INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

IJARIIT

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue3)
Available online at www.ijariit.com

Analyzing the Performance of BER and SER in an Equalized OFDM System over AWGN by Using 16, 64, 128, 256 QAM Modulation

Vandana Chhoker
Smalkha Group Of Education
id-vandie.chhokerece@gmail.com

Hitesh Taluja
Smalkha Group Of Education
hiteshtaluja@gmail.com

Abstract: For wireless communications system, Orthogonal Frequency Division Multiplexing (OFDM) is a widely applied technique. This system also enables simple filtration or equalization by cyclic prefix insertion. The sensitivity of single-carrier systems to carrier frequency offset (CFO) is much lesser than that of OFDM systems. In present OFDM standards, such as IEEE802.11a/g or DVB-T, preamble (or pilots) is used to estimate and compensate the carrier frequency offset (CFO) and channel impulse response. There is a considerable problem i.e. the residual carrier frequency offset still destroys the orthogonality of the received OFDM signals after the CFO estimation and compensation. This situation further worsens the bit error rate of OFDM systems during the equalization process. In this research work, an equalized OFDM system over AWGN noise by using 16, 64, 128 and 256 QAM is designed. The designed system is modified by using QAM mapping at transmitter and receiver ends. Also, normalization of transmission bits and de-normalization of received bits is done for decreasing BER and SER. Performance analysis of designed OFDM architecture with ZF equalization is performed by using four efficient modulation indexes (16, 64, 128 and 256) with M-QAM modulation. The whole analysis is implemented over OFDM model with AWGN noise. Here the OFDM architecture is used to reduce noise (can be inter-symbol interference) which is the most important loss or attenuation in optical signals, thus mapping and equalization (filtering) is performed. After implementation of proposed method, we have evaluated the performance of the same by using Symbol Error Rate (SER) and Bit Error Rate (BER). These parameters are calculated and plotted with respect to input SNR. MATLAB R2013a has been used as an implementation platform using generalized MATLAB toolbox and wireless communication tool box.

Keywords: Orthogonal Frequency Division Multiplexing, DVB-T, CFO, QAM, AWGN Noise.

1. INTRODUCTION

Now, these days as technology get advanced with an increase in a number of users we need to adopt a concept which allows us reliability to access a network that will provide fast access, high speed and flexibility with cost effectiveness. As the popularity of the Internet, IPTV, triple play, video on demand, audio and video conferencing, online gaming, fast downloading/uploading speed is increased, thus we need a network which would give dynamic bandwidth allocation instead of static bandwidth allocation. Current networks are providing dynamic bandwidth allocation [1].

Due to increase in demand for higher internet speeds, driven by media-rich apps such as on–demand HDTV, Voice over IP (VoIP), video conferencing and online gaming, will require Internet Service Providers (ISPs) to upgrade their existing networks to satisfy the needs of both residential and commercial customers as current Ethernet speeds of 10 GB/s will be upgraded to 100 GB/s [1].

Over the past few years, there has been increasing the attention on extending the services available on wired public telecommunications networks to mobile/movable non-wired telecommunications users. At present only low bit- rate data services are available to mobile users for voice services. The demand for wireless broadband multimedia communication systems (WBMCS) are anticipated within both the public and private sectors because the wired networks are cannot support extension to wireless mobile networks due to mobile radio channels are more contaminated than wired data transmission channels and system cannot preserve the high QoS (Quality of service) required in wired networks. The mobile radio channel is attributed to multipath reception:

- The signal which is introduced to the receiver contains not only a direct line-of-sight (LOS) radio wave but also a large number of reflected radio waves that arrive at the receiver at different times.

- Delayed signals are the result of reflections from terrain features like trees, hills, mountains, vehicles, or buildings. These delayed waves interfere with the direct wave and cause inter-symbol interference (ISI) which causes degradation of network performance.
- A wireless network should be designed to minimize adverse effects. To design broadband multimedia mobile communication systems, it is requiring using high-bit-rate transmission of at least several megabits per second. If digital data is transmitted at the rate of several megabits per second, the delay time of the delayed waves should be greater than 1 symbol time.

