International Journal of Control Theory and Applications

ISSN : 0974-5572

Volume 10 • Number 33 • 2017

A Novel Algorithm for Improving MC-CDMA BER Performance using NNT for Wireless Applications

P. Sreesudha[a] and B.L. Malleswari[b]

[a]*Assistant Professor, Department of Electronics and Telematics Engineering, GNITS for Women Hyderabad, Telangana, India*

E-mail: sreesudhaphd2016@gmail.com

[b]*Principal, Department of Electronics and Communications Engineering Sridevi Women's Engineering College, Hyderabad, Telangana, India*

E-mail: blmalleswari@gmail.com

Abstract: Now a days, many researchers are trying to discover a way to support a frequently growing number of users and services because of increasing demand in wireless technologies. For mobile radio systems, Multi Carrier with Code Division Multiple Access (MC-CDMA) is a promising candidate. In Multi Input Multi Output (MIMO) technique, the performance can be increased and Bit Error Rate (BER) can be reduced. The proposed model with help of Quasi Orthogonal Space Time Block Code (QOSTBC) and Neural Network Tool (NNT) will increase the performance of MC-CDMA by reducing BER.

Keywords: *MC-CDMA, MIMO, quasi orthogonal space time block code, neural network.*

1. INTRODUCTION

Wireless communication is an enormous technology, which contributes to Homo sapiens. It is used to transmit the information from one place to another place without involvement of cables, wires, or any other electrical conductor. The range of transmitting distance from few meters to thousands of kilometres. Television remote control is the example of few meter communication and radio connectivity is the example of thousands kilometres communication [1]. In wireless communication, the devices are utilized such as mobiles, wireless computer parts, satellite television, GPS unit and cordless telephones. The main application of this method involve cell phones, computer interface devices, security system, various wireless communication based projects, television remote control and wireless power transfer. CDMA multiple access technique can be helped in wireless communication [2]. CDMA (Code-Division-Multiple-Access) denotes to number of protocols operate in second-generation (2G) and third-generation (3G) wireless communication.

In the transmission channel, the numerous signal can be occupied to optimize the bandwidth in the form of multiplexing. This CDMA operates in ultra-high-frequency (UHF) cellular telephone systems in the range of 800 MHz to 1.9 GHz [3]. Spread-spectrum technique that can be used for digital cellular technology to extend the range of frequency. In CDMA system does not allocate a specific frequency to each user. Here, individual communication can be encoded with a pseudo-random digital sequence. So that, CDMA is much better than TDMA and FDMA [4]. The standard of IEEE 802.11 set the some attributes for different kind of channels. This channel exhibit as 2.4 GHz channel, 2.4 GHz WLAN channel, 2.4 GHz Wi-Fi channel overlap, ISM bands, 802.11 system bands, 2.4 GHz 802.11 channels, 2.4 GHz Wi-Fi channel frequency, 3.6 GHz Wi-Fi band, and 5GHz Wi-Fi channels [5]. In the wireless channel, channel valuation is an important part to evaluate the function of channel. While the signal moving to the channel, it can be affected or some respective noise is added.

The main motivation is to eliminate the signal error and distortion noise in the receiver side. First of all, find out the channel characteristics that can be utilized for further estimation process. Transmitting signal can be changed to the receiving side with either attenuation, phase shift, or noise [6]. If we want to get desire received signal, we need to increase the presentation of the channel characteristics. Types of channel estimation technique is classified as FIR-MIMO, conventional training-based methods, and enhanced training based methods [7]. In FIR-MIMO channel, broadband communication and frequency selectivity due to multipath is essential. In this method the single-carrier MIMO system can be restricted with in a frequency-selective fading channel. The conventional training based method operates only received samples which depends on training symbols [8].

The maximum likely-hood channel estimation, may not be need the source of statistical information of the channel or knowledge of the noise variance. The process of decoupled different antenna is the result of channel estimation problem. The problem can't be decoupled because the correlation between different antennas will come into the picture. In enhanced training based method, ML (maximum likely-hood) channel estimation is plays a huge role. Here unknown and unwanted data symbols are implicate to adopt different options [9]. DML (deterministic maximum likely-hood) and GML (Gaussian maximum likely-hood) also important channel estimation in this technique. The data symbols are unknown parameters in DML system and the data symbols are unknown random variable with a Gaussian distribution in GML system [10]. These two system can't able to take finite alphabet property of the symbol data into account. Because, this algorithm is more complex. So the proposed system used in NNT (Neural Network Tool) technique to minimize the BER.

2. RELATED WORK

T. Fath and H. Haas [11] have compared the performance of multiple-input-multiple-output (MIMO) techniques applied to indoor optical wireless communications (OWC) assuming line-ofsight (LOS) channel conditions. The SM (spatial modulation) results as to reduce the channel correlation and it can provide little channel difference.

A. Marczak [12] has proposed the design of transmitter and receiver for MC-CDMA radio interface. Two turbo codes with 8-state recursive systematic convolutional were utilized in the simulation. With help of turbo codes the BER value can be reduced but not possible to reduce as much as possible.

L. K. Bansal et al. [13] have evaluated and compared the performance of reduced state space-time trellis coded multi carrier code division multiple access (STTC-MC-CDMA) system, with the performance of original state STTC-MC-CDMA system. This technique can be decrease the decoders but can't possible to concentrate on error rates.

Y.W.Kuo et al. [14] have proposed a complete solution to adaptively allocate resource for downlink Multi-Carrier Code Division Multiple Access (MC-CDMA) systems with the power and BER constraints. This method power utilization is high and during the transmission the data can be loss.

