Performance Assessment of MB-MF-SIC Detector using Space Time Block Codes

[1] B. Suneela, [2] E.V. Krishna Rao, [3] Sarat K. Kotamaraju, [4] K. Ch. SriKavya

[2] *Department of ECE*, Lakireddy, Bali Eddy College of Engineering, Mylavaram, Krishna, A.P., India.

[1, 3, 4] *Department of ECE*, Koneru Lakshmaiah Education Foundation, Guntur, A.P, India.

Abstract **- The requirement for remote correspondence frameworks with high information rate and enhanced connection quality for an assortment of uses has significantly expanded. Multiple Input Multiple Output frameworks are a proficient means for expanding the execution. Space Time Block Code (STBC) is planned to be a basic part in future remote framework to diminish the multifaceted nature of different radio wire procedures and fulfill the need of higher information rates. It is the cutting edge innovation in remote interchanges. In this paper, we present Space-Time Block Codes at the transmitter side. The execution of the framework is done under Nakagami Fading channel. The Bit Error Rate examination of the framework is performed for 2x2 different radio wire choices in MIMO-OSTBC framework. The Performance of MB-MF-SIC framework is analyzed in the transmission of STBC and LDPC.**

Keywords - Diversity, Space Multiplexing, MB-MF-SIC processing, Detector, Space Time Block Codes

I. INTRODUCTION

Wireless communications applications such as cellular 4G, broadband internet, video and audio streaming has go into in every aspect of present day life. To support the applications, broad investigation has particularly conducted on MIMO systems in recent years. MIMO systems [1] exploit spatial diversity and enhance channel capacity without acquiring transmission power or at the expense of Bandwidth. Multiple transmit and multiple receiving antennas are currently used to significant increase the performance of wireless communication of MIMO systems. MIMO systems combination of successive interference cancellation detectors are under the transmission of LDPC codes and STBC codes performed. These detectors already explained in references [1][3][6-9]. Space-time block codes has risen one of the promising technique in exploiting the spatial diversity [2][4-5]. In broad sense, MIMO classified in three main categories, space diversity, spatial multiplexing and beam forming techniques. In beamforming, technique beam size and beam with changed in accordance with the conditions of the receiver and variation in the environment. In this scheme antenna mixed with adaptive signal, processing unit a significant output is achieved for mobile users. Many another resource allocation methods introduced in order to improve the spectral efficiency. It also compensates effect of continuous change in environment between transmitter and receiver. To improve error rate performance, multiple antennas can also use by transmitting the redundant signals using the same transmitting information. The information sequence is transmitted over the multiple transmitted antennas by two-dimensional coding i.e. time and space, which is known as space-time coding. At the output side, these redundant signals combined with several diversity techniques. Here the advantage is compared with single antenna system. Diversity gain coding gain achieved without degrading effect of Bit error rate. A Low density parity check code is a linear error correcting code.it is a method of transmitting message over noisy channel. It is constructed by many techniques Design of LDPC codes and decoding techniques covered in reference [10].

II. MULTIPLE INPUT MULTIPLE OUTPUT MODEL

Wireless communication using Multiple Input Multiple output model. Consider a link in which the transmitting blocks as well as receiving blocks equipped with multiple antenna elements as shown in Fig1.the main idea behind MIMO is that signals on the transmitting antennas at one end and receiving antennas at other end combined in such a way that quality for each user will be improved.

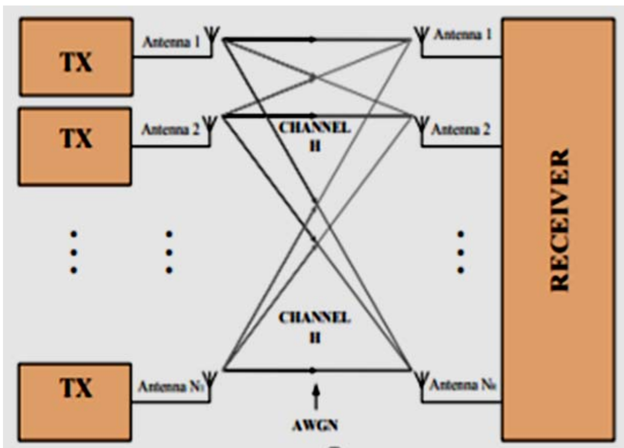

Fig 1. Multiple Input Multiple Output system.