2. DIGITAL MODULATION SCHEMES

Various modulation schemes are explained below

A. BPSK

BPSK is Binary Phase Shift Keying or also known as phase reversal keying (PSK) or 2PSK. It is able to modulate 1bit/symbol and not suited for high data rate applications. BPSK is functionally equivalent to 2QAMmodulation. As the name indicates BPSK uses two phases separated by 180 degrees. Among all PSK‟s it is the most robust technique because it takes distortion and noise of higher level force the demodulator to take an incorrect decision.

BPSK Transmitter and Receiver

The simplest form of PSK, also known as phase reversal keying or 2-PSK. Phases are separated by 180̊. The maximum rate of modulation is 1 bit/ symbol.

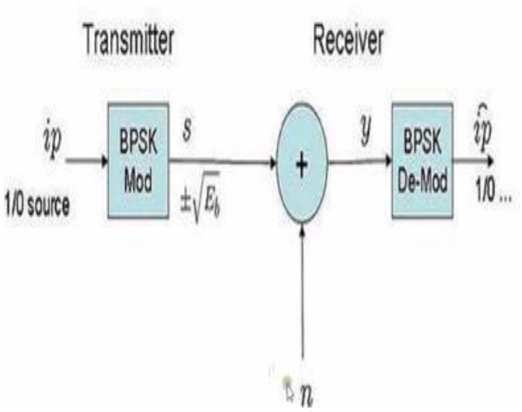

Fig - 1: Block diagram of BPSK system

B. QPSK

It is quadrature phase shift keying and also known as quadric-phase PSK, 4PSK or 4QAM. The resulting waveforms of QPSK and 4-QAM are exactly same but the concept is different. QPSK contain four points in the constellation diagram shows the data points.

The advantage of QPSK over BPSK is that over the same BER the QPSK can transmit twice the data rate in a given bandwidth compared to BPSK. It can encode only two bits per symbol to minimize the bit error.

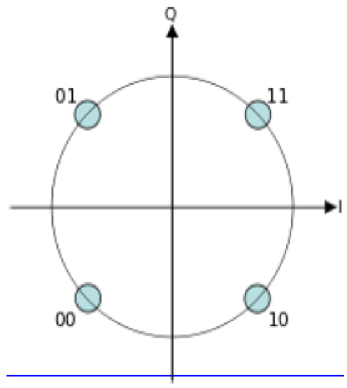

Fig-2 Constellation Diagram of QPSK

Phase -shift keying (PSK) is a digital modulation scheme that conveys data by modulating or changing the phase of the carrier wave. In the QPSK the odd (even) bits are used to modulate the Quadrature-phase component and the even (odd) bits interpretation is used to modulate the in-phase component of the carrier.

C. QAM

It is M array quadrature amplitude modulation technique have many different orders like 4, 8, 16, 32, 64, 128 so on. In QAM the two waves are orthogonal to each other and out of phase each other by 90 degrees. In QAM the constellation points with equal vertical and horizontal spacing are arranged in a square grid. QAM is a combination of amplitude and phase shift keying. In this amplitude and phase, both are changed at the same time.

QAM conveys data by modulating the amplitude of two carrier waves. In QAM the resulting waveform is the combinations of both ASK and PSK techniques. Above 8 PSK, QAM modulation is used. The most common forms of QAM are 16, 64, 128 QAM and 256 QAM. With the increase in order, the possibility of transmission more bits per symbol increases. But with this noise get increased. This results in higher bit error rate (BER). So the higher order QAM delivers data with high rate but less reliably 64-QAM and 256-QAM are often used in digital cable television and cable modem applications. The BER depends on the bit to symbol mapping, but for Eb/No >>1 we assume that each symbol causes only one-bit error.

1).ADVANTAGES

(a) For the long distance communication

(b) Can carry high data rate and capacity

(c) Less BER

(d) Increased system performance.

With the following figure we can see the constellation diagrams of different orders QAM obtained when 1024 bits with 128 samples are modulated and demodulated over Rayleigh channel with AWGN noise. We use CP of 0.0625us and 10 GHz frequency band. The constellation diagram obtained with same input but with 64, 256 and 32-QAM orders determine the data points.

