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Space Time Block Coding For Orthogonal Designs Coding And Receiving Techniques

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ABSTRACT: The STBC will improve the performance which is degraded by increase in data rate. Our work will shows the probability of error decreases with the increase of SNR. The coding gain measures the distance between the descending probability of error curve from the ordinate axis and is an indication of how high the SNR is before the probability of error curve starts to fall. Our work shows that orthogonal code performs better than the Alamouti code. Simulation results show that full transmission rate is more important at very low SNR values and high BERs, whereas full diversity is the right choice for high SNR values and low BERs. Our work done on diversity analysis of multiple-input multiple-output (MIMO) space-time block codes using various receiving techniques in a Rayleigh fading channel, Performance analysis of different space-time block codes using M-ary phase shift keying (PSK) in a Rayleigh fading channel and Performance analysis of joint transmit and receive antenna selection in a STBC coded MIMO system by comparing sphere decoder technique with zero-forcing (ZF), minimum mean square error (MMSE) and maximum likelihood (ML) techniquesThe performance of the proposed OSTBC over frequency-selective fading channels we compare with other existing methods for MIMO-OFDM systems.

Keywords : stbc,;nino;,ml,;berm;snr

1 INTRODUCTION

In a MIMO system, Multi-Element Antenna (MEA) structures are used at both the transmitter and receiver side. Multiple antennas allow MIMO systems to perform precoding (multilayer beam forming), diversity coding (space-time coding) & spatial multiplexing. Many space-time block codes for different number of transmit and receive antennas have been developed in order to achieve maximum diversity. The MIMO system have many advantages over conventional antenna system. Use of multiple antenna system will increase data transmission rate of the system by increasing number of transmission data copies over the independent fading paths from each transmitter antenna to each receiver antenna. The improvement of transmission data rate and system performance in a MIMO system can be achieved by efficient STBC designs. The STBC will improve the performance which is degraded by increase in data rate. Our work will shows the probability of error decreases with the increase of SNR. The coding gain measures the distance between the descendingprobability of error curve from the ordinate axis and is an indication of how high the SNR is before the probability of error curve starts to fall. Omong the many STBC scheme the orthogonal STBC can provide maximum diversity using linear processing ML detector and provide simple linear optimal decoding. A STBCis denoted by L X M matrix which every element represents the the transmitted symbol of antenna uuring each time slot. The each column of matrix represents the transmission symbols of a particular antenna for all L time slots, and each row of matrix represents the transmitted symbols in one time slot for all NIt transmitter antennas. But for the number of the transmitter antennas greater than two, no orthogonal STBC can achieve full data rate. To improve on the low transmission rate, Jafarkhani, Tirkkonen-BoariuHottinen and Papadias-Foschini proposed STBC with quasi-orthogonal designs. Space-time block coding (STBC) has been proved to be a powerful diversity technique to combat channel fading in wireless communication. Space-time coding is performed in both spatial and temporal domain introducing redundancy between signals transmitted from various antennas at various time periods. The complexity of signal processing at the transmitter side is very low. The receiver has to regain the transmitted symbols from the mixed received symbols. Several receiver strategies can be applied which can be Maximum Likelihood (ML) Receiver, Zero Forcing (ZF) receivers and Minimum Mean Square Error (MMSE) receivers etc

1. Maximum Likelihood (ML) Receiver:

ML achieves the (maximum diversity and lowest bit error ratio (BER), but needs the most complex detection algorithm. The ML receiver calculates all possible noiseless receive signals by transforming all possible transmit signals by the known MIMO channel transfer matrix. Then it searches for that signal calculated in advance, which minimizes the Euclidean distance to the actually received signal. The undisturbed transmit signal that leads to this minimum distance is considered as the most likely transmit signal.

2. Linear Receivers:

Zero Forcing (ZF) receivers and Minimum Mean Square Error (MMSE) receivers belong to the group of linear receivers. The ZF receiver completely nulls out the influence of the interference signals coming from other transmit antennas and detects every data stream separately.

3. Alamouti's Scheme:

Alamouti shows two branch transmit diversity scheme with one receive antenna. The setup shows one transmitter and two or more receive antennas. During the period t1 , the symbols s1 and s2 , which represent constellation points from any modulation scheme, are sent simultaneously from transmit antennas Tx1 and Tx2 , respectively. Period t2 , Tx1 transmits s*2 − and 2 Tx transmits s*1 , where (·)* represent the complex conjugate.

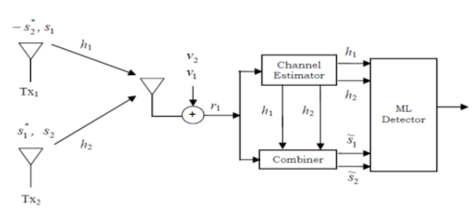

Fig 1 Alamouti's two-branch transmit diversity scheme with one receiver.

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This simple orthogonal code can be represented in matrix form as

$$\mathbf{G}_2 = \begin{matrix} t_1 \\ t_2 \end{matrix} \left\{ \overbrace{\begin{bmatrix} s_1 & s_2 \\ -s_2^* & s_1^* \end{bmatrix}}^{\mathrm{Tx}_1 \quad \mathrm{Tx}_2} \right.$$

where the columns represent transmit antennas and the rows represent time.