This advantage can be utilized to enhance both network quality of service. The idea in MIMO systems are space time signal processing in which n dimension of wireless communication data is complemented with the spatial dimension inherent in the use of multiple spatially distributed antennas As such MIMO systems can be called smart antennas. A popular technique-using antenna arrays for improving the wireless communication performance. Each antenna element operates on same frequency so there is no need of extra bandwidth.

$$\sum_{K}^{N} = {}_{1}{}^{pk \leq p} \quad (1)$$

The total power through all antenna elements is less than or equal to that of a single antenna system i.e. eqn. 1 as shown above where N is total number of elements, pk is the power allotted for kth antenna element, P is the power of single antenna system. The equation indicates that MIMO system consumes no extra power due to its multiple antenna elements.

III. SYSTEM AND CHANNEL REPRESENTATION

For the MIMO channel model between the transmitter and receiver, we consider it as Nakagami fading. The model assumes n_T transmit antennas, n_R receiving antennas and can be represented by n_T x n_R matrix below [7]:

$$\begin{bmatrix} h_{1,1} & \cdots & h_{1,n_R} \\ \vdots & & \vdots \\ h_{n_T,1} & & h_{n_T,n_R} \end{bmatrix} \quad (2)$$

where hij denotes the channel response between the transmitting antenna ‘i’ and receiving antenna ‘j’. The characteristics of MIMO configuration is the capability to make multi propagation useful to the user when random fading occurs caused by multipath propagation. The probability of losing signal dies out exponentially with the number of de-correlated antenna elements being used. Spacing between the antenna elements in the antenna array has on immediate impact on the level of correlation between the channels associated to these antenna elements.

The MIMO system model may be represented as:

$$y = Hs + n$$

Where:
y signifies the ($n_R \times 1$) matrix of the conventional signs,

H the ($n_R \times n_T$) MIMO network matrix,

s is the ($n_T \times 1$) broadcast representation vector plus n the ($n_R \times 1$) preservative noise vector.

IV. SPACE-TIME BLOCK CODES

A. Space Time Coding

It is a technique that uses a combination of coding modulation and signal processing and is called transmit diversity. Almouti transmit diversity is a space-time coding technique proposed in 1998. The transmit diversity scheme provides diversity and coding gain by sending the same information sequence over multiple transmitting antennas. Multiple transmitting antennas are required at the transmit diversity technique at the transmitter side. Fig2 shows the basic structure of space-time coding.

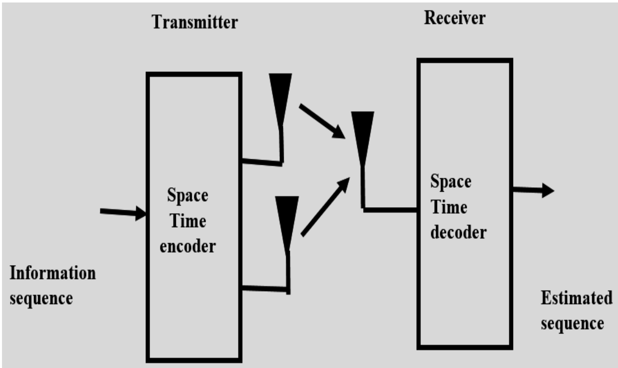

Fig 2. Basic Structure of Space Time Coding

Space-time encoder encodes a single stream space using all transmitting antennas through time by sending each symbol at different times, thus this form of coding is termed space time coding. Space-time encoder carries out the pre-processing of redundant signals at the receiver, the corresponding decoding process is carried out by space time decoder. Space Time Block codes are generalized scheme of Alamouti and have the same characteristics. These codes are orthogonal and can achieve transmit diversity specified by a number of transmit antennas. Space-time block codes are complex version of Alamouti scheme. The encoding and decoding process is the same as there in Alamouti scheme [2]. The number of columns equal to number of transmitting antennas and number of rows equal to number of time slots required to transmit data. The receiver receives and combines all signals which are then sent to a maximum likelihood detector where the decision rules are applied. Space-time block codes were designed to achieve maximum diversity order for the given number of transmit and receiving antennas. These codes have simple decoding algorithms. Training based channel estimation methods are used at the receiver in order to increase the performance. But this has a disadvantage when bandwidth efficiency is required.