Y. Wang et al. [15] have employed the zero forcing (ZF) and minimum mean square error (MMSE) decoders to mitigate the severe performance degradation. Additionally, they proposed a zero forcing interference cancellation decision-feedback equalizer (ZF-IC-DFE) and a minimum mean-square error interference cancellation decision-feedback equalizer (MMSE-IC-DFE) via Cholesky factorization of the channel Gram matrix after executing interference cancellation.

3. PROPOSED SYSTEM

The structure of proposed NNT system is formed by a transmitting and receiving terminal.

3.1. Transmitter

Transmitter part Fig.1 consists of user information data, IFFT, CP, Modulation, and STBC.

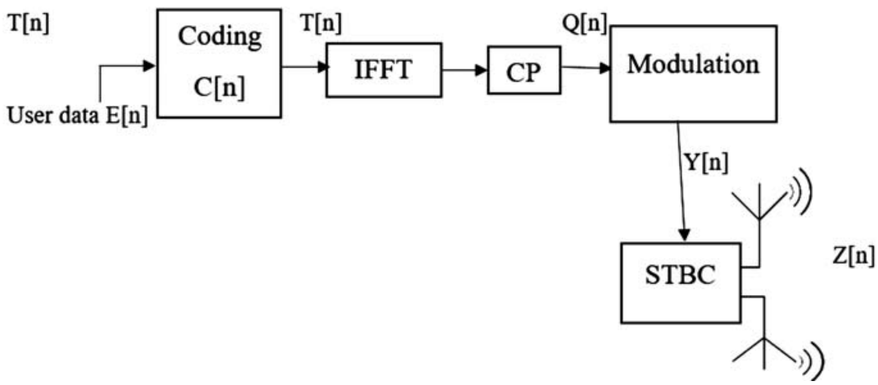

Figure 1: Block diagram of transmitter

User information data mentioned as the input data E[n] to perform the initial operation. The input data will react with coding terminal C[n] that generates new sequence T[n] which is represent as:

$$T_u[n] = T[n], T_1[n], ...T_{PN-1}[n] \tag{1}$$

Here, PN is processing gain of the system, hence we can write:

$$T_u[n] = E_u[n]. C^k \tag{2}$$

$$T_u[n] = [E_u[n]. C^k d_u[n]. C_1{}^k[n]. C^k_{p-1} \tag{3}$$

IFFT process, the signal that can be changed from frequency domain to time domain. IFFT converts N number of complex data points to N number of time samples. In the cyclic prefix, the repetition of the signal that can be added before the original signal. In the multipath channel cyclic prefix (CP) that causes the inter-symbol-interference. The output of cyclic prefix denoted as Q[n].

$$Q[n]=[CPIFFT(T_u[n])] \tag{4}$$

The cyclic prefix output is the input to the modulation block. In the modulation technique, we execute to changing the characteristics of carrier signal with respect to the message signal. The output of the modulation technique indicates as Y[n]. The serial modulated symbols are stacked and transferred as a symbol vector Y[n] = [y_1, y_2, y_3, y_4] T. The space time block codes (STBC), can be attained transmit diversity in the transmitting antennas and the code sets are fully orthogonal.

In OSTBC, four transmitting antennas produce 4 symbols over 4 time slots and gives much diversity. We use different transmitted symbols for different constellations. Here the symbols y3 and y4 are rotated before the transmission. The complex orthogonal coding matrix represent as:

$$G = \begin{bmatrix} Y_{12} & Y_{34} \\ -Y^*_{34} & Y^*_{12} \end{bmatrix} \tag{5}$$

$$\begin{bmatrix} y_1 & y_2 & y_3 & y_4 \\ -y_2^* & y_1^* & -y_4^* & y_3^* \\ -y_3^* & -y_4^* & y_1^* & y_2^* \\ y_4 & -y_3 & -y_2 & y_1 \end{bmatrix} \tag{6}$$

$$Y_{12} = \begin{bmatrix} y_1 & y_2 \\ -y_2^* & y_1^* \end{bmatrix} \quad (7)$$

$$Y_{34} = \begin{bmatrix} y_3 & y_4 \\ -y_4^* & y_3^* \end{bmatrix} \quad (8)$$

Due to the powerful diversity, simple pairwise decoding and rate one produce the good powerful resulting code. The QOSTBC with the symbol of rotation is known as rotated QOSTBC.

3.2. Receiver

The receiver part consists of STBC decoding, neural network, demodulation, CP removal & FFT and de-spreading.

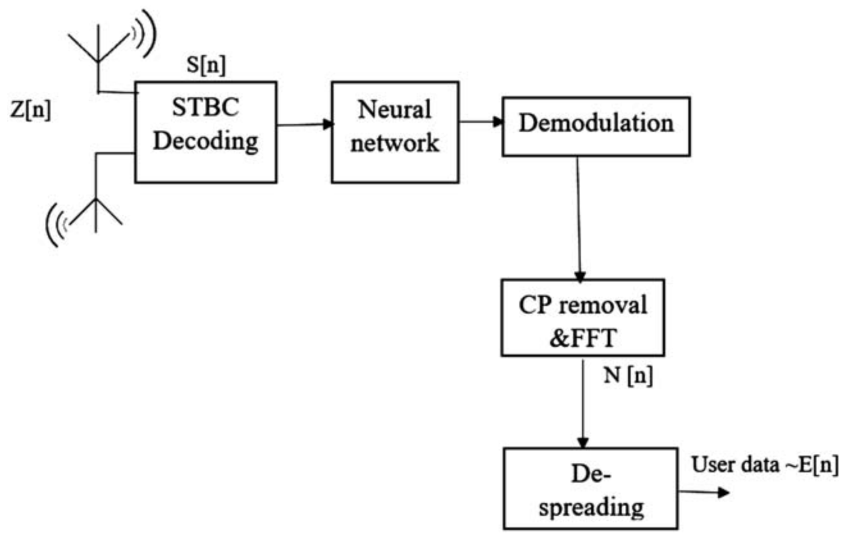

Figure 2: Block diagram of Receiver

In the receiver, the received signal is:

$$S_j[n] = \sum_{i=1}^{T} k_{ij} . Z_i[n] + o[n] \quad (9)$$

Here, Q_j mentioned as received signal, T is the number of transmitting antenna, k_{ij} denoted as channel coefficient between the ith transmitting antenna and the jth receiving antenna, O[n] is the Additive White Gaussian noise (AWGN) and Z_i is the transmitting signal from the antenna.