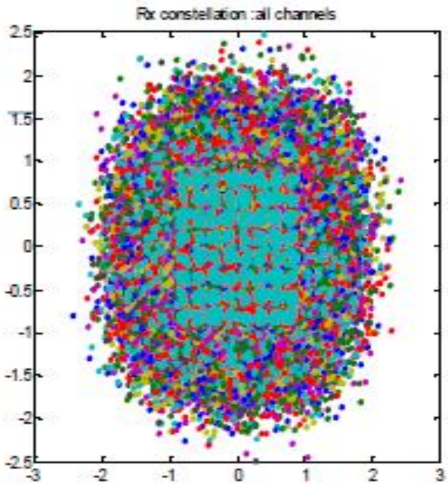

Fig-3 Constellation diagram of 64-QAM

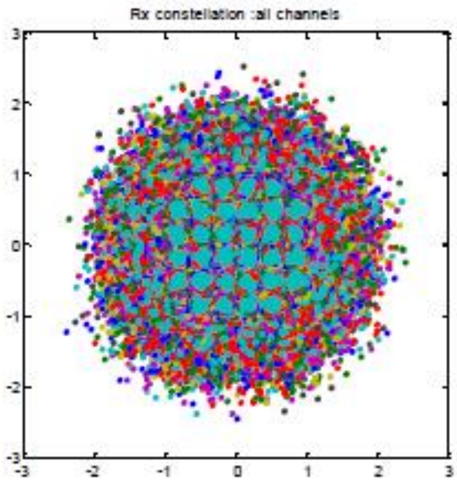

Fig-4 Constellation diagram of 32-QAM

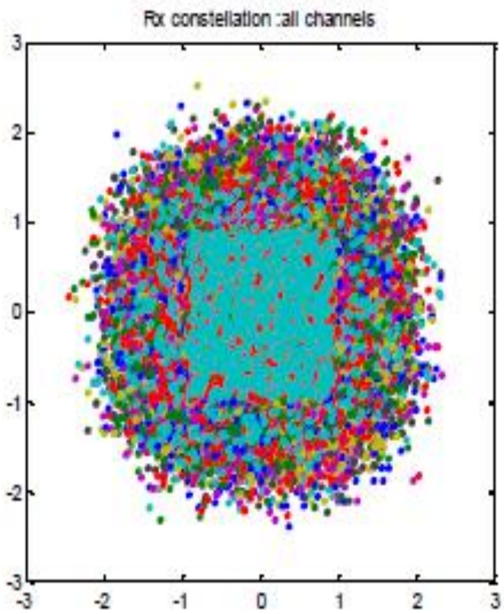

Fig-5 Constellation diagram of 256-QAM

QAM supports both analog and digital modulation schemes; it transmits two message signals by changing the amplitude of the carrier signal.

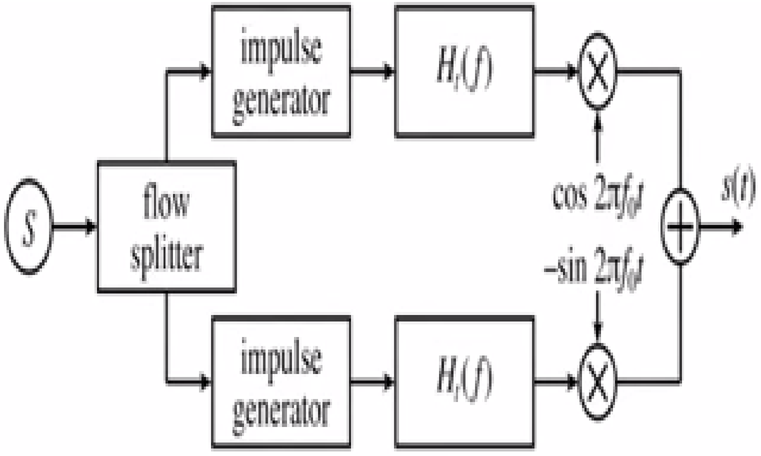

Fig - 6: Block diagram of QAM Modulation

3. PROPOSED METHODOLOGY

1. Initialization and inputting of global system parameters

General Channel Parameters

- Type of Channel i.e. PURE_AWGN

OFDM Parameters

- Total number of symbols in 1 frame to simulate trans-receiver
- Number of average iterations considered
- number of FFT operations or modulation order
- Number of careers (to load all carriers with data)
- Number of cyclic prefixes

Case-Specific Simulation Parameters

- Declaration of modulation order

Other Common Parameters

- Input SNR i.e. Eb/N0 range for simulation
- Number of SNR values
- Computation of signal to noise power