B. Alamouti Scheme

Alamouti scheme is the basis of the Space Time Coding Scheme. The mathematical analysis of basic scheme with two transmitter and one receiver antenna is explained below. A two branch diversity scheme is implemented Using this scheme it provides same diversity order as maximal ratio receiver combining with one transmitter antenna and two receiving antenna .This scheme generates two transmit antennas and one receive antenna provide the diversity order of 2M. At the transmitter a block of two symbols taken from the source data and sent to the modulator. Alamouti space encoder takes two modulated symbols called s1 and s2 and are mapped to two transmit antennas in two timeslots [3-4]. The fading coefficients h1(t) and h2(t) are assumed as constants across the two consecutive symbol transmission periods and they can be defined as:

$$h_1(t) = h_1(t + T) = h_1 = |h_1|e^{j\theta} \qquad (3)$$

$$h_2(t) = h_2(t + T) = h_2 = |h_2|e^{j\theta} \qquad (4)$$

The two received signals r1 and r2 over two consecutive symbol periods for t and t+T. The received symbols can be expressed by:

$$\begin{bmatrix} r_1 \\ r_2 \end{bmatrix} = \begin{bmatrix} s_1 & s_2 \\ -s_2^* & s_1^* \end{bmatrix} \begin{bmatrix} h_1 \\ h_2 \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \end{bmatrix} = \begin{bmatrix} h_1 s_1 + h_2 s_2 + n_1 \\ -h_1 s_2^* + h_2 s_1^* + n_2 \end{bmatrix} \qquad (5)$$

The ML decoder selects a pair of two signals from constellation to decrease the distance metric overall possible values s_1^ and s_2^. The output is:

$$\begin{bmatrix} \tilde{s}_1 \\ \tilde{s}_2 \end{bmatrix} = \begin{bmatrix} h_1^* & h_2 \\ h_2^* & -h_1 \end{bmatrix} \begin{bmatrix} r_1 \\ r_2^* \end{bmatrix} = \begin{bmatrix} h_1^* r_1 + h_2 r_2^* \\ h_2^* r_1 - h_1 r_2^* \end{bmatrix} \qquad (6)$$

C. Block Diagram

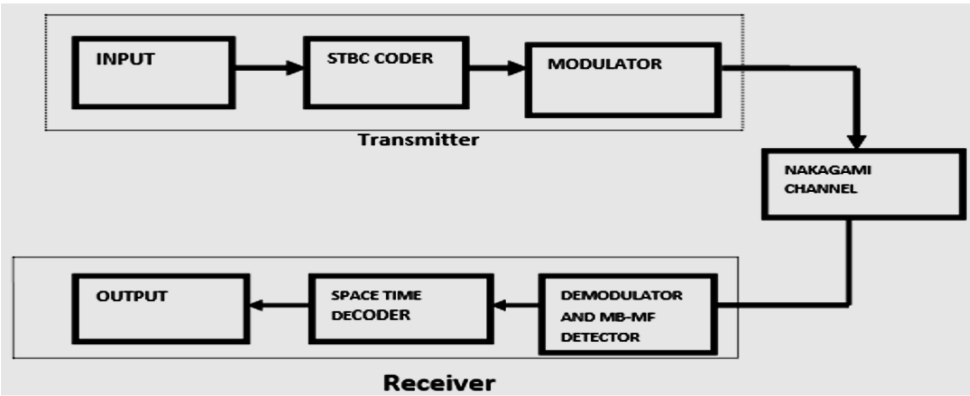

Fig 3. Block Diagram of the Proposed Scheme

The proposed Multiple branch Multiple feedback cancellation detection scheme as shown in Fig3 is near to optimal performance. STBC encoder encodes the transmitted data. Output of the information is transmitted through Nakagami channel. In the receiver data is again decoded through MB MF SIC detector. Space-time Block codes are more efficient than LDPC codes.

