO-OFDM under single-RF system	For a better quality of STBC - OFDM along with MMSE elitist	A 2*2 antenna based single RF bit error rate compared using 4QMand 16QM	A 2*2 a single RF MIMO-OFDM is superior to 2*2 MIMO-OFDM
Madalina-Georgina Berceanu et al	The performance of uplink large scale MIMO system with MMSE-SIC detector	The base station antennas vary from 10-15 its BER and SNR are compared to achieve better performance	MMSE liner and MMSE-SIC outputs are compared for different SNR values and base station antennas using graphical method	When multiple users are close to the multiple antennas the MMSE-SIC works better than MMSE-linear
Suprja Eduru et al	BER analysis of massive MIMO System under correlated Rayleigh fading channel	For a 32*32 MIMO and BER of 10-3, the channel gain of MMSE is 10dB to 15dB in comparison to ZF	Different decomposition techniques are applied and the output of these methods are compared with BPSK using 8,16,32 MIMO systems	BER doesn't change by the decomposition techniques in MMSE detection
Kamaljit Kaur gill et al	Comparative analysis of ZF and MMSE detections for NAKAGAMI-M faded MIMO Channels	Using the gamma random variable (RVS) the NAKAGAMI –M channel matrix was originated	Different algorithms are taken from detection techniques and their results. I.e. E b / N0	ZF detection method has lower performance than MMSE detection technique i.e. a 4-branch receiver is better than 2 -branch receiver
Zenitha Rehman et al	BER performance comparison of MIMO system using OSTBC with ZF and ML decoding	ML detection techniques offer a better result than ZF when BPSK and QPSK are considered	BER vs. SNR Graphs are drawn for un-coded and coded STBC codes and MONTE CARLO stimulations are carried	Sphere decoding is obtained
Purnima k Sharma et al	Bit error rate analysis of pre coding technique in a different MIMO system	ZF is the simplest technique among all other techniques	Various comparison is done with pre- coding and compared to ZF, MMSE, BD and SIC Technique	SIC has better among different configurations

IV. COMPARED ANALYSIS

According to Ambika Verma et al. [7] fountain codes are considered as Rateless codes, which help the system to improve the performance. Result in Fig. [1] and fig. [2] Is obtained with the help of fountain codes when compared with the MIMO-OFDM system over a RICIAN faded channel. A 2×2 MIMO and 3×2 MIMO-OFDM fountain coded Configuration is compared with convolution coded MIMO-OFDM and analyzed that Fountain codes are better than convolution codes.

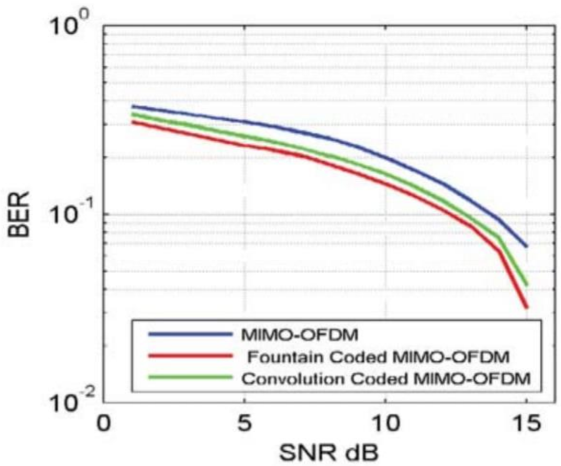
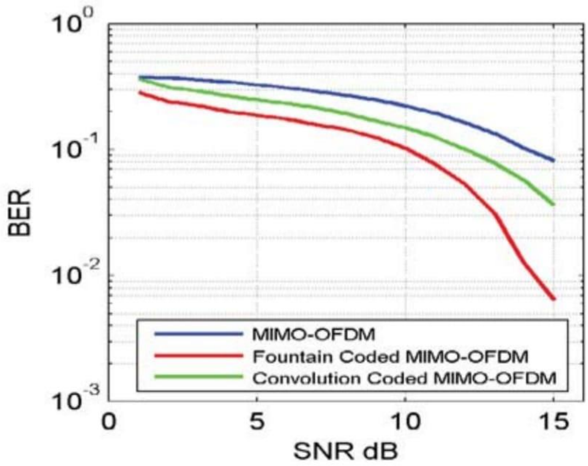


figure [1]



figure[2]

In figure [3] and figure [4] Zenitha Rehman et al.[4] Compared AWGN Channel for un-coded and coded STBC modulation using ML decoding and comparison for un-coded and coded STBC modulation scheme is obtained for flat fading channel using ML decoding are performed respectively.

