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Computation of System Performance of MIMO Technique in Communication Channel using V-BLAST Method.

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Abstract*: In order to improvement both system performances and data rate Multiple Input Multiple Output techniques play an important role in transmission system. A number of techniques are used to do the needful work for performance improvement in MIMO systems belongs to different block codes, apart from that BLAST architecture are used Such as Diagonal Bell laboratories layered space-time (D-BLAST), Vertical Bell Labs Space-Time Architecture (V-BLAST) method. This work defines the performance improvement using V-BLAST technique in Multiple Input Multiple Output detector. Here we discuss the concept of Multiple Input Multiple Output with BLAST architecture. Depends upon the Bit Error Rate and Frame Error Rate, the comparison is made with the existing methods.

Keywords: STBC, STTC MIMO, D-BLAST, V-BLAST, ZF, MMSE and SIC.

I. INTRODUCTION

During the last few years Multi Input Multi Output techniques were used to improve the system performance as well as to increase the system efficiency. In each and every signal processing algorithm the receiver side is highly essential for signal reception. In the literature survey D-BLAST algorithms were used [1]. Due to certain limitations of this existing method, this paper proposed the Vertical Bell Labs Space-Time Architecture. The major drawback of Diagonal Bell laboratories layered space-time is used to acquire entire Multi Input Multi Output channel capacity also provides the complex architecture .To overcome this mentioned limitation this paper uses Vertical Bell Labs Space-Time Architecture. This V-BLAST provides simpler in architecture and acquire a portion of Multi Input Multi Output channel capacity. Vertical-Bell Laboratories Layered Space- Time method basically uses MIMO antenna .The advantages of using this MIMO antenna is that it identify the signal which has high Signal to Noise ratio, after that by available on decision of the device the signal is received in the receiver side. Then, the regenerated signal is subtracted from the received signal, it exceeds identify the other signal which is needed to the second receiver [2]. Because of this the interference between the signals is reduced [3]. Apart from that the Vertical Bell Labs Space-Time Architecture method provides the process of encoding the vectors by following the method of demultiplexion, depending upon bit-to-symbol mapping. In this technique No inter-sub stream coding is required. Vertical-Bell Laboratories Layered Space- Time method uses a joint detection of both new and old techniques in order to separate the signal by using Shannon capacity [4]. In order to determine the symbols present in multiple antenna systems, calculate the channel coefficient. While detecting the channel coefficient assumed that there is no estimation error in the channel matrix. But practically due to presence of the channel estimation error the performance of the signal is degraded

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II. ARCHITECTURES DESCRIPTION

A. Diagonal Bell laboratories layered space-time Techniques:

Fig. 1 shows the model of Diagonal Bell laboratories layered space-time method, which is analyzed by the two blocks such as 1.Encoder 2.Decoder.The detail description of this method can be explained below.

The Encoder*:* In D-BLAST method the process of encoding is done by using space time arrangement. Here the elements are arranged using diagonally. In this encoding section, whatever the bit stream are transmitted by source, at first the given data is demultiplexed in to different sub bit stream i.e the data is converted to serial nature to parallel nature. Now each sub bit stream is coded and converted to complex symbols [5]. These complex symbols are used as a diagonally across the antenna after which the complex symbol present in layers are ready for transmission by using 4 transmit antenna. Care should be taken that the each layer consist of the symbol is greater than that of the number of antenna used.

The Decoder*:* This is the reverse process of encoding. The prime function of decoder is that first find the symbol bit without error then decode one by one. After decoding one layer by other the next symbol of the preceded layer is identified which face 1 may interfere if the process is continuing the number of interfere are increased by increasing the number of layer [6]. Make sure that all data bit of first layer is demodulated then the data stream is decoded which is error free.

In the decoder section this technique does not reach the maximum capacity limit because the space time wastage is necessary, and also there is a wastage of symbol in each layer while the data are to be transmitted. Because of this reason this method is no longer exist.