With the help STBC decoding, we have to attain maximum diversity order for the transmitting and receiving antenna. By using these multiple antenna it is very easy to merge spread streams. This decoding algorithm is very simple and easy to access. In Quasi Orthogonal Space Time Block Coding (QOSTBC), the channel state information (CSI) is already available to estimate the channel approach. Form the transmission constellation N, the decoder choose the decision symbol $\hat{x}$. The decision metric minimized as:

$$\hat{x} = \arg_{x \varepsilon M} \min \| r - BZ \|^2 \quad (10)$$

From the decision metric we can split the two parts such as g_{14} (y_1, y_4) and g_{23} (y_2 , $y3$), where g_{14} (y_1 , y_4) is independent of y_2 and y_3, and g_{23} (y_2, y_3) is independent of y_1 and y_4. According to equation (10), it can obtained by,

$$g_{14}(y_1, y_{14}) = \sum_{j=1}^{R}\left\{\sum_{i=0}^{4}|B_{ij}|^2\right\}.(|y_1|^2+|y_4|^2)+2R\begin{Bmatrix}(-B_{1,j}s_{1,j}^* - s_{2,j}B_{2,j}^* - s_{3,j}B_{3,j}^* - B_{4,j}s_{4,j}^*)y_1 + \\ (-B_{4,j}s_{4,j}^* + s_{2,j}B_{3,j}^* + s_{3,j}B_{2,j}^* - B_{1,j}s_{4,j}^*)y_4)\end{Bmatrix}$$

$$= +4R\left\{B_{1,j}\ B_{4,j}^* - B_{3,j}\ B_{2,j}^*\right\}R\left\{y_1y_4^*\right\} \quad (11)$$

$$g_{23}(y_2, y_3) = \sum_{j=1}^{R}\left\{\sum_{i=0}^{4}|B_{ij}|^2\right\}.(|y_2|^2+|y_3|^2)+2R\begin{Bmatrix}(-B_{2,j}s_{1,j}^* + s_{2,j}B_{1,j}^* - s_{3,j}B_{4,j}^* + B_{2,j}s_{4,j}^*)y_2 + \\ (-B_{3,j}s_{1,j}^* - s_{2,j}B_{4,j}^* + s_{3,j}B_{1,j}^* - B_{2,j}s_{4,j}^*)y_3)\end{Bmatrix}$$

$$= +4R\left\{B_{2,j}B_{3,j}^* - B_{4,j}B_{1,j}^*\right\}R\left\{y_2y_3^*\right\} \quad (12)$$

The symbol pair (y_1, y_4), and (y_2, y_3) is choose by the decoder. The pair is should satisfy,

$$\arg_{x\,\varepsilon\,M} \min f_{14}(x_4, x_4) \quad (13)$$

$$\arg_{x\,\varepsilon\,M} \min f_{23}(x_2, x_3) \quad (14)$$

Demodulation process is described in the Fig.2, we can extract the original information from the modulating signal. After that, removing unwanted signal from the original data and the help of FFT we have to change the domain from time to frequency. The output of this block modified data denoted as N[n].De-spreading the final stage of receiving terminal. Here, the conversion technique is done, which converts the modified data N[n] to original data E[n].