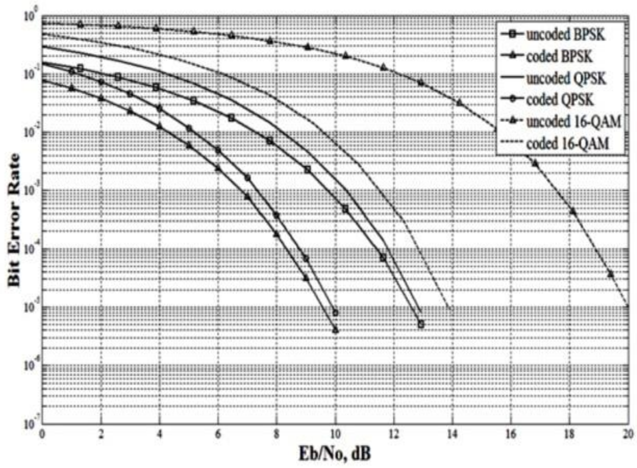


Figure [3]

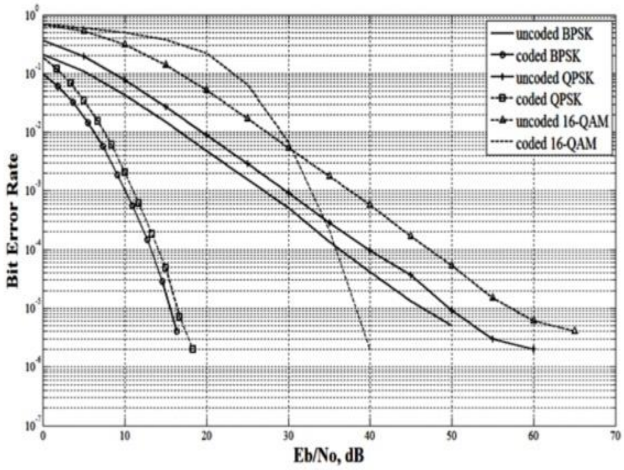


Figure [4]

Himankashi Grover et al. [9] concluded that STBC-OFDM based signal using (RF-using) antennas were Superior despite MIMO-OFDM as shown in Fig [5] and Fig [6]. Bit error rate using the MIMO-OFDM RF signal system and MIMO Convolution system for 4-Quadrature amplitude modulation (QAM) fig. [5] and 16QAM fig. [6] Respectively. Performance is compared for SIC –single RF 2×2 and conventional 2×2.

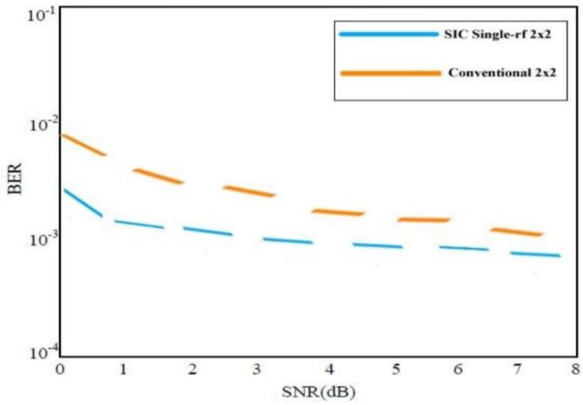


Figure [5]

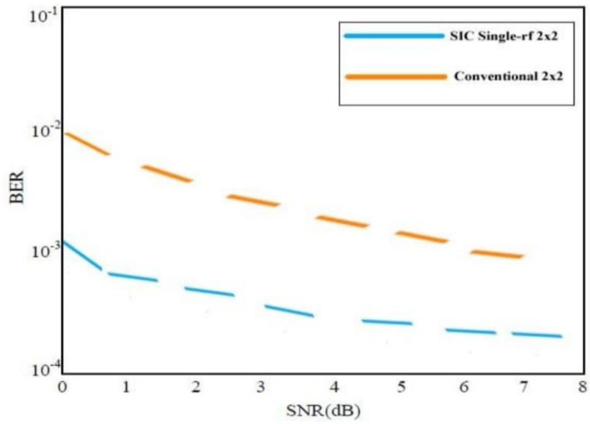


Figure [6]

Purnima K. Sharma et al [1] analyzed variation of BER with SNR for a 2×2, 3 ×3 and 4×4 MIMO system. Pre-coding techniques are used and their result is plotted in figure [7] and fig. [8] On which comparison of pre-coding techniques is performed along with different techniques.

