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PERFORMANCE ANALYSIS OF MB-OFDM SYSTEM WITH QPSK AND QAM FOR WIRELESS COMMUNICATION

Arpita Mishra[1], Stuti Rastogi[2], Ritu Saxena[3], Pankaj Sharma[4], Sachin Kumar[5]

Dept. of ECE, Moradabad Institute of Technology, Moradabad, GBTU, U.P., India[1,2,3,4,5]

ABSTRACT - **In this paper, we have investigated the performance of MB-OFDM system with higher order QPSK/QAM mapping. The main objective of this paper is to compare the performance of these two modulation techniques with an AWGN channel in terms of BER (Bit Error Rate) and PSD (Power Spectral Density) in the system.**

Keywords - MB-OFDM, QAM ,QPSK, PSD ,BER.

I. INTRODUCTION

In February 2002, the Federal Communications Commission allocated 7500 MHz of spectrum for unlicensed use of commercial ultra-wideband (UWB) communication devices. This spectral allocation has initiated an extremely productive activity for industry and academia [5]. Wireless communications experts now consider UWB as available spectrum to be utilized with a variety of techniques. Ultra Wide Band (UWB) is a high data rate, low power, short range wireless technology that is an emerging technology that has attracted a great deal of interest from academia, industry and global standardization bodies. It is based on the Wi-media standard that brings the convenience and mobility of wireless communication to high speed that interconnects the devices throughout the digital home and office. **U**ltra wide band (UWB) communication systems use signals with a bandwidth that is larger than 25% of the central frequency or more than 500 MHz. The traditional UWB techniques has many disadvantages over the whole allocated bands and therefore there is a shift in UWB system design from initial ‘single band’ radio that occupies the whole allocated spectrum in favour of ‘Multi-band’ design approach. Multi-banding consists in dividing the available UWB spectrum into several sub-bands, each one occupying approximately 500 MHz. The objective of this paper is to analyze the performances in terms of BER and other relevant information such as Power Spectral Density (PSD) and signal constellations.

This paper is organized as follows: Section-II describes the MB-OFDM system and Section-III describes the digital modulation techniques. Section-IV shows the simulation setup and section-V presents the Simulation results and analysis. Finally, section-VI provides concluding remarks.

II.MB- OFDM SYSTEM

Multiband-OFDM (MB-OFDM) [3] is one of the promising candidates for PHY layer of short-range high data-rate UWB communications .It combines Orthogonal Frequency Division Multiplexing (OFDM) with the above multi-band approach enabling UWB transmission to inherit all the strength of OFDM technique which has already been proven for wireless communications (ADSL,DVB,802.11a,802.16a etc.).For that reasons MB-OFDM -UWB technology has been proposed by the IEEE 802.15.3a .High Rate Alternative Physical Layer (PHY) Task Group (TG3a) and ECMA standards.

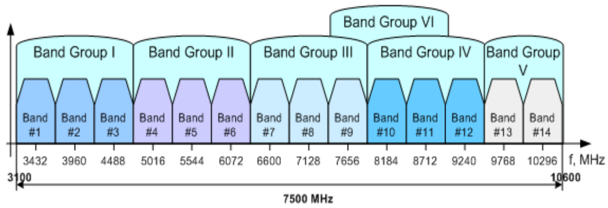

Figure1. Band Groups of the MB-OFDM System

Figure 1 shows the band groups of the MB- OFDM system [8]. The available spectrum (3.1 GHz − 10.6 GHz) is divided into 14 sub-bands, each one occupying 528 MHz The first 12 bands are grouped into four band groups consisting of three bands. The fifth band group includes the last two bands. Each OFDM symbol is transmitted across a sub-band of a band group, providing frequency diversity in the system.