3.3. Block diagram

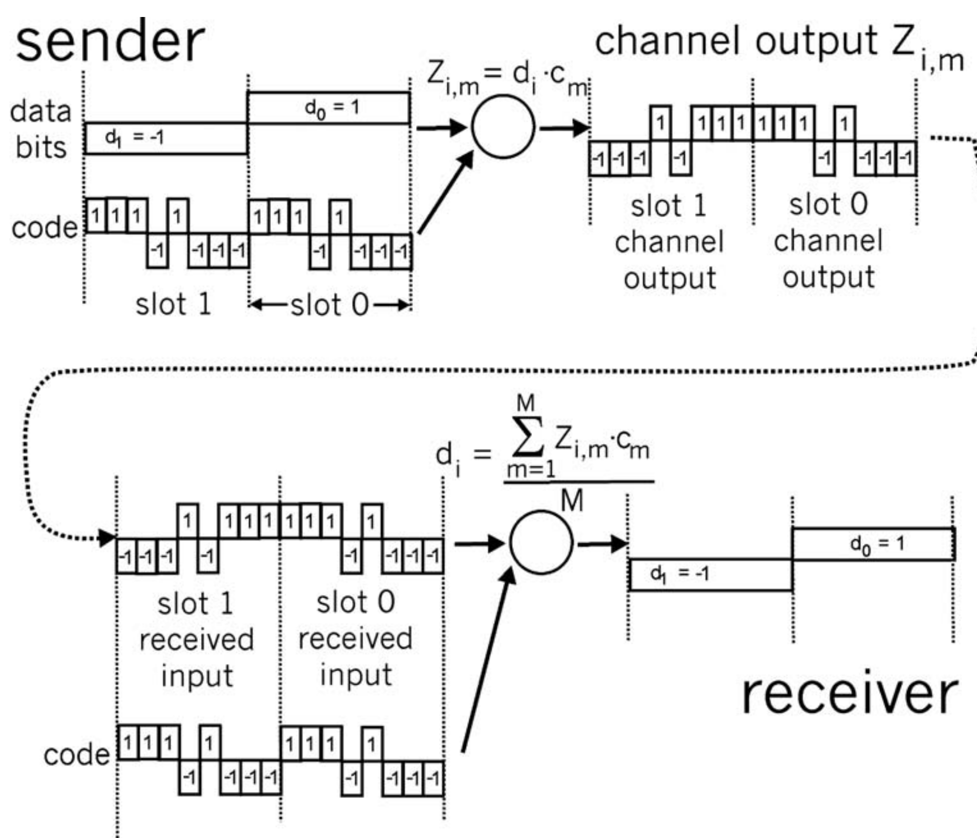

Figure 3: CDMA transmitter and Receiver

The Fig 3 is the CDMA transmitter/Receiver system, as we know CDMA is the code division multiple access. In this system the total channel is divided into sub channels to avoid the crosstalks in channel. For each sub channel specific code has to be assigned as we can in the Fig 3.To transmit data over a channel we need to assign a code for channel for easy retrieval of data at the receiver end. In two slots the system has successfully transmitted the data and it is received at the receiving part. Here in the Fig 3 we have shown only for two slots, it is not limited to two.

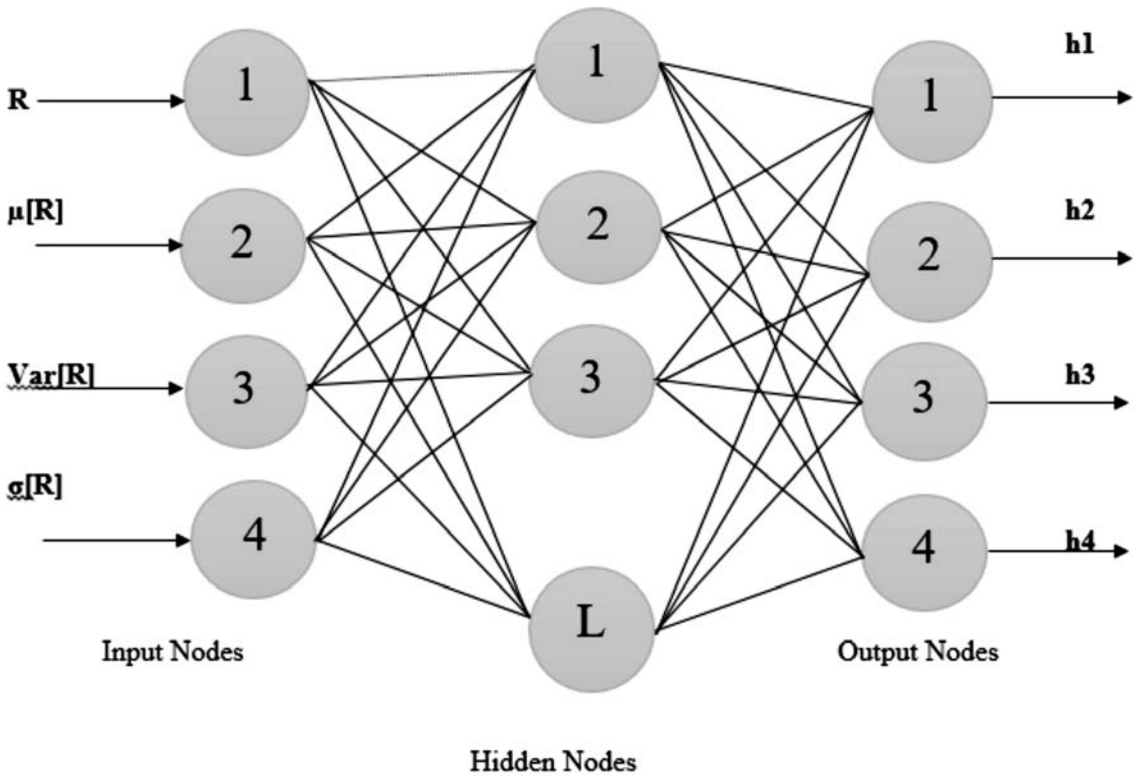

Figure 4: Neural network for channel coefficient estimation

Fig.4. describes the estimation of channel coefficient with the help neural network at receiver side of the system. In NNT, there are three types of nodes such as input nodes, hidden nodes and output nodes as shown in figure 4. The input layer is connected with received signal R, mean of received signal μ[R], variance of the received signal V[R] and standard deviation σ[R]. Number of hidden layers in the neural network is directly proportional to the computation time as well as accuracy. In proposed work we have chosen number of hidden layer as 100 it is optimal for computation time as well as the accuracy. At first NNT system have trained with received signal vs. original channel response with multiple randomly generated sequences. The accuracy of the system can be increased by giving more training sample while performing training. In proposed work, neural network is mainly used to estimate the channel response based on the received signal and other features that is explained above.

4. EXPERIMENTAL SETUP

The proposed method is coded in MATLAB version 2015b to verify the algorithm. The entire work is done by using I7 system with 8 GB RAM. By randomly changing the input we determined BER for different SNR.