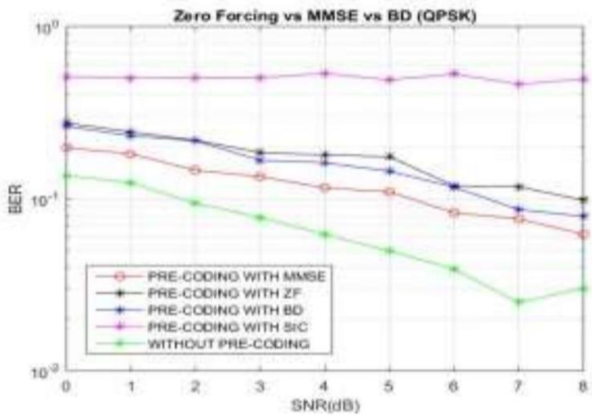


Figure [7]

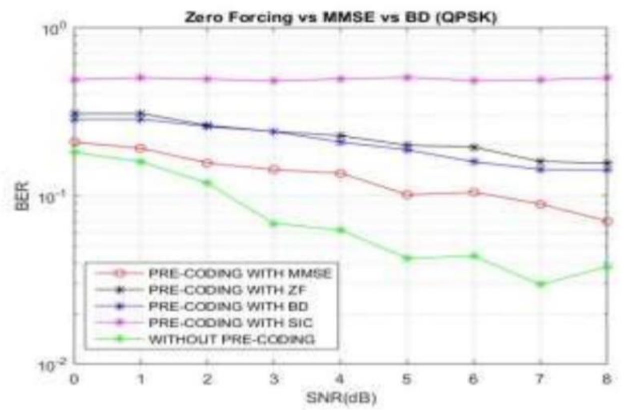


Figure [8]

According to Brijesh Kumar Yadav et al [5] error probability and Execution complexity of V-BLAST and STBC are the same the main difference is on spectral efficiency. The spectral efficiency of V-BLAST is higher than STBC. Comparison of BER with ZF, MMSE and ML with or without V-BLAST is compared and results are shown in fig. [9] and fig. [10].

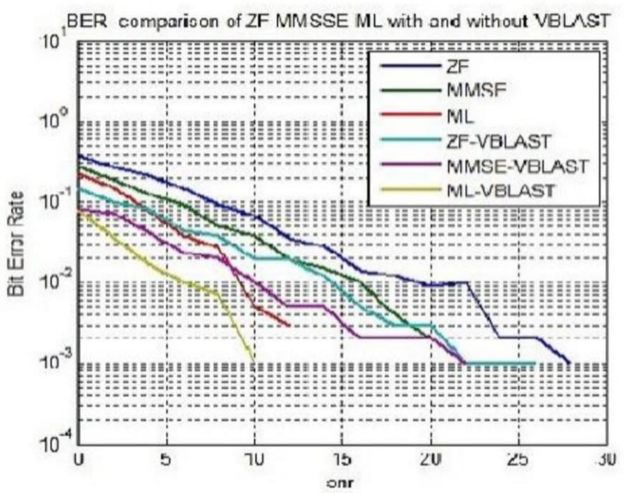


Figure [9]

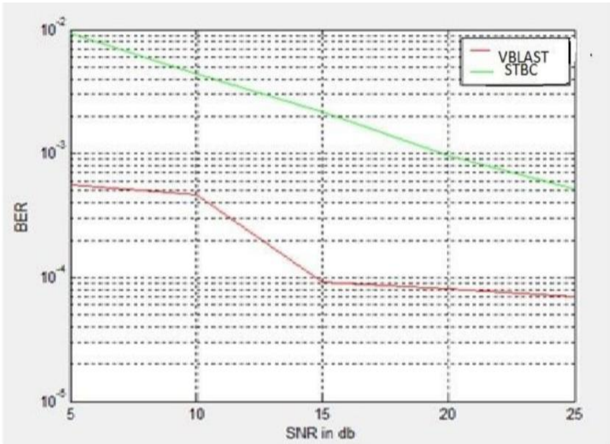


Figure [10]

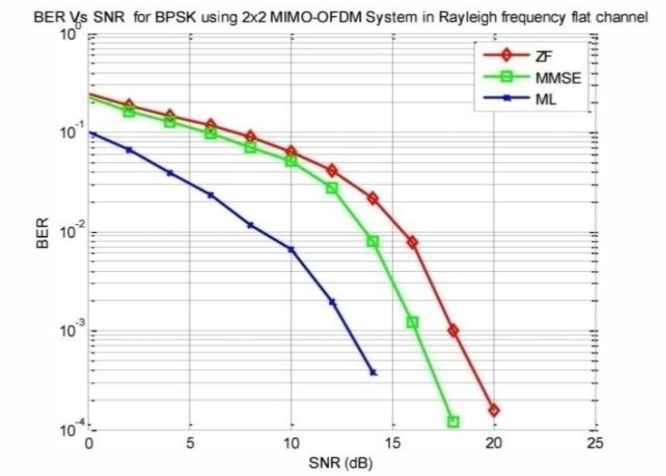


Figure [11]