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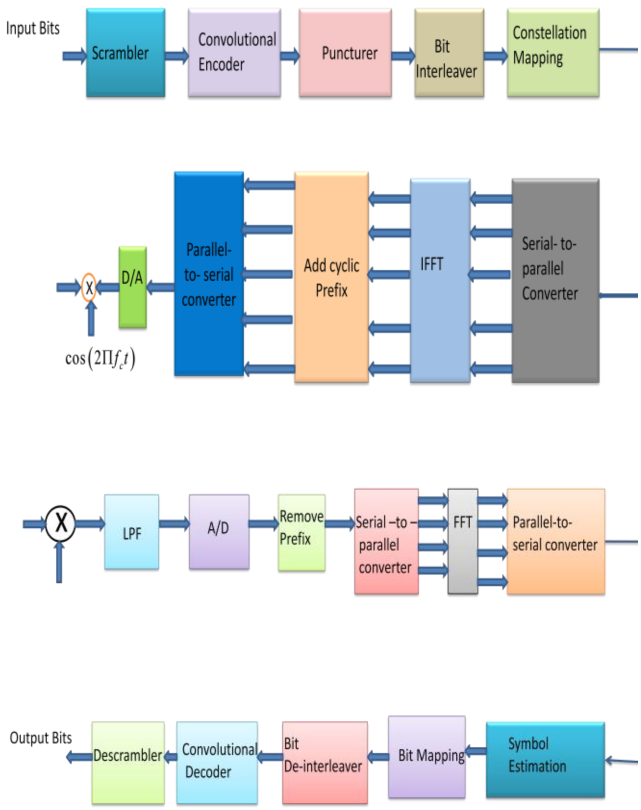

Figure 2.Architecture of MB-OFDM transmitter and receiver

Figure 2 shows the architecture of MB-OFDM transmitter and receiver. The information bits are whitened by scrambler. After this, convolution encoder encoded the bits and then these bits are further interleaved to avoid time-frequency diversity and multipath fading. We use constellation mapping for mapped resulting bits into constellation symbols and then converted into a basic of N symbols by the serial-to-parallel converter. These N-symbols are called frequency components which are being transmitted by the use of the N-subcarrier of the OFDM modulator. These symbols are then converted to OFDM- symbols by the unitary Inverse Fast Fourier transform [10].

III. DIGITAL MODULATION TECHNIQUES

(A) QUADRATURE PHASE SHIFT KEYING

Quadrature Phase Shift Keying (QPSK) is a form of Phase
Shift Keying in which two bits are modulated at once, selecting one of four possible carrier phase shifts (0, Π/2, Π, and 3Π/2).QPSK perform by changing the phase of the In-phase (I) carrier from 0° to 180° and the Quadrature-phase (Q) carrier between 90° and 270°. This is used to indicate the four states of a 2-bit binary code. Each state of these carriers is referred to as a Symbol. Quadrature Phase-shift Keying (QPSK) is a widely used method of transferring digital data by changing or modulating the phase of a carrier signal. In QPSK, digital data is represented by 4 points around a circle which correspond to 4 phases of the carrier signal. These points are called symbols. With four phases, QPSK can encode two bits per symbol, with gray coding to minimize the BER. The QPSK signal consists of two parts In phase and Quadrature phase. In phase gives the real part of the signal and quadrature gives the imaginary part of the signal. The implementation of QPSK is more general than that of BPSK and also indicates the implementation of higher-order PSK [1].

The QPSK formula is mathematically represented as follows:

$$s(t) = A\cos\left(2\pi f_c t + \phi(t)\right) \quad (1)$$

Where $\phi(t)$=135, 45,-45,-135.

$$s(t) = A\cos\phi(t)\cos\left(2\pi f_c t\right) - A\sin\phi(t)\sin\left(2\pi f_c t\right)$$
(2)

The probability of bit error rate (BER) in QPSK is given by:

$$Q(x) = \frac{1}{\sqrt{2\pi}}\int_x^{\infty}\exp\left(\frac{-t^2}{2}\right)dt, x \geq 0 \quad (3)$$

$$Q(x) = \frac{1}{2}erfc\left(\frac{x}{\sqrt{2}}\right)$$

Where Q(x) will give the probability that a single sample taken from a random process with zero-mean and unit-variance Gaussian probability density function will be greater or equal to x.

The symbol error probability is given by:

$$P_s = \left[1 - Q\left(\sqrt{\frac{2E_b}{N_0}}\right)\right]^2 \quad (4)$$

(B) QUADRATURE AMPLITUDE MODULATION

Quadrature Amplitude Modulation (QAM) has fast become the dominant modulation mechanism for high speed digital signals. From the wireless 802.11 protocols to ADSL modems to personal communicators for the military, QAM has become a necessary part of