2. Declaration of constellation points according to number of careers
3. Computation of bits per symbol
4. Computation of Average Energy per QAM symbol,
5. Computation of energy per bit
6. Computation of total OFDM symbols
7. Computation of total number of bits
8. Placement of alphabets or symbols in QAM rectangle
9. Declaration of a loop according to number of SNR values
10. Calculation of Noise Power
11. Declaration of counter for symbol error rate
12. Declaration of counter for bit error rate
13. Generation of binary data to transmit using Bernoulli Random Binary Generator
14. Designing of a QAM mapping object
    - Creation of QAM modulation according to Modulation order
    - Enable gray coding for binary bits
    - QAM modulation of bits (to be transmitted)
    - Normalization of modulated data
15. Preparation of transmission sequence
    - Creation of an empty matrix for sequence
    - Start iteration over given number of OFDM symbols
    - Extraction of normalized bits one by one
    - Conversion of signal in time domain
    - Addition of cyclic prefix to the extracted time domain data
16. Generation and addition of Additive White Gaussian Noise to the prepared signal so as to send it to receiver
17. Estimation and Equalization of channel using Zero forcing method
18. Preparation of receiving sequence
    - Creation of an empty matrix for sequence
    - Start iteration over given number of OFDM symbols
    - Removal of cyclic prefix from the received data
    - Extraction of bits one by one and conversion into frequency domain

- Equalization of data using Zero forcing method

19. De-normalization of received data
20. QAM Mapping of received data
    - Segregation of Real and Imaginary part from received data
    - Mapping to the nearest alphabet
    - Mapping boundary conditions for Real and Imaginary part
    - Mixing of real and imaginary part
21. Designing of demodulator and Demodulation of received data
22. Calculation of Symbol Error
23. Calculation of Bit-Error
24. Calculation of Symbol Error Rate
25. Calculation of Bit-Error Rate

Plotting the Performance of proposed system

4. EXPERIMENTAL RESULTS

In this research work, an equalized OFDM system over AWGN noise by using 16, 64, 128 and 256 QAM is designed. The designed system is modified by using QAM mapping at transmitter and receiver ends. Also, normalization of transmission bits and de-normalization of received bits is done for decreasing BER and SER. Performance analysis of designed OFDM architecture with equalization is performed by using four efficient modulation indexes (16, 64, 128 and 256) with M-QAM modulation. The whole analysis is implemented over OFDM model with AWGN noise. Then the performance comparison is done with three modulations with equalization. Here the OFDM architecture is used to reduce noise (can be inter-symbol interference) which is the most important loss or attenuation in optical signals, thus mapping and equalization (filtering) is performed. To implement the proposed system, we have used some global system and specific system parameters. To obtain the results we have used following input values with ZF equalization shown in table

Table 1: Input parameters for Proposed Parameters

S.No.	Parameter	Value
1.	IFFT/FFT Window Size	16, 64, 128 and 256
2	Symbols per frame	500
3	Digital modulation technique	QAM
4	Bits Per OFDM Symbol	4, 6, 7 and 8
5	Number Of Total Bits	32000, 192000, 448000 and 10^6
6	Channel Equalization Method	ZF
7	Type Of channel	AWGN
8	SNR	0-16

After implementation of proposed method, we have evaluated the performance of the same by using SER and BER. These parameters are calculated and plotted with respect to input SNR. The snapshots of these plots for all four modulation order are given below.

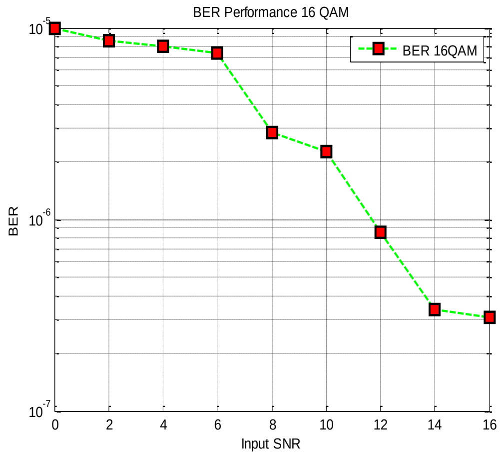

Fig- 7 BER vs. SNR plot for 16 QAM modulation methods.

Figure 7 is a BER vs. SNR plot for ZF equalization 16 QAM modulation methods. In this figure BER is decreases exponentially with increasing SNR.