4. $$\left(s_1, -s_2^*\right)\cdot\left(s_2, s_1^*\right)^* = s_1 s_2^{\ *} + \left(-s_2^*\right)\left(s_1\right) = 0$$

Let h1(t) and h2(t) represent the path from Tx1 and Tx2 to the receiver, respectively. Assuming that channel fading is quasi-static, that is constant across two consecutive symbol transmissions, we have

$$h_1(t) = h_1(t+T) = h_1 = \alpha_1 e^{j\theta_1}$$

$$h_2(t) = h_2(t+T) = h_2 = \alpha_2 e^{j\theta_2} ,$$

where T is the symbol period. The corresponding received signals are

$$r_1 = r(t) = h_1 s_1 + h_2 s_2 + v_1$$

$$r_2 = r(t+T) = -h_1 s_2^* + h_2 s_1^* + v_2 ,$$

5. Graphical Analysis:

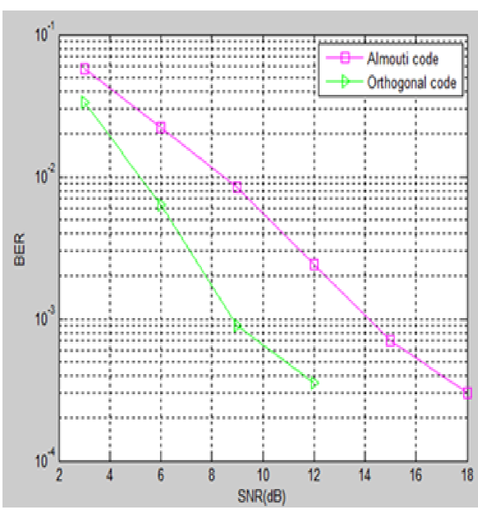

Fig. 2 BER plot for Alamouti code Vs Orthogonal code

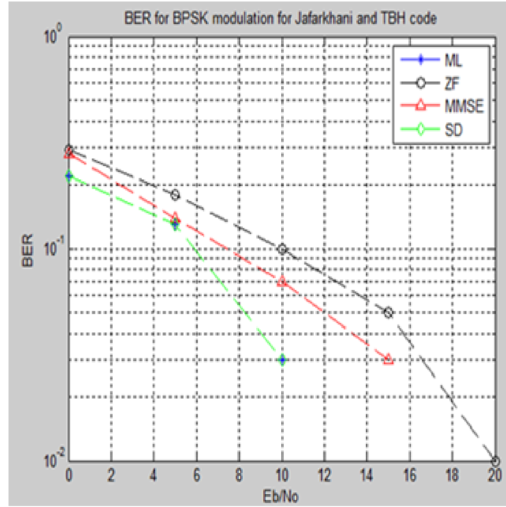

Fig 3 Comparison between different receiving techniques (Maximum Likelihood, Zero Forcing, Minimum Mean Square and Sphere Decoder)

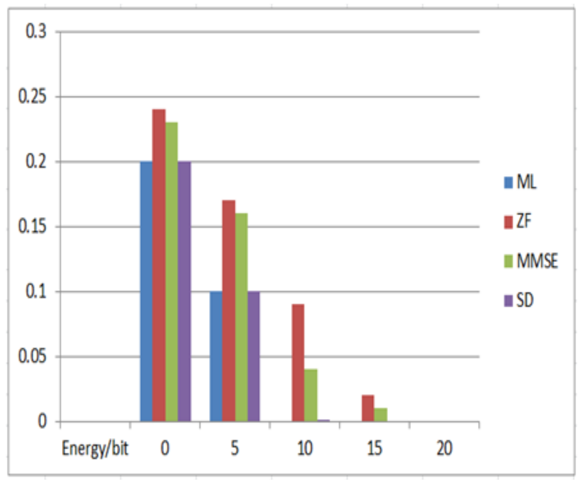

Figure 2 and Graph 1 shows the bit error rate performance of Alamouti code and the orthogonal code. It is seen in the graph that orthogonal code performs better than the Alamouti code. Simulation results show that full transmission rate is more important at very low SNR values and high BERs, whereas full diversity is the right choice for high SNR values and low BERs. This is due to the fact that the slope of the performance curve at high SNR is determined by the diversity order. The analysis is done on the basis of SNR vs BER graph for a Rayleigh fading channel. Using PSK modulation and orthogonal codes at the transmitting end, in order to reduce the effective bit error rate in MIMO system from 10^{-1} to 10^{-4} may require only 3-12 dB SNR. Achieving the same in the Alamouti code may require up to 18 dB. Simulation results show that full transmission rate is more important at very low SNR values and high BERs, whereas full diversity is the right choice for high SNR values and low BERs. This is due to the fact that the slope of the performance curve at high SNR is determined by the diversity order.

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Conclusion:

We apply an ML receiver as well as a ZF receiver and compare our simulation results with MMSE and SD. Graph shows that the bit error rate reduces to zero when energy per bit equals 10 in case of maximum likelihood receiver which is not in the case of zero-forcing and minimum mean square error receivers.

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