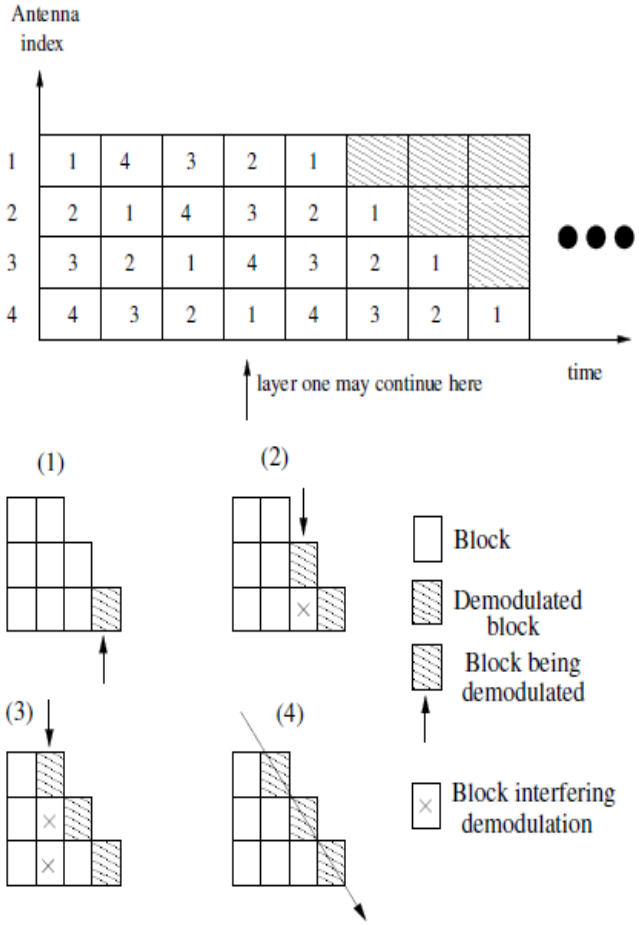

Fig. 1

B. Vertical Bell Labs Space-Time Architecture:

This method is used to reduce the complexity [3] of the previous method (D-BLAST). This method is also consisting of both Encoder and Decoder section.

Encoder*:* In encoder section each bit stream is combined and transferred through an antenna .The output of input antenna array is a vector. $[S_{1k}.s_{2k} \ldots\ldots S_{NKT}]^T$ where s_{ik} shows the k^{th} symbol of the i^{th} stream.

Decoder*:* The prime function of decoder is for the purpose of demodulation of the concern symbol. Due to the method of channel coding, buffering is used for transmission of all data unit. For this method number of decoders is used. Here this paper uses the Maximum Likehood Decoder for decoding purpose. This decoder is used for calculation of the vector.

$$\hat{\mathbf{s}} = \underset{\mathbf{s}}{\operatorname{argmin}} \left\| y - \sqrt{\frac{E_s}{N_T}}\mathbf{H}\mathbf{s} \right\|_F^2 \quad (1)$$

In order to reduce the complexity the linear detectors are used one of the most prominent linear detector is ML detector apart from that some other linear detector are also used such as Zero forcing detector and MMSE detector. The linear detectors are used slicing techniques for calculation of post processed vector and is defined by:

$$\mathbf{G}_{zf} = \sqrt{\frac{N_T}{E_s}}\mathbf{H}^{\dagger} \quad (2)$$

Where Hermitian transpose is H and † denotes Moore-Penrose pseudo inverse.

$$\mathbf{G}_{mmse} = \sqrt{\frac{N_T}{E_s}}\left(\mathbf{H}^H\mathbf{H} + \frac{N_T}{\rho}\mathbf{I}_{N_T}\right)^{-1}\mathbf{H}^H \quad (3)$$

In MIMO system for improvement of data rate and capacity both T_x and R_X antenna are used.