D. Nakagami Fading

This depicts the complexity of the resulting motion after Maximum Ratio Diversity joining. After k branch maximum Ratio Combination, the subsequent flag is Nakagami with m = k. MRC consolidating of m Nakagami blurring signals in k branches gives a Nakagami motion with shape factor mk. The total of numerous free and indistinguishably appropriated Rayleigh blurring signals have a Nakagami dispersed flag amplitude [7]. This is especially important to demonstrate impedance from different sources in a cell system [8]. The Nakagami dissemination coordinates some experimental information superior to different models. Nakagami blurring happens for multipath scrambling with generally vast postpone time spreads, with various groups of reflected waves. Inside any one bunch, the periods of individual reflected waves are irregular, yet the defer times are roughly equivalent for all waves accordingly envelope of each cumulated group flag is Rayleigh conveyed. In the event that the postpone times additionally essentially surpass the bit time of computerized interface, the distinctive bunches create genuine bury image impedance, so the multipath self-obstruction at that point approximates the instance of co divert obstruction by different in cognizant Rayleigh blurring signals. The Rican and Nakagami models carry on roughly comparably close to their mean esteem [10]. This perception has been utilized in numerous ongoing papers to advocate the Nakagami demonstrate as an estimate for circumstances where Rican model would be more proper while this might be precise for circumstances where Rican model would be more suitable while this might be exact for the principle group of likelihood thickness, it turns out to be very incorrect for the tails. As bit mistakes or blackouts for the most part happen amid profound blurs, the tail of likelihood thickness function [10] essentially dictates these execution measures.

E. Multiple Branch Multiple Feedback Successive Interference Cancellation Detector (MB-MF-SIC)

MB-MF-SIC working under the principle of shadow area constraint as explained in reference [1] [5-9]. For each branch,

$$l_{opt} = \arg\min_{1\le l\le L} J(l)$$

$$J(l) = \|r[i] - H\tilde{s}[i]\|^2 = \|r[i] - H'\hat{s}_l[i]\|^2 \quad (7)$$

Thus, the proposed method implementation of MB-MF-SIC metric J (l) of every MF-SIC branch can gain and straight from the optimization of l-th branch. The detected symbol vector is denoted as:

$$\bar{s}[i] = \tilde{s}_{lopt}[i] = T_{lopt}^{T}\hat{s}_{lopt}[i] \quad (8)$$

The proposed multi-branch cancellation scheme is near to the optimal performance. Hence the comprehensive search includes L = K! branches, which is not a practical assumption. So the reduction of branch number method was developed using FSB (Frequently Selected Branches). It is used to find the sub-optimal solution for choosing l branch of the system [9]. This consists of ordering patterns of chosen branches as well as attaining a number of branches that is near to the reduced optimal performance.