5. RESULTS AND DISCUSSION

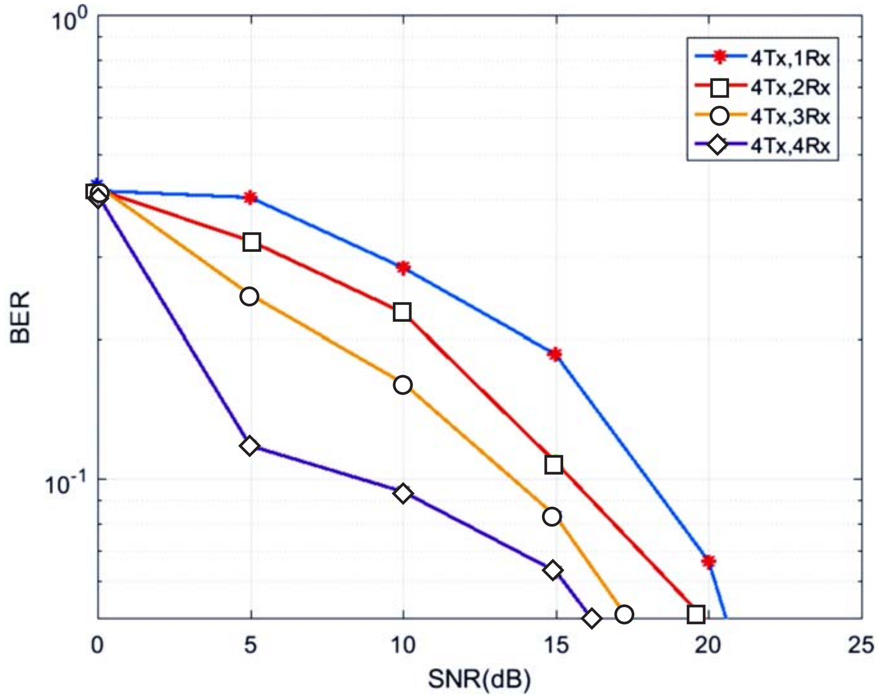

Figure 5: Performance of QOSTBC for Different number of Receiver antennas

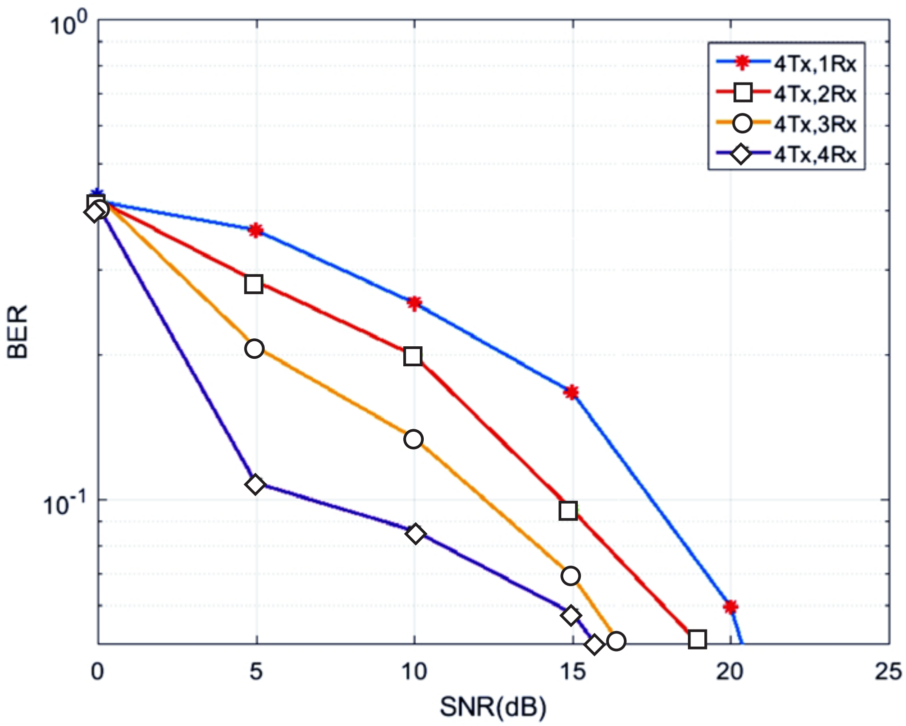

Figure 6: Performance of Rotated-QOSTBC with NNT based channel estimation for Different number of Receiver antennas

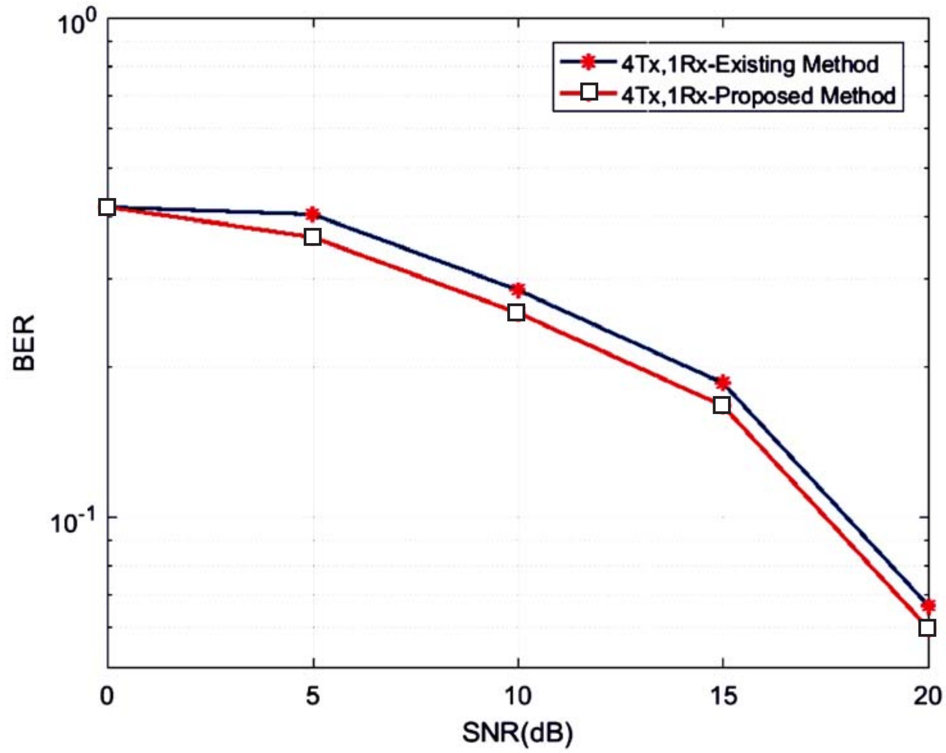

Figure 7: (*a*) Comparison of Existing and Proposed method for 4 Transmitter and 1 receiver