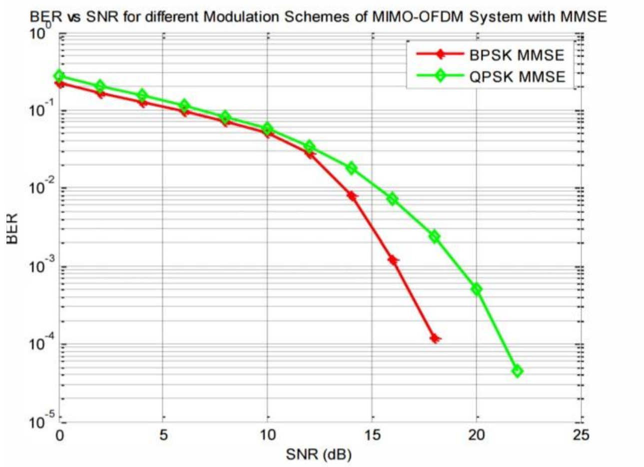


Figure [12]

Shubhangi R. Chaudhary et al [3] compared BER with Signal to noise ratio to different modulation strategies for MIMO-OFDM along with Minimum mean square error fig. [12] and Rayleigh frequency flat channel fig. [11] With and without OFDM. In comparison a gain of 4 dB and 5 dB using different techniques are observed at BER of 10^{-3}.

According to Lusekelo kibona et al. [10] BER against SNR in figure [14] when the number of antennas i.e. “M” is increased then it effects positively the quality of the signal. Where increase the value of “e” (estimation error) it affects negatively shown in fig. [13].So, to surpass the system execution a number of antennas is increased and estimation error is kept constant.

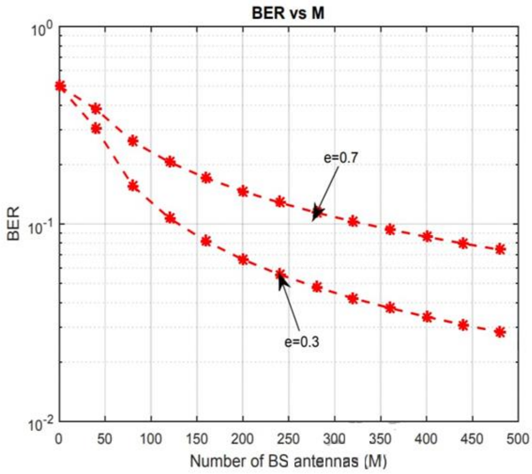


Figure [13]

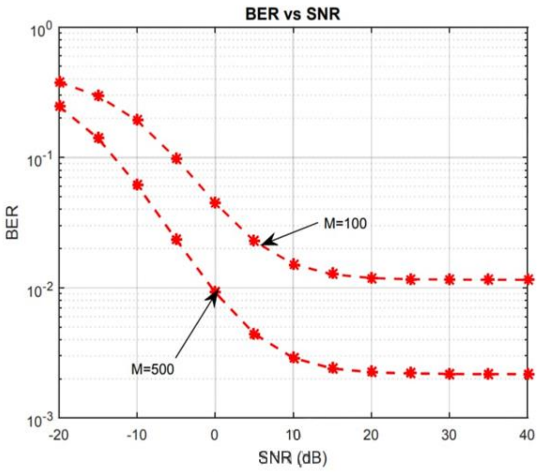


Figure [14]

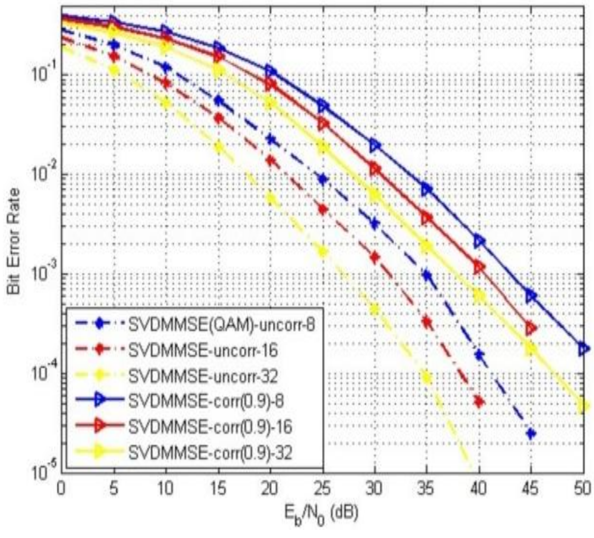


Figure [15]