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our daily lives.QAM is a method of combining two amplitude-modulated (AM) signals into a single channel, thereby doubling the effective bandwidth. In a QAM signal, there are two carriers, each having the same frequency but differing in phase by 90 degrees (one quarter of a cycle, from which the term quadrature arises). One signal is called the I signal, and the other is called the Q signal. Mathematically, one of the signals can be represented by a sine wave, and the other by a cosine wave. The two modulated carriers are combined at the source for transmission. At the destination, the carriers are separated, the data is extracted from each, and then the data is combined into the original modulating information. The QAM signal is mathematically represented as follows:

$$s(t) = m_1(t)\cos w_c t + m_2(t)\sin w_c t \quad (5)$$

Where $m_1(t)$ and $m_2(t)$ are the two message signals. One of them is sent in phase i.e. by multiplying it with $\cos w_c t$ and the other one is sent in quadrature by multiplying it with $\sin w_c t$ .Finally, the two signals are added to obtain the QAM signal [6].
The bit error rate for Gray coded 16-QAM in Additive White Gaussian Noise is

$$P_b = \frac{3}{2k} erfc\left(\sqrt{\frac{kE_b}{10N_0}}\right) \quad (6)$$

Where k is the number of bits transmitted by each symbol.

IV. SIMULATION SET UP

Simulink is one of the most important tool boxes offered by MATLAB [7].The simulation model of the QPSK and QAM modulation technique as shown in figure 3 and 4.

(a) Simulation setup of QPSK

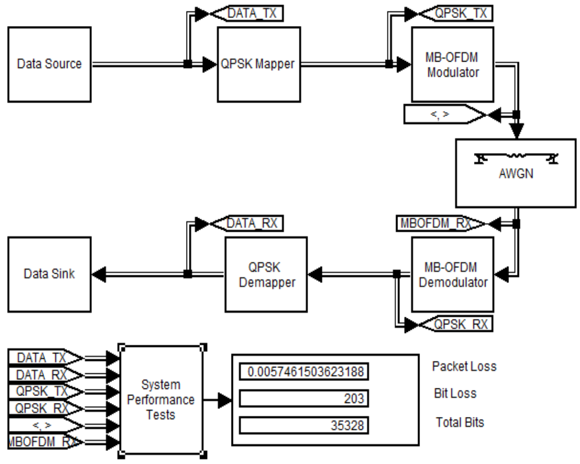

Figure 3.Simulating diagram of MB-OFDM system architecture with QPSK

(a) Simulation setup of QAM

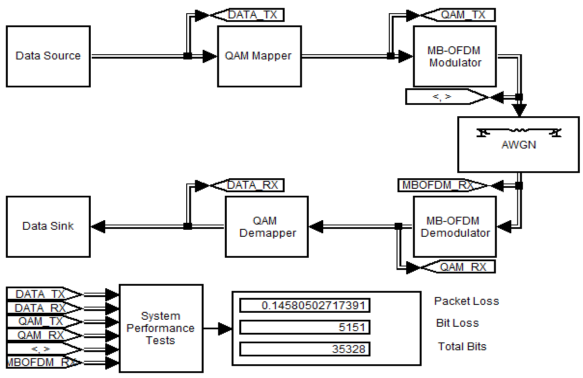

Figure 4.Simulating diagram of MB-OFDM system architecture with QAM

V.SIMULATION RESULTS AND ANALYSIS

In the performance analysis of MB-OFDM system, we have used Bit loss and packet loss for evaluating the performance of both the modulation techniques with MB-OFDM. From the simulation result, we observed that QPSK modulation is more prone to errors while transmitting signal through noisy channel than QAM. The simulation parameters are shown in Table 1:

TABLE1. Simulation Parameters

PARAMETERS	VALUES
Number of subcarriers	64
Number of IFFT size channel	AWGN
Modulation	QPSK & 16-QAM
Bandwidth	528 MHz

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The simulation results show that the QAM modulation is more prone to errors while transmitting signal through noisy channel than QPSK.

Table 2 shows comparative analysis between two modulation scheme using MB-OFDM techniques.Result shows that QPSK scheme having minimum bit loss and packet loss as compared to 16-QAM .Hence, the QPSK modulation scheme can be efficiently used for future generation.

TABLE 2. Comparative Analysis

Modulation	Total Bits	Packet Loss	Bit Loss
QPSK	35328	0.0057461503623188	203
QAM	35328	0.14580502717391	5151