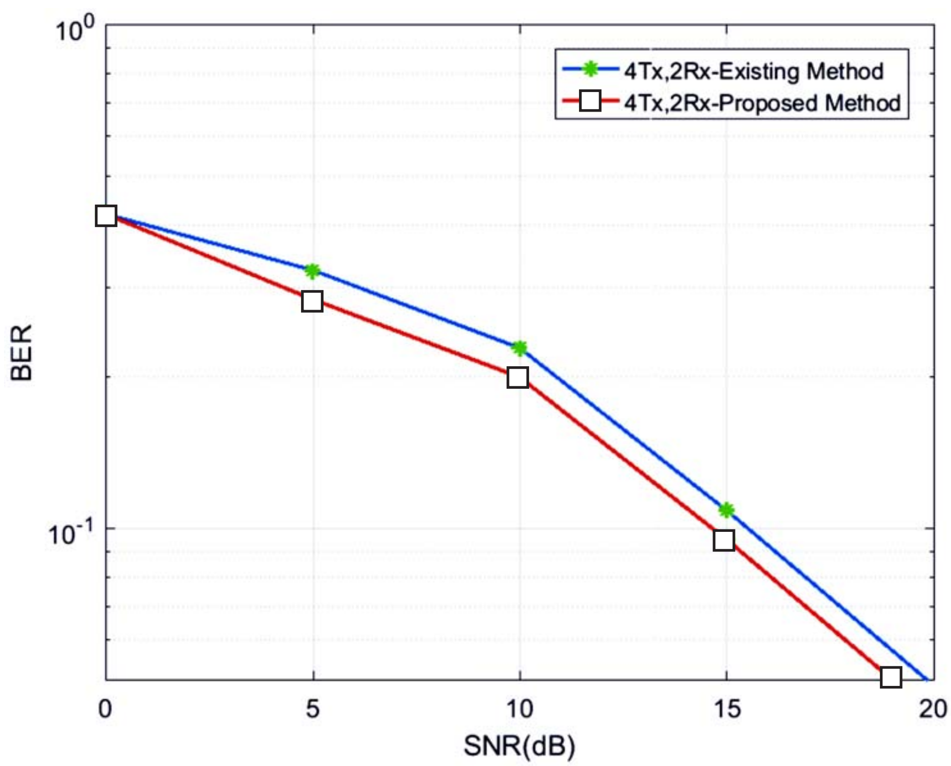

Figure 7: (*b*) Comparison of Existing and Proposed method for 4 Transmitter and 2 receiver

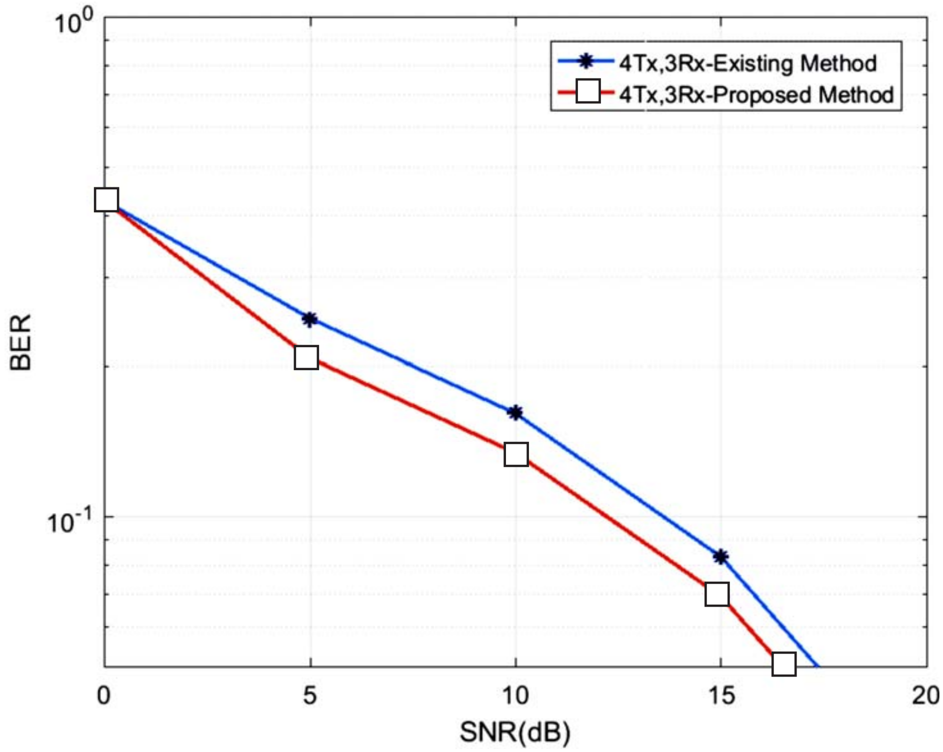

Figure 7: (*c*) Comparison of Existing and Proposed method for 4 Transmitter and 3 receiver