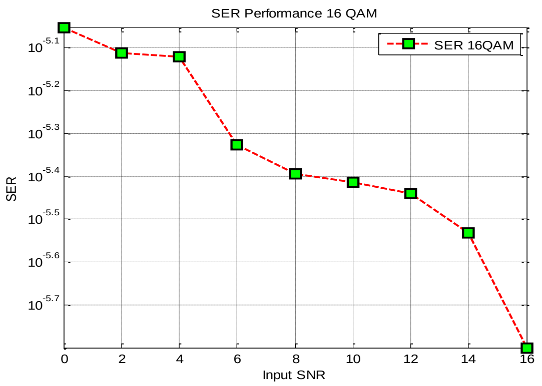

Fig- 8 SER vs SNR plot for 16 QAM modulation methods

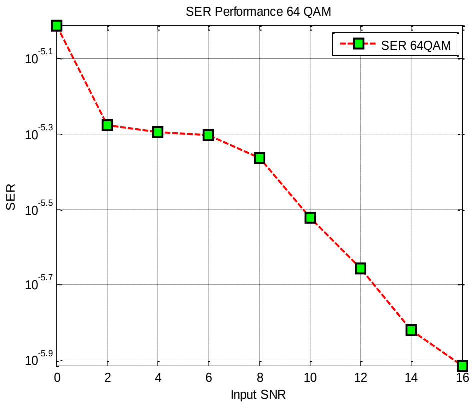

Fig- 10 SER vs. SNR plot for 64 QAM modulation methods

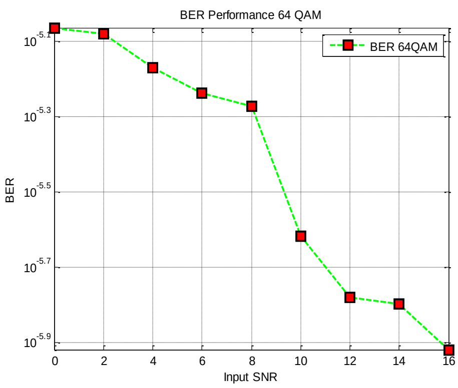

Fig- 9 BER vs. SNR plot for 64 QAM modulation methods

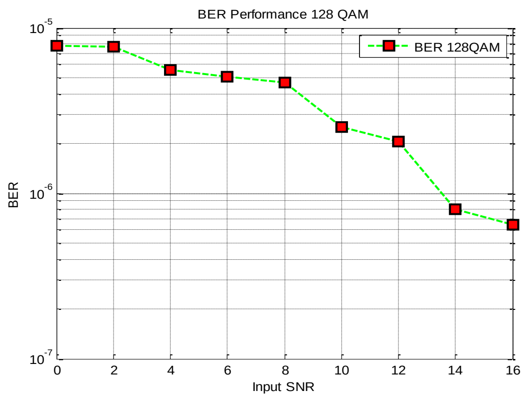

Fig - 11 BER vs. SNR plot for 128 QAM modulation method

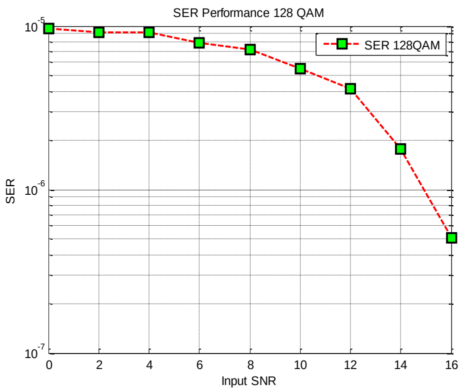

Fig- 12 SER vs. SNR plot for 128 QAM modulation methods

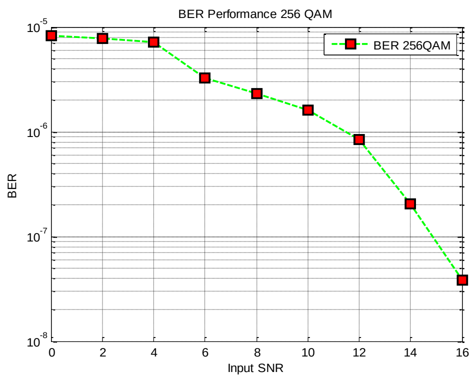

Fig - 13 BER vs. SNR plot for 256 QAM modulation methods

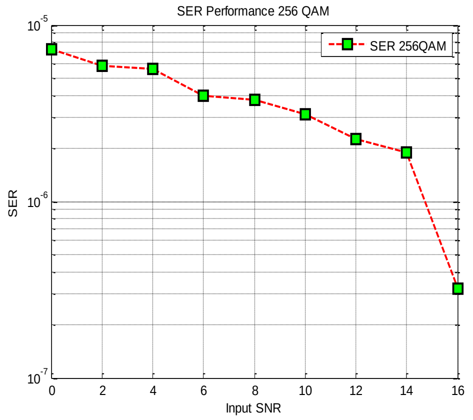

Fig - 14 SER vs. SNR plot for 256 QAM modulation methods

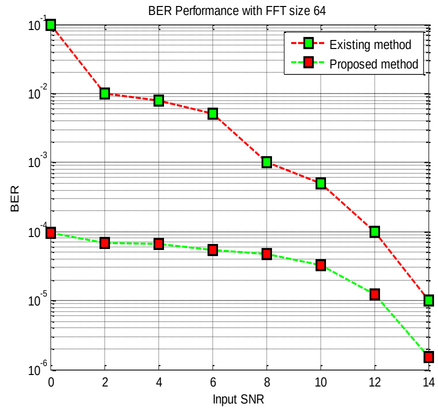

Fig - 15 Comparison of existing method and proposed method

Figure 15 is the comparison of existing method and proposed method which shows that proposed method is more efficient than previous. Thus ZF equalization method is better than Minimum Mean Square Equalizer (MMSE).

5. CONCLUSION AND FUTURE SCOPE

It can be concluded from the previous chapter that ZFequalized OFDM system over method 16, 64,128 and 256-QAM has better performance as compared to existing methods. Here our equalizer performs linearly because we use only one transmitter and receiver model. After simulation on "Matlab", we obtain that 256- QAM performs better than lower order QAM Modulation. Data transmission and reception is better over AWGN by providing less bit to noise ratio. And best results are obtained over 256-QAM with ZF equalizer. Whether equalizer performs linearly but it improves with a higher order of QAM. AWGN is best-suited channel but its thermal noise can be reduced by using efficient methods. We analyzed the working, advantages, disadvantages and performance of OFDM system with different modulation schemes, channel equalization method, and modulation orders. From the previous chapter, we get the performance of proposed system in terms of BER and SER. When these