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BER Analysis of MIMO-STBC Using Various Coding Techniques

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***Abstract*: The performance of space–time block codes, which provide a better way for transmission over AWGN channels using multiple transmit antennas. It has been shown that a orthogonal design that provides full diversity and full transmission rate for a space–time block code is not possible for more than two antennas. The objective of this paper is to provide the description of different type of space time block codes and to provide the Comparative performance analysis with different schemes. According to the analysis of existing, transmission matrices of space-time block codes (STBC), we generalize some of their characters and derive new patterns.**

***Keywords*: MIMO systems, diversity, bit error rate, linear receivers, OSTBC, Q-OSTBC.**

I. INTRODUCTION

There has been a dramatic increase in the demand for higher data rates. One of the most significant and promising advances in wireless communications that can meet the demand for higher data rate is the use of multiple antennas at the transmitter and receiver. Deploying multiple antennas at the transmitter and receiver creates a multiple-input multiple-output (MIMO) channel that not only offers higher transmission rates, but it can also decreases error rates that improve the system reliability and robustness to noise compared to single antenna systems. In addition to this, multiple antennas can also be utilized in order to mitigate co-channel interference. A major problem in the wireless channel is that out-of-phase reception of multipath causes deep attenuation in the received signal, known as multipath fading. The distortion induced by the time-varying fading is caused by the superposition of delayed, reflected, scattered and diffracted signal components from different objects in the environment, before it reaches the receiver antenna. At the receiver due to multipath fading, the receiver cannot correctly detect the transmitted signal unless some less attenuated replica of the signal is provided to the receiver. This technique is called diversity. A practical, effective and, hence, a widely applied technique for reducing the effect of multipath fading in wireless systems is antenna diversity.

Space Time Coding: The term Space-Time Code (STC) was originally coined in 1998 by Tarokh et al. to describe a new two-dimensional way of encoding and decoding signals transmitted over wireless fading channels using multiple transmit antennas [2]. STC make use of both the space (different antennas) and the time domain while encoding and decoding information symbols. It uses multiple transmit antennas and (optionally) multiple receive antennas to provide high data rates and reliable communications over fading channels, this concept combines coding, modulation and spatial diversity into a two-dimensional coded modulation technique. Examples of space-time coding include space-time trellis codes, space-time block codes. Space-time trellis codes provide full diversity and coding gain at the cost of a complex receiver. Space-time block codes provide full diversity and simple decoding, but no coding gain.

Objective of the paper: The objective of this paper is to provide the basics of space time block codes and propose a new scheme. This paper is organized as follows. In Section I, we present general introduction. In Section II, we present the different type of space time block codes and their property. In section III, We give the simulation result and performance comparison of different space time block codes with different schemes. In Section IV, Some conclusions are presented.

II. TYPES OF SPACE TIME BLOCK

Types of Space Time Block Codes:

First I explained ALAMOUTI code which are full rate and full diversity code.

ALAMOUTI Code: Historically, the ALAMOUTI code is the first STBC that provides full diversity at full data rate for two transmit antennas [3]. The information bits are first modulated using an Marry modulation scheme. The encoder takes the block of two modulated symbols S1 and S2 in each encoding operation and hands it to the transmit antennas according to the code matrix.

$$S = \begin{bmatrix} s_1 & s_2 \\ -s_2^* & s_1^* \end{bmatrix}$$

(5) The first row represents the first transmission period and the second row the second transmission period. During the first transmission, the symbols S1 and S2 are transmitted simultaneously from antenna one and antenna two respectively. In the second transmission period, the symbol -S2* is transmitted from antenna one and the symbol S1* from transmit antenna two. It is clear that the encoding is performed in both time (two transmission intervals) and space domain (across two transmit antennas). The two rows and columns of S are orthogonal to each other and the code matrix is orthogonal.

Orthogonal Space Time Block Code: The theory of orthogonal designs is an arcane branch of mathematics which was studied by several great number theorists including Radon and Hurwitz. Radon determined the set of dimensions for which an orthogonal design exists [4]. Radon's results are only concerned with real square orthogonal designs. The results of orthogonal design by Radon is extended by Tarokh [5] to both non square and complex orthogonal designs and introduce a theory of generalized orthogonal designs. Using this theory, they construct space–time block codes for any number of transmit antennas.