V. SIMULATION RESULTS AND DISCUSSION

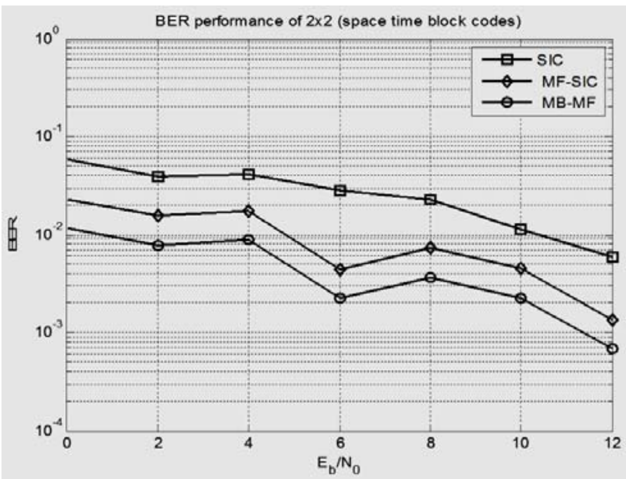

Fig 4. BER performance of 2x2 Antenna system

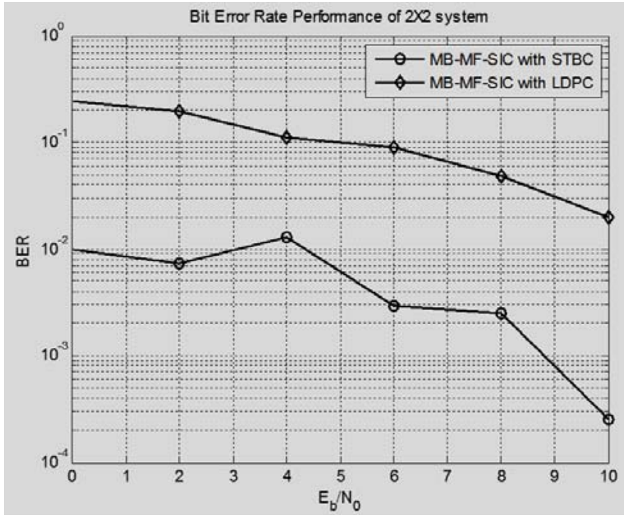

Fig 5. Bit Error rate Performance of STBC and LDPC of 2x2 system

The Bit Error rate performance of the 2x2 system is shown in Fig4. The BER of MF-SIC and MB-MF-SIC Detectors improved more than the SIC Detector method. As SNR increases the BER performance also improved up to the optimum level. The BER performance of Detectors observed under the transmissions of LDPC and STBC codes. BER performance of 2x2 system under transmission of STBC is more efficient than the LDPC scheme. Coding gain and diversity gains also improved.

VI. CONCLUSION

Plan of complex symmetrical space-time block codes includes the science writing inspired from the pieces of quadratic structures Real and complex symmetrical Codes are utilized to develop space-time square codes. By expanding Signal to Noise Ratio, the bit blunder rate diminished and thus the Performance of the Wireless Communication framework expanded. From the Simulation results Fig 4, the proposed MB-MF-SIC identifier accomplished better identification assorted variety request and Bit Error Rate than customary plans. At SNR 10db BER of proposed strategy is 0.00068 and customary plan of SIC is 0.01.The proposed arrangement of 2x2 MB-MF-SIC finder enhanced execution of Bit Error rate. From Fig 5, the execution of MB-MF-SIC Detector under STBC transmission is superior to the LDPC Transmission and coding gain is likewise moved forward.

REFERENCES

[1] Pengi Li, Rordigo, “Multiple Feedback Successive Interference Cancellation Detection for Multi user MIMO Systems”, IEEE Transactions on wireless communication, Vol10, N0 8, Aug2011.

[2] Camilla Hollanti, Kalleranto,”Asymmetric Space Time Block Codes for MIMO Systems”, IEEE Information Theory workshop on Information Theory for wireless Networks.2007.

[3] Imran Mahmood, ”Multi Branch Layers Ordered Multiple Feedback Successive Interference Cancellation in MU-MIMO Spatial Multiplexing System”, Proceedings of 2017 14th International Bhurban Conference on Applied Science & Technology, Islamabad, Pakistan, 10 - 14 Jan2017.

[4] Santumon S D, and B.R. Sujatha “Space Time Coding for Wireless Networks”, International Journal of Distributed and Parallel Systems, Vol3, No4, July2012.

[5] Ali H. Alqshtani, Ahmed Iyandasulyan and Abdulhameed Alsanie, “Rate less Space Time Block codes for Massive MIMO Systems”, International Journal of Antennas and Propagation August 2014.

[6] B. Suneela, EV Krishna Rao, K. CH. SriKavya,” Design and Implementation of MF-MB SIC Detection in Transmission of Physical Layer Network “, 2016 15 thSept Vol 91, No.1.

[7] B. Suneela, EV Krishna Rao, K.CH. Sri Kavya, SaratK.Kotamraju.” An Efficient Method to increase the Network Throughput using Interference Cancellation Approach”, Journal of Adv. Research in Dynamical Control Systems, Vol 9, Issue1, Nov 2017.

[8] B. Suneela, EV Krishna Rao, SaratK.Kotamraju. K.CH. Sri Kavya, Performance Improvement of MB-MF-SIC Detector System using Nakagami –m Fading Channel, Journal of Adv. Research in Dynamical Control Systems, Vol 10 , 07, Special Issue1,Nov 2018.

[9] B. Suneela, EV Krishna Rao, SaratK.Kotamraju. K.CH. Sri Kavya, “Performance Capacity Improvement in MB-MF-SIC Detector System using Resource allocation Approach”, Journal of Adv. Research in Dynamical Control Systems, Vol10, N07, Special Issue1, Nov 2018.

[10] Stephenson Brink, Gerhard Kramer, “Design of Low Density Parity Check Codes for Modulation and Demodulation”, IEEE transactions on communications, Vol54, No4Apr 2004.

.