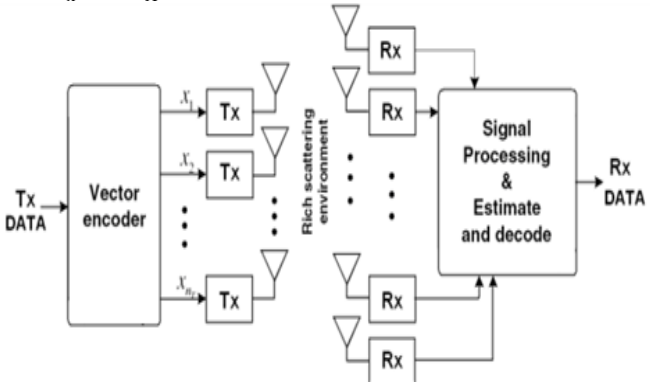

Fig 2. Vertical Bell Labs Space-Time Architecture

In order to increase the Bit Error Rate by following the proper method of analysis the end to end antennas are used. This paper strictly follow the effect of fading in terms of probability error and Bit error Rate For achieving the quality of transmission system in this paper we propose Vertical Bell Labs Space-Time Architecture with Multi input Multi output system .As this techniques gives low functionality and high spectral efficiency as compared to D-Blast system [5], Vertical Bell Labs Space-Time Architecture is mostly used.

III. MODELING THE SYSTEM

The name itself represent Multi Input and Multi Output system, it consist of many transmitter and receiver here we consider Rayleigh channel. The received signal is represented as

$$r = HX + n \quad (4)$$

Now $r = [y1, y2\ y3, yr,]$ (5)

$$\dot{H} = \begin{bmatrix} h_{11} & h_{12} & \cdots & h_{1Nt} \\ h_{21} & h_{22} & \ldots & h_{2Nt} \\ \vdots & \vdots & \ddots & \vdots \\ h_{Nr1} & h_{Nr2} & \ldots & h_{NrNt} \end{bmatrix}$$

Where the impulse response of the channel is H transmitted signal

$$X = [x_{1,2}\ x_{Nt}]^T \quad (6)$$

And

noise $= [n_1, n_2\ n_{Nr}]^T$ (7)

V-BLAST Detection Methods:

Vertical Bell Labs Space-Time Architecture is used for both linear as well as non linear purpose. Such as for nulling method linear techniques are use and for symbol cancellation non linear methods are used. As the MIMO system consist of multiple antenna, the data rate is increased by transmitting different information by different antenna.

Procedure for Vertical Bell Labs Space-Time Architecture detection

1. Select the right path for Ordering.
2. using Zero Forcing, Maximum Mean Square Error, and Maximum Likehood for Nulling
3. Use symbol decision for Slicing
4. Differentiating the detected symbol for Canceling
5. Go to first step to detection of the next symbol [4] for Iteration.

The procession of detection two following steps:

1. Nulling: In this method After that, normal detection of the first symbol is performed The suppression operation nulls out interference by projecting the received vector onto the null subspace of the subspace spanned by the interfering signals..
2. Differentiation: The contribution of the detected symbol is subtracted from the received vector.

IV. ZERO FORCING

In Vertical Bell Labs Space-Time Architecture zero forcing method is simplest detection scheme because it can recompensate the outcome of the channel. Another advantages of this method is that it can working in high Signal to Noise Ratio [7]. The following criteria must satisfies the zero forcing method i.e.

$$Y_{ZF} = (H^T \mathrm{H})^{-1} H^T \qquad (8)$$

Fig.3 shows the simulation of traditional zero forcing with Vertical Bell Labs Space-Time Architecture zero forcing method and also represent that ZF with Vertical Bell Labs Space-Time Architecture method perform better than traditional zero forcing in case of Bit Error Rate.