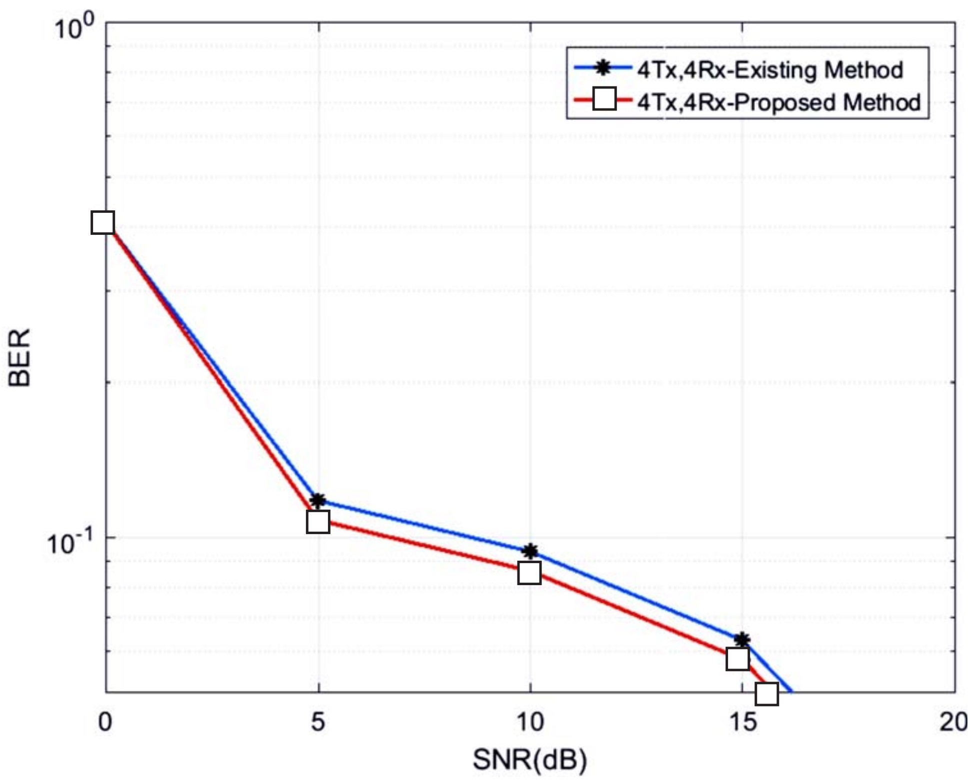

Figure 7: (*d*) Comparison of Existing and Proposed method for 4 Transmitter and 4 receiver

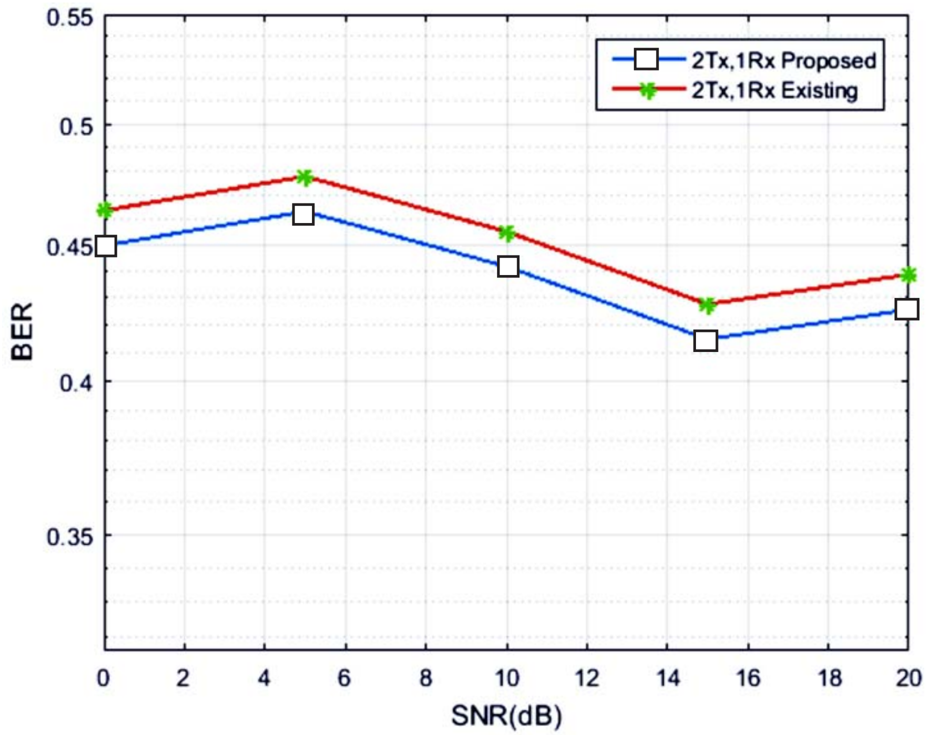

Figure 8: (*a*) Comparison of Existing and Proposed method for 2 Transmitter and 1 receiver