(A) SIMULATION RESULTS OF QPSK

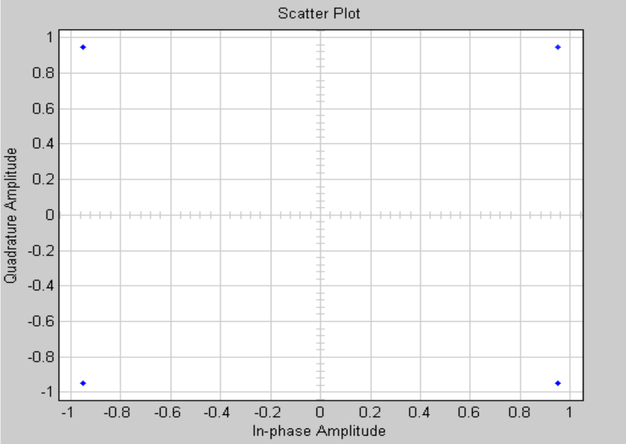

Figure 5(a) Scatter plot of QPSK Transmitter

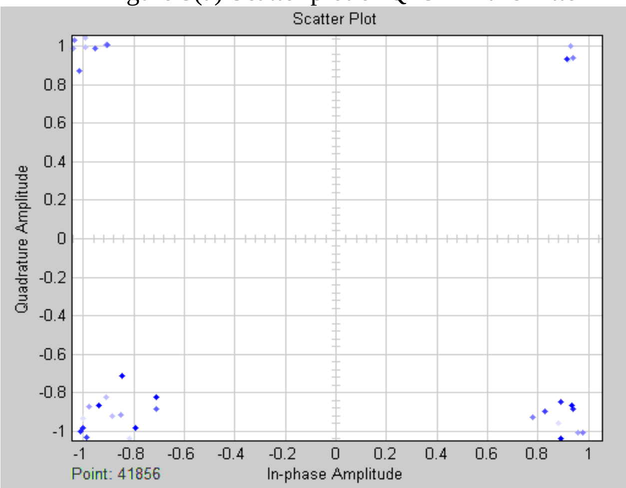

Figure 5(b) Scatter plot of QPSK Receiver

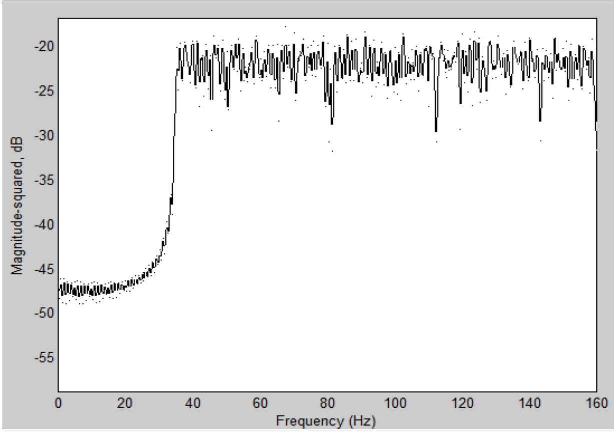

Figure 5(c) Frequency plot of QPSK Transmitter

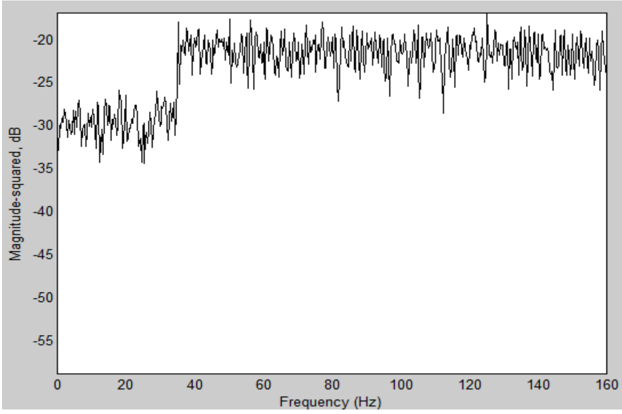

Figure 5(d) Frequency plot of QPSK Receiver

(B) SIMULATION RESULTS OF QAM

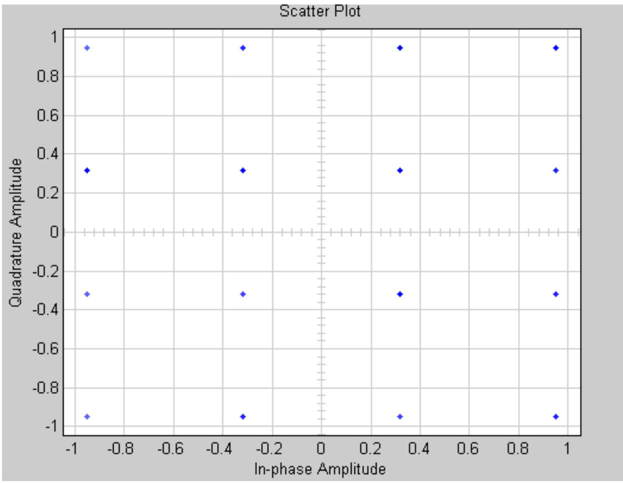

Figure 6(a) Scatter plot of QAM Transmitter

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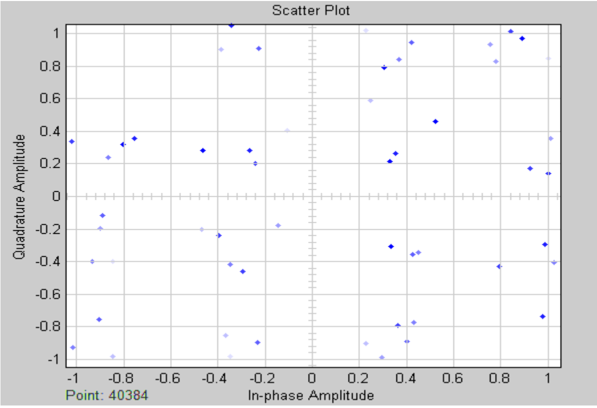