Quasi-Orthogonal Space Time Block Code: The main characteristic of the codes designed in [5] is the orthogonality property of the codes. The codes are designed using orthogonal designs which are transmission matrices with orthogonal columns. It is shown how simple decoding which can separately recover transmit symbols, is possible using an orthogonal design. In Quasi orthogonal space time block code (JAFARKHANI code) [6], The structures that are not orthogonal designs and, therefore, at the decoder, cannot separate all transmitted symbols from each other. Instead, in Quasi OSTBC structure, the transmission matrix columns are divided into groups. While the columns within each group are not orthogonal to each other, different groups are orthogonal to each other. We call such a structure a quasi-orthogonal design. It is shown that using a quasi-orthogonal design, pairs of transmitted symbols can be decoded separately. The application of such a structure is in designing codes which provide higher transmission rates while sacrificing the full diversity.

JAFARKHANI [6] gave a quasi orthogonal STBC form for four transmit antennas as

$$C_{j} = \begin{bmatrix} x_1 & x_2 & x_3 & x_4 \\ -x_2^* & x_1^* & -x_4^* & x_3^* \\ -x_3^* & -x_4^* & x_1^* & x_2^* \\ x_4 & -x_3 & -x_2 & x_1 \end{bmatrix}$$

Further, different from JAFARKHANI scheme a new scheme **TBH [**7] gave the same a quasi orthogonal STBC form for four transmit antennas with a unitary pattern idea introduced in [8]

$$C_{t} = \begin{bmatrix} x_1 & x_2 & x_3 & x_4 \\ -x_2^* & x_1^* & -x_4^* & x_3^* \\ x_3 & x_4 & x_1 & x_2 \\ -x_4^* & x_3^* & -x_2^* & x_1^* \end{bmatrix}$$

to investigate the distribution of conjugates in the transmission matrices, we find that it is related to the positions of correlated values. By changing the distribution of conjugates, we can obtain matrices with different positions of correlated values.

JAFARKHANI Case with TBH Correlated Position We change the conjugates' distribution of JAFARKHANI matrix, and let

$$c_{JT}^{H} = \begin{bmatrix} x_1 & x_2 & x_3 & x_4 \\ -x_2^* & x_1^* & -x_4^* & x_3^* \\ x_4 & -x_3 & -x_2 & x_1 \\ -x_3^* & -x_4^* & x_1^* & x_2^* \end{bmatrix}$$

TBH case with JAFARKHANI-Similar to the above modification, we exchange the last row and the third row from eqn. (7) and let

$$c_{TJ}^{H} = \begin{bmatrix} x_1 & x_2 & x_3 & x_4 \\ x_2^* & -x_1^* & x_4^* & -x_3^* \\ x_4^* & -x_3^* & x_2^* & -x_1^* \\ x_3 & x_4 & x_1 & x_2 \end{bmatrix}$$

Proposed Code We proposed a new space time block code matrix whose performance is better than other space time block codes. This space time block code isorthogonal in nature. We use MMSE technique for the analysis of this code. Channel is assumed to be AWGN channel. The matrix of the proposed code is given

$$C_P = \begin{bmatrix} X_1 & -X_2 & -X_3 & -X_4 & X_1^* & -X_2^* & -X_3^* & -X_4^* \\ X_2 & X_1 & X_4 & -X_3 & X_2^* & X_1^* & X_4^* & -X_3^* \\ X_3 & -X_4 & X_1 & X_2 & X_3^* & -X_4^* & X_1^* & X_2^* \end{bmatrix}$$

III. SIMULATION RESULT AND PERFORMANCE COMPARISION

In simulation result, first we give the comparison of different space time block codes. Proposed work better than all the space time block codes explained in this paper. The codes are compared under the different modulation schemes like 4PSK, 16 PSK, 64PSK. We see that the proposed code has better performance than other codes under different modulation schemes. Linear receiver techniques like MMSE are used in simulation model. Channel is assumed to be AWGN channel.