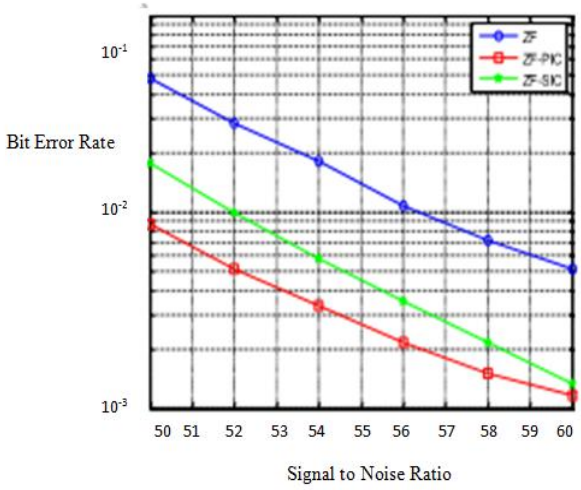

Fig 3. Bit Error Rate of Vertical Bell Labs Space-Time Architecture 2×2 Antenna

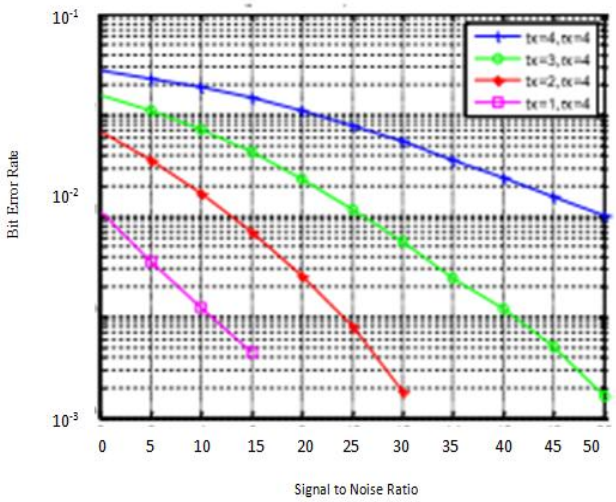

Fig 4. V-BLAST ZF detector fixed receiving Antenna

Minimum Mean Square Error: In case of zero forcing method it only eliminates the noise. But in Minimum mean square method it can eliminate both intrusion as well noise. Hence this method is superior then zero forcing method. So the equation related this method is expressed as

$$Y_{MMSE} = (H^T \mathrm{H} + 1/\mathrm{SNR})^{-1} H^T \qquad (9)$$

Successive interference cancellation: Basically this method is used to reduce the interference of the successive symbols. The following steps are used for calculating the ZF SIC concerned to sub optimal algorithm.

a. Make decision for the favorable method of to identify the transmitter with least error.

b. Take the most deterministic signal to cancel the nulling effect known as Interference Cancellation

c. Select the most useful transmitting signal to the adjacent group for onward transmission

d. Interference Cancellation: To decrease the difficulty by Subtracting the input of the identified representation from the residual arriving signal vector and go back to the step [a].

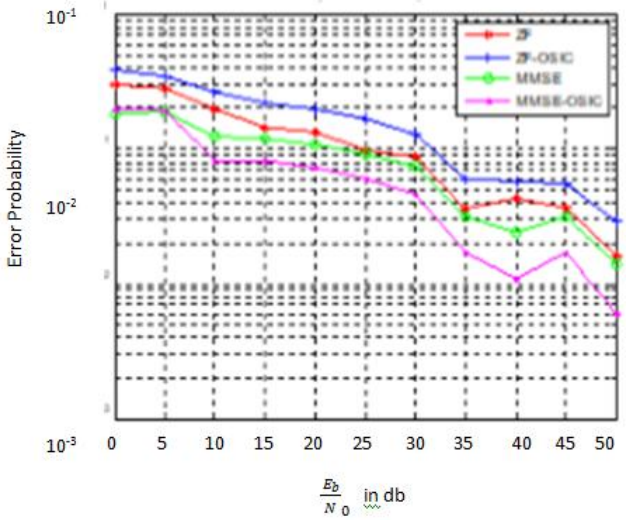

Fig 5. Probability of error using different techniques.