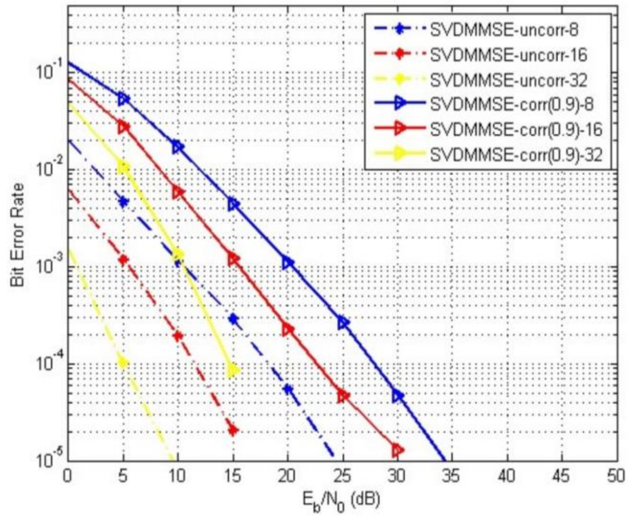


Figure [16]

Supraja Eduru et al. [6] observed that, at a target of 10^{-4}, channel gain of 5db is obtained by MMSE and for BPSK 2.5db when order of MIMO system is doubled and the order varies from 8 to 32 as shown in figure [16] and fig. [15].

According to Madalina –Georgiana Berceanu et al. [2] in figure [17] MMSE "linear and SIC" detector detects the various values of "K" with various base station antennas and concluded that performance is only better when several users closest to the base station. In the graph, k represents the maximum active users in which 25 to 50 base station antennas are considered and their effects are plotted.

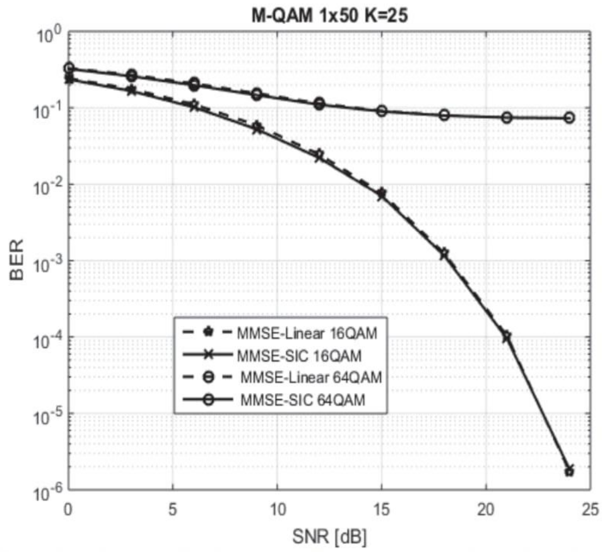


Figure [17]

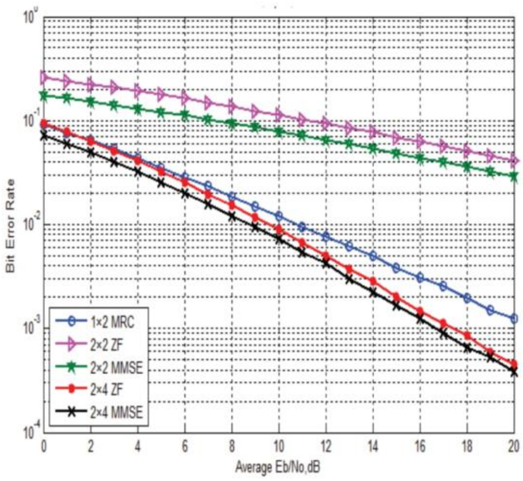


Figure [18]

Kamaljit Kaur gill et al. [8] plotted the graph for BER Performance of MIMO system using different detection techniques i.e. MRC, MMSE and ZF using BPSK. Improvement in the performance is observed when a 2×2 SM-MIMO system using ZF and MMSE is compared to the SIMO-MRC.

V. CONCLUSION

This paper analyzes the performance of MMSE with other techniques and compared them based on their results obtained. The Performance of ML is founded lower than the MMSE and it is concluded that the performance performed by MMSE was better than other techniques. MMSE is not an intricate technology; MMSE is a very versatile and easy technique that is used to minimize the bit error rate. The Calculation performed in ML was complex in comparison to MMSE. It is used to calculate noise power despite the abandonment of users.

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