Figure 6(b) Scatter plot of QAM Receiver

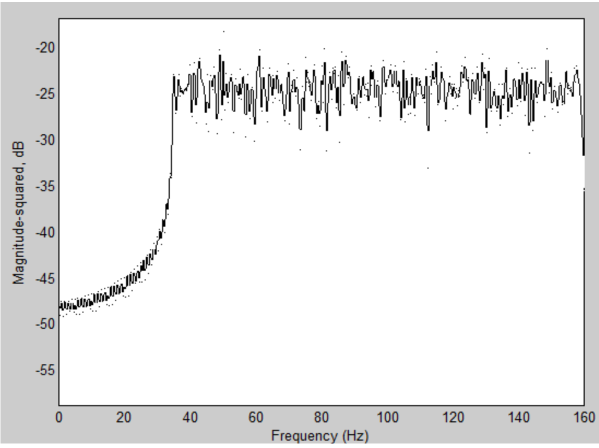

Figure 6(c) Frequency Plot of QAM Transmitter

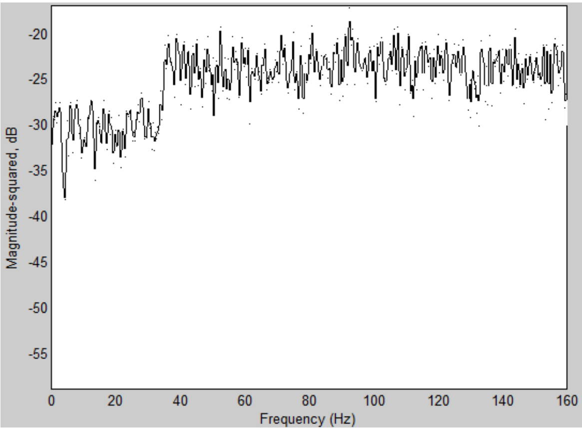

Figure 6(d) Frequency Plot of QAM Receiver

VI. CONCLUSION

Performance analysis of MB-OFDM System with QPSK and QAM has been carried out in this research. In this paper, we have analyzed the effects of a QPSK and QAM modulation technique on the performance of MB-OFDM signal. The performance analysis of MB-OFDM UWB system using QPSK technique is better than that of 16-QAM.