results are compared with that of existing OFDM system, proposed method is much efficient in terms of error rate with that of existing OFDM system. The proposed method can be modified by introducing any other efficient equalization method instead of ZF or higher order of M-QAM Modulation. And if BER is reduced than data access can be done more efficiently.

REFERENCES

1. Sachin Dogra and Natasha, "Analyzing the Performance of an Equalized and Un-equalized OFDM-PON System over AWGN & Rayleigh Fading Channel by Using BPSK, QPSK & 16-QAM and 32-QAM Modulations" International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 7, July 2015.
2. Mohd. Abuzer Khan, Sonu Pal and Ankita Jose, "BER Performance of BPSK, QPSK & 16-QAM with and without using OFDM over AWGN, Rayleigh and Rician Fading Channel" International Journal of Advanced Research in Computer and Communication Engineering Vol. 4 Issue 7, July 2016.
3. Natasha and Chandni, "Analyzing the BER Performance of OFDM-System with QPSK and BPSK Modulation Technique" International Journal of Innovative Research in Advanced Engineering (IJIRAE) Issue 6, Volume 2 (June 2015).
4. Sachin Bhoria, "Analyzing the Performance of OFDM-Architecture Using Numerous Order QAM Modulation" International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 4, Issue 6, June 2015.
5. A.N. Gaikwad, Pranav M. Patil, and P.N. Kota, "Adaptive Modulation for SFBC-OFDM Systems with Zero-Forcing Equalization" Communications on Applied Electronics (CAE) – Foundation of Computer Science FCS, New York, USA Volume 3– No.2, October 2015.
6. Pratima Manhas and Dr. M.K. Soni, "BER Analysis of BPSK, QPSK & QAM-based OFDM System using Simulink" International Journal of Electrical and Electronics Engineers Vol. 7 Issue 02, July-December 2015.
7. Dr. K. R. Nataraj, "BER Performance of Digital Modulation Schemes With and Without OFDM Model for AWGN, Rayleigh and Rician Channels" International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064, 2014.