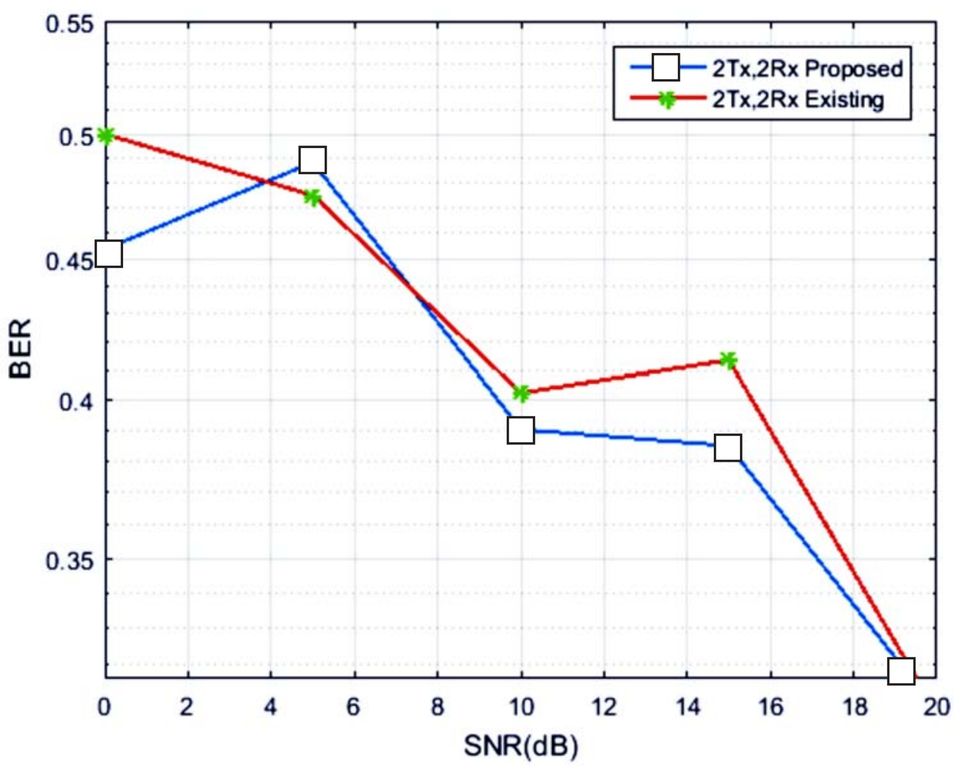

Figure 8: (*b*) Comparison of Existing and Proposed method for 2 Transmitter and 2 receiver

In proposing method the channel estimation is determined by using a neural network and the estimated channel response is fed to the Rotated QOSTBC for the decision making. Here NNT is used to predict the channel response of the received data. A feed forward, back propagation NNT is used to predict the channel response. Fig. 5 and Fig.6 shows the performance of the existing system and proposed system. The BER of the system is decreasing with respect to the number of transmitters. For 4T and 1R the BER is almost 10-1.5 and for more number of receiving antenna it is less than that of 10-1.5. Fig.7 shows the comparison between the proposed method and existing method for different number of receiving antennas. From this it is clear that the proposed method is reducing bit error rate when compared to the existing algorithm. Fig.8 shows the comparison between proposed and existing algorithm by considering two transmitter and one receiver is in Fig.8 (*a*) and two transmitter and two receivers Fig.8 (*b*). As we can observe the Fig.8 (*a* and *b*), BER of the proposed algorithm has reduced compared to the existing algorithms. So proposed algorithm is very efficient in fields we require less BER.

6. CONCLUSION

In this paper, we have proposed a new algorithm to improve the performance of the MC CDMA system using neural network and QOSTBC encoder. The algorithm has been analyzed by various numbers of parameters like number of receiving antenna and for different SNR values. From the results we conclude that the BER performance is improved when compared to the existing algorithm.

REFERENCES

[1] S.E. Sharef, M. Khedr, and E.F. Badran, “Enhancing MC-CDMA system using rotated quasi-orthogonal STBC in wireless channels,” Wireless Advanced (WiAd), vol.19, no. 3, pp. 251-264, 2012.

[2] S.M. Alamouti, “A simple transmit diversity technique for wireless communications,” IEEE Journal on selected areas in communications, vol.16, no. 8, pp. 1451-1458, 1998.

[3] V. Tarokh, N. Seshadri, and A.R. Calderbank, “Space-time codes for high data rate wireless communication: Performance criterion and code construction,” IEEE transactions on information theory, vol.44, no. 2, pp. 744-765, 1998.

[4] P. Kaškonas, and R.P. Žilinskas, “Validation and verification methodology of GSM network call duration measurement system,” Measurement, vol.43, no. 10, pp. 1676-1682, 2010.

[5] G. Sing, S. Singh, “IEEE 802.11 WLAN and advancements: A review,” IEEE transactions on communications, vol. 23, no. 6, pp. 621-635, 2014.

[6] S. Zhang, C.L. Bai, Q.L. Luo, L. Huang, and F.F. He, “An improved least square channel estimation algorithm for coherent optical OFDM system,” Optik-International Journal for Light and Electron Optics, vol. 124, no. 23, pp. 5937-5944, 2013.

[7] H.K. Shah, T.N. Parmar, N.J. Kothari, and K.S. Dasgupta, “Performance of CR-QOSTBC for Multiple Receive Antennas in MIMO Systems,” In Computational Intelligence and Communication Networks (CICN), vol.21, no. 2, pp. 1-6, 2010.

[8] A. Gomaa, and N. Al-Dhahir, “A new design framework for sparse FIR MIMO equalizers,” IEEE Transactions on Communications, vol.59, no. 8, pp. 2132-2140, 2011.

[9] P. Chen, and H. Kobayashi, “Maximum likelihood channel estimation and signal detection for OFDM systems,” Communications, vol.32, no. 8, pp. 20-32, 2002.

[10] C. Ari, S. Aksoy, and O. Arıkan, “Maximum likelihood estimation of Gaussian mixture models using stochastic search,” Pattern Recognition, vol.45, no. 7, pp. 2804-2816, 2012.

[11] T. Fath, and H. Haas, “Performance comparison of MIMO techniques for optical wireless communications in indoor environments,” IEEE transactions on communications, vol. 61, no. 2, pp. 733-742, 2013.

[12] A. Marczak, "Performance analysis of data transmission in MC-CDMA radio interface with turbo codes," Telecommunication Systems, vol. 59, no. 4, pp. 501-507, 2015.

[13] L.K. Bansal, and A. Trivedi, "Performance of Reduced State S–T Trellis Coded MC-CDMA Systems," Wireless personal communications, vol. 77, no. 1, pp. 449-461, 2014.

[14] Y.W. Kuo, C.C. Lu, and G.Y. Shen, " Adaptive resource allocation for downlink grouped MC-CDMA systems with power and BER constraints," AEU-International Journal of Electronics and Communications, vol.68, no. 1, pp. 25-32, 2014.

[15] Y. Wang, J. Wang, L. Zhaobiao, and X. Liu, "Performance improvement of QO-STBC over time-selective channel for wireless network," Journal of Network and Computer Applications, vol. 36, no. 3, pp. 1018-1026, 2013.