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REFERENCES

[1] Brian Krongold, Timo Pfau, Noriaki Kaneda and Sian Chong Jeffrey, "Comparison between PS-QPSK and PDM-QPSK with equal rate and bandwidth" IEEE photonics technology letters, vol.24, no. 3, February 1, pp 203-205 ,2012.
[2] Kyung-chul Cho, Young-Chang Kang, Sun-hyung, "Performance Analysis of the DQPSK-OFDM System with Equalizer for the Wireless Multimedia Communication" Second International Conference on Future Generation Communication and Networking, pp 78-81,2008.
[3] Zhiweii Lin , Xiaoming Peng, Khiam-Boon and Francois Chin, "Iterative sampling frequency offset estimation for MB-OFDM UWB systems with long transmission packet" IEEE Transactions on vehicular technology, vol.61, no.4, pp 1685-1697 ,May 2012.
[4] Qiyue Zou, Alireza Tarighat and Ali H. Sayed, "Performance Analysis of Multiband OFDM UWB communications with application to range improvement" IEEE Transactions on vehicular technology, vol. 56, no. 6, pp 3864-3878 ,November 2007.
[5] Gerhard Wunder, Thomas Michel and Chan Zhou, "Delay-Limited Transmission in OFDM Systems: Performance Bounds and Impact of System Parameters" IEEE Transactions on wireless communications, vol. 8, no.7, pp 3747-3757, July 2009.
[6] Fanxin Zeng, Xiaoping Zeng ,Zhenyu Zhang and Guixin Xuan, "New constructions of 16-QAM periodic complementary sequences" IEEE communications letters, vol.16, no.12, pp 2040-2043, December 2012.
[7] B K Mishra, S K Singh and M Sharma, "An OFDM based Technique with QPSK and DQPSK Modulation for Next Generation Network" International Conference and Workshop on Emerging Trends in Technology (ICWET 2011)-TCET, Mumbai, India ,pp 912-916,2011. Ch. Sasmita Das, Bikramaditya Das and Susmita Das , "Efficacy of Multiband OFDM Approach in High Data Rate Ultra Wide Band WPAN Physical Layer Standard using Realistic Channel Models" International Journal of Computer Applications vol. 2, pp 0975-8887,May 2010.
[8] S. Ramesh, V vaidehi, "Performance Analysis of UWB Channels for Wireless Personal Area Network" Wireless Personal Communication, pp 169-178 , 2007.
[9] Tan and K.-C. Lin, "Performance of space-time block coded MB-OFDM UWB systems" in Proc.4th Annual Communication Networks and Services Research Conference (CNSR'06), pp.323-327, May 2006.
[10] W.P. Siriwongpairat,W.Su,M. Olfat and K.J.R.Liu, "Multiband OFDM MIMO coding framework for UWB communication systems" IEEE Trans. Signal Processing , vol. 54 , no. 1, pp 214-224, Jan 2006.
[11] Shinya Sugiura, Chao Xu, Soon Xin Ng and Lajos Hanzo, "Reduced-complexity coherent versus non-coherent QAM-Aided space-time shift keying" IEEE Transactions on communications,vol.59, no.11, pp 3090-3101, November 2011.
[12] C.A. Corral, S. Emami and G. Rasor, "Model of Multi-Band OFDM Interference on Broadband QPSK Receivers" IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP'05), vol. 3, March 18-23, pp 629-632, 2005.
[13] When Fan and Chiu-Sing, "Robust, Low complexity and energy efficient downlink baseband receiver design for MB-OFDM UWB system" IEEE Transactions on circuits and systems-I: regular papers, vol. 59, no.2, pp 399-408, February 2012.

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Biography

Arpita Mishra , B.Tech Final year student from electronics and communication engineering from Moradabad institute of Technology, Moradabad, affiliated to Gautam Buddha Technical University, Lucknow, U.P. Her research includes Ultra wideband (UWB) technology and women entrepreneurship education in India & Entrepreneur Education. Her current research interests include the areas of wireless communications and corresponding signal processing, especially for OFDM system.

Stuti Rastogi, B.Tech Final year student from electronics and communication engineering from Moradabad institute of Technology, Moradabad, affiliated to Gautam Buddha Technical University, Lucknow, U.P. Her research include broadband multimedia communications, wireless communications with applications in MB-OFDM and MIMO systems.

Ritu Saxena, B.Tech. Final year student from electronics and communication engineering from Moradabad institute of Technology, Moradabad, affiliated to Gautam Buddha Technical University, Lucknow, U.P. Her paper published in national conference on UWB Technology and women entrepreneur. Her current research interests include the areas of wireless communications and corresponding signal processing, especially for OFDM, UWB system.

Pankaj Kumar Sharma received the B.E. degree in E & T.C. Engineering from North Maharashtra University, Jalgaon (M.S), India, M. Tech. and Ph.D. degree from MNNIT, Allahabad, India. He is currently with M.I.T, Moradabad (U.P.),India, where he is working as an Associate Professor in the Department of Electronics and Communication Engineering. He is a member of IEEE, Institution of Engineers (India), Institution of Electronics and Telecommunication Engineers (IETE), Computer Society of India (CSI), Indian Society for Technical Education (ISTE) and International Association of Engineers (IAEN), Hongkong. He has authored or co-authored many technical papers in major national and international conferences and journals. His current research interests are in the area of wireless communication systems, especially OFDM systems with emphasis on PAPR problem.

Sachin Kumar, B.Tech. Final year student from electronics and communication engineering from Moradabad institute of Technology, Moradabad, affiliated to Gautam Buddha Technical University, Lucknow, U.P. His research interests include broadband multimedia communications, QPSK and M-ary QAM systems.