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MIMO Performance Analysis with ALAMOUTI STBC Code and V-Blast Detection Scheme

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***Abstract:** An analysis of the performance of Multiple Input Multiple Output (MIMO) antenna systems has been carried out by determining the transmit diversity using Alamouti Space Time Block Coding (STBC) techniques. In this paper our purpose is that, peformance analysis of Alamouti STBC and also comparing with SISO performance. It includes definition of SISO system,STBC, after that Alamouti STBC theory and its mathematical expressions. Also we define process of project and lastly we give our results for each of SISO, 2x1 and 2x2 Alamouti STBC. This paper also includes study of VBLAST technique, many algorithms have been proposed to reduce the interference in the received signals caused by other transmitters in the system. Also, they aim achieve closer values to the Shannon capacity limit. D-BLAST (Diagonal Bell Labs Layered Space Time) and V-BLAST (Vertical Bell Labs Layered Space Time) are such schemes used for detection and suppression the interference in MIMO systems.*

***Index Terms:** MIMO, SISO, STBC, VBLAST.*

I. INTRODUCTION

A. *Space-Time Block Coding*

One of the methodologies for exploiting the capacity in MIMO system consists of using the additional diversity of MIMO systems, namely spatial diversity, to combat channel fading. This can be achieved by transmitting several replicas of the same information through each antenna. By doing this, the probability of losing the information decreases exponentially [1]. The antennas in a MIMO system are used for supporting a transmission of a SISO system since the targeted rate of is that of a SISO system.

II. SYSTEM MODEL

MIMO systems are composed of three main elements, namely the transmitter (TX), the channel (H), and the receiver (RX). In this paper, Nt is denoted as the number of antenna elements at the transmitter, and Nr is denoted as the number of elements at the receiver. Figure 1 depicts such MIMO system block diagram. It is worth noting that system is described in terms of the channel. For example, the Multiple-Inputs are located at the output of the TX (the input to the channel), and similarly, the Multiple-Outputs are located at the input of the RX (the output of the channel).[3]

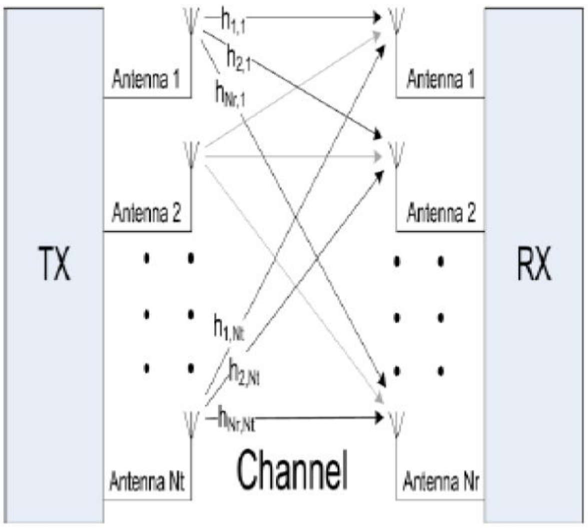

Figure 1. Multiple-input Multiple-output System Block Diagram

The channel with Nr outputs and Nt inputs is denoted as a Nr X Nt matrix:

$$H = \begin{pmatrix} h_{1,1} & h_{1,2} & \cdots & h_{1,N_t} \\ h_{2,1} & h_{2,2} & \cdots & h_{2,N_t} \\ \vdots & \vdots & \ddots & \vdots \\ h_{N_r,1} & h_{N_r,2} & \cdots & h_{N_r,N_t} \end{pmatrix}$$

III. SINGLE INPUT SINGLE OUTPUT (SISO)

It is a traditional model in wireless system which uses one antenna at transmitter and one antenna at receiver. Its overall performance largely dependent on channel behavior and environment .It is used in radio and TV broadcast and our personal wireless technologies such us wi-fi and Bluetooth