FIG 1: BER performance comparisons of different STBC under 4PSK scheme

FIG 2: BER performance comparisons of different STBC under 16PSK scheme

FIG 3: BER performance comparisons of different STBC under 64PSK scheme

IV. RESULTS & DISCUSSION

Comparative BER analysis for 4 PSK

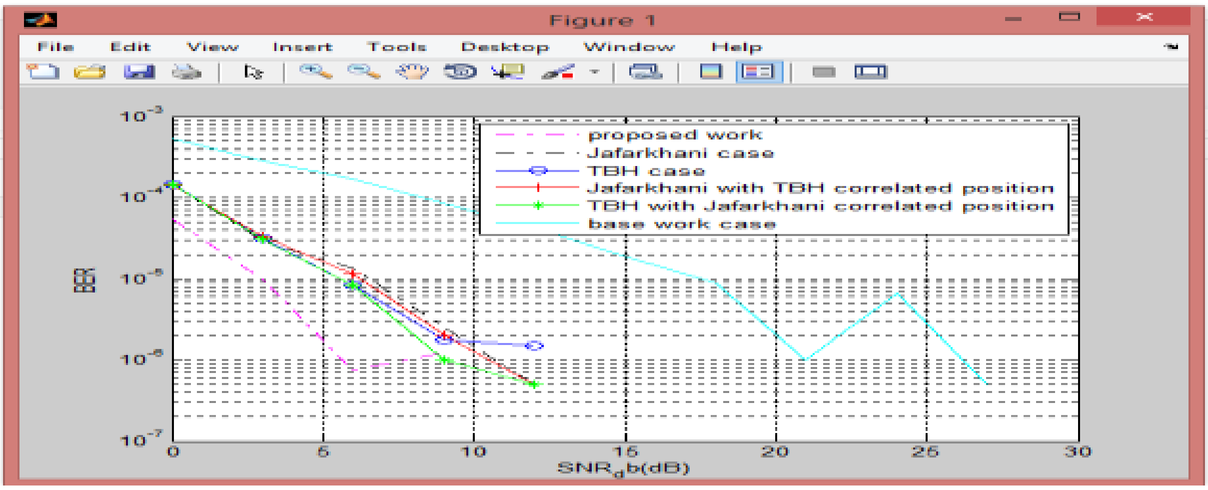

Fig. 1

The above Fig 1Proposed model bit error rate is less than all other; the simulation is for 4 PSK modulation techniques.