Maximum Likelihood: Due to some drawback of zero forcing, minimum mean square method this technique is used in this paper .The most advantages of this method is that it can be only applicable to non linear channels**.** In order to locate the least distance by using this method the incoming signal is multiplied by channel matrix H [8]. The approximate transmitted signal vector X can be found using ML detection method as

$$X_{ML} = a[|Y - HX|F]^2 \qquad (10)$$

The Frobenius norm is F.

Q-R decomposition: For solving matrix inversion method this technique is used and is calculated as $H = [R] * [Q]$.

The simulation results of fig. 7 shows Bit Error Rate vs Signal To Noise Ratio using Q-R detection method.The main purpose of this method is to reduce the computational complexity. The symbol size 4N× (M-1) are used for departure symbols with its channel matrix H can be replaced with N × M .If the symbol size is N< M-1 this decomposition method is invalid.

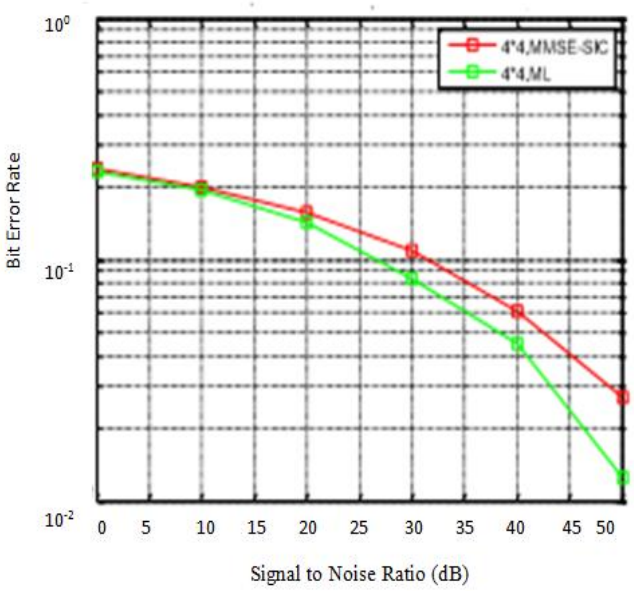

Fig 6. Bit Error Rate of using Maximum like hood detection.

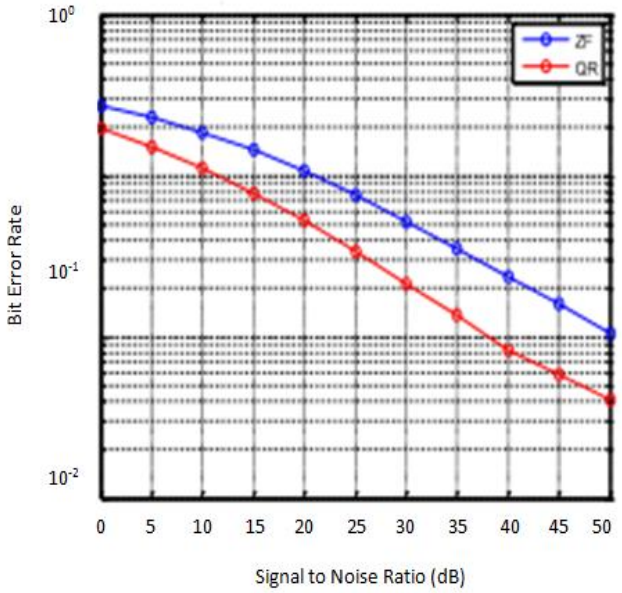

Fig 7. Bit Error Rate using Q-R decomposition method.

V. CONCLUSION

Various equalization schemes are analysed in this paper such as Zero Forcing,Minimum Mean square and maximum Likehood equalizer with different number os antenna with Vertical Bell Labs Space-Time Architecture. The simulation results shows Maximum Like hood Equalizer outperform better than others. Again we found that due to certain drawback of ML we use Q-R decomposition method. From the simulation results we found that this technique is better than all other technique in any noisy condition as well as this method is also applicable in nonlinear channel. Apart from that QR decomposition method gives significantly reduced arithmetic complexities.

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