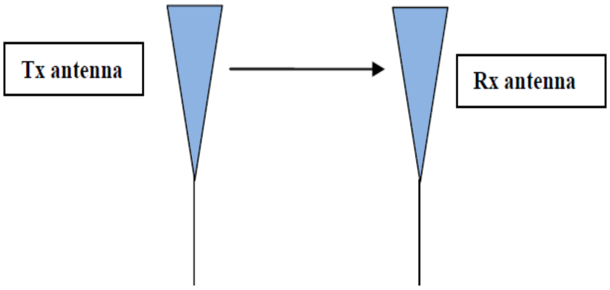

Figure 2: SISO MODEL

It can be represented by $\vec{r} = H\vec{s} + \vec{n}$ defined above

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IV. ALAMOUTI‟S STBC

In Alamouti published his technique on transmit diversity. Historically, Alamouti‟s scheme was the first STBC .The simplicity and structure of the Alamouti STBC has placed the scheme in both the W-CDMA and CDMA-2000 standards. The Alamouti STBC scheme uses two transmit antennas and Nr receive antennas and can accomplish a maximum diversity order of 2Nr . Moreover, the Alamouti scheme has full rate (i.e. a rate of 1) since it transmits 2 symbols every 2 time intervals. Next, a description of the Alamouti scheme is provided for both 1 and 2 receive antennas, followed by a general expression for the decoding mechanism for the case of Nr receive antennas.[2][3]

V. V-BLAST THEORY

V-Blast is a single user scheme which has multiple transmitters. It divides the data stream into substreams and transmits them through multiple transmitters at the same time and frequency. The transmission is described as follows. A data stream is demultiplexed into M sub-streams termed layers and transmits them through multiple transmitters at the same time and frequency. This results in receiving the data at the receiver at the same time and frequency. By implementing V-BLAST algorithm, the diversity gain is increased and the bit error rate (BER) performance is improved. The MIMO system is assumed to undergoes flat fading channel. The system model of the output signal is given by:

$$y = Hx + \eta$$

VI. RESULTS AND DISCUSSIONS

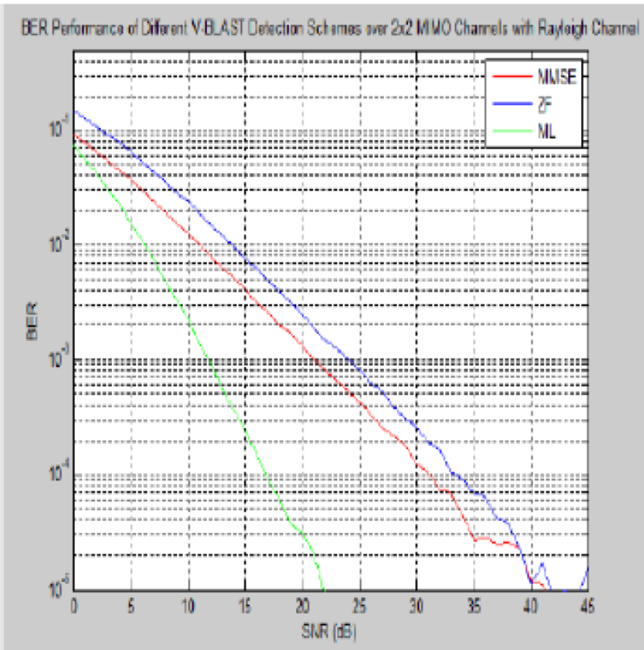

Figure 3: BER Performance of Different V-blast Detection Scheme over 2X2 MIMO Channels with Rayleigh.

At a BER of 10-4, the SNRs of ML, MMSE and ZF are 16 dB, 31 dB and 33 dB respectively. We see a huge improvement in using ML detection over MMSE and ZF detections by 15 dB. The performance of MMSE detection is better than ZF detection by 2- 3 dB. From the above results, it has been observed that the ML detection has better BER performance than the MMSE and ZF detections by 15dB. In Addition, the performance of MMSE detection is better than ZF detection by 2- 3 dB. Finally, by using the adaptive scalar recursion for fast fading, the complexity order reduces to square and the computation becomes less compared to other techniques.

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