Comparative BER analysis for 16 PSK

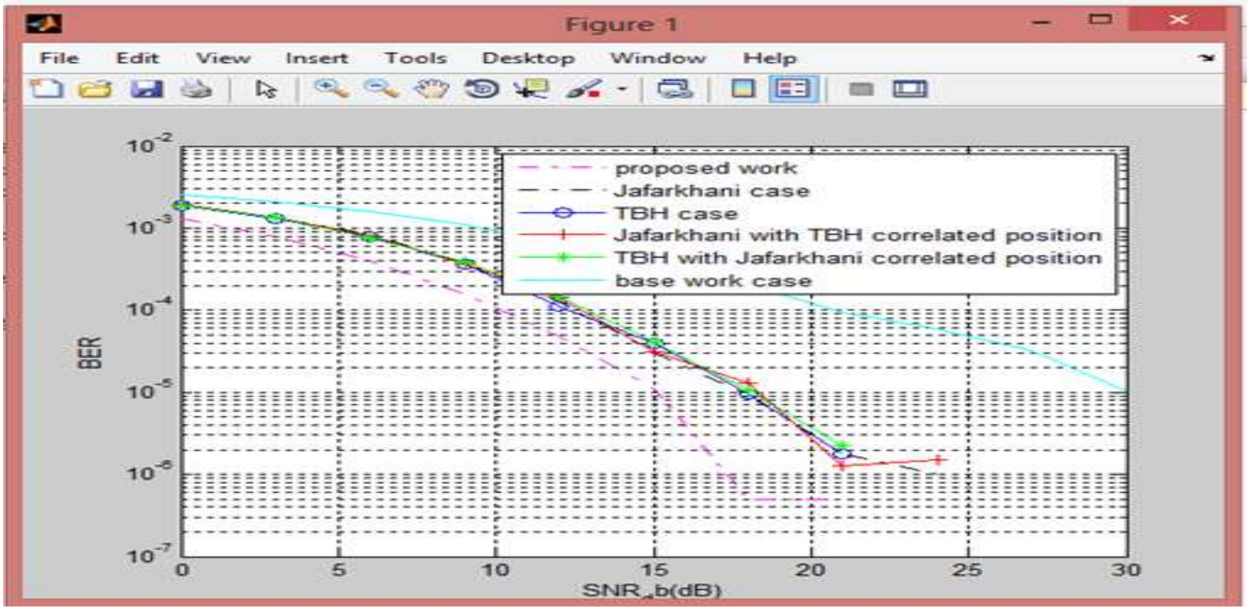

Fig.2

In fig2 proposed model bit error rate is less then all other; the simulation is for 16PSK modulation technique.

Comparative BER analysis for 64 PSK

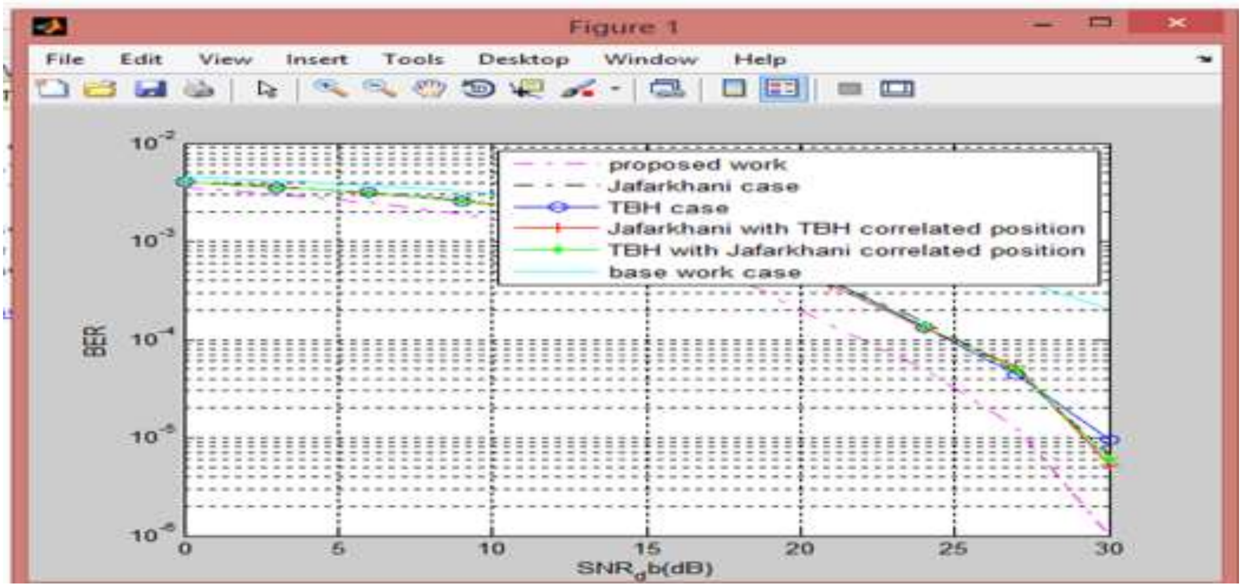

Fig.3

In fig.3 proposed model bit error rate is less than allother; the simulation is for 64 PSK modulation technique.

Comparison Table1.1

Modulation scheme	Jafarkhani	TBH	Base	Proposed
4 PSK	0.00165	0.00162	0.0022	0.0012
16 PSK	0.00042	0.00041	0.00078	0.000024
64 PSK	0.000019	0.000175	0.000104	0.0000060

Table1.1 shows comparative analysis of BER with other methods & conclude that the proposed method having very low bit error rate.

V. CONCLUSION

We have designed new space-time block codes for MIMO systems considering reduction in BER leads to power and manufacturing cost savings, mitigating the system imperfections is necessary to prevent possible transmission errors.

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