Image Transmission through OFDM System under the Influence of AWGN Channel

M.Gnanesh Goud
Department of Electronics and Communication Engineering,
TKR College of Engineering and Technology,
Affiliated to JNTU Hyderabad,
Telangana-500097, India.

N.Naresh
Department of Electronics and Communication Engineering,
TKR College of Engineering and Technology,
Affiliated to JNTU Hyderabad,
Telangana-500097, India.

B. Purender Reddy
Department of Electronics and Communication Engineering,
TKR College of Engineering and Technology,
Affiliated to JNTU Hyderabad,
Telangana-500097, India.

Dr.D.Nageshwara Rao
Department of Electronics and Communication Engineering,
TKR College of Engineering and Technology,
Affiliated to JNTU Hyderabad,
Telangana-500097, India.

Abstract:
OFDM system is one among the modern techniques which is most abundantly used in next generation wireless communication networks for transmitting many forms of digital data in efficient manner than compared with other existing traditional techniques. In this paper, one such kind of a digital data corresponding to a two dimensional (2D) gray-scale image is used to evaluate the functionality and overall performance of an OFDM system under the influence of modeled AWGN channel in MATLAB simulation environment. Within the OFDM system, different configurations of notable modulation techniques such as M-PSK and M-QAM are considered for evaluation of the system and necessary valid conclusions are made from the comparison of several observed MATLAB simulation results.

Keywords: AWGN, OFDM, BPSK, QPSK, M-QAM.

I.INTRODUCTION:
In a communication system, in order to make use of the channel capacity, it is desirable to transmit more than one signal on the same transmission media. This is possible to process called multiplexing.

The field of electronics can be classified in to three major classes: Computers, communications and control. The computer field is the youngest of three, while communications industry is the oldest, since electronics really started with radio communication. Orthogonal Frequency Division Multiplexing (OFDM) is a key wireless broad band technology, it support large bandwidth and data rate is very high. In single carrier communication system, the symbol period must be much greater than the delay time in order to avoid inter symbol interference (ISI). Since data rate is inversely proportional to symbol period, having long symbol periods means low data rate and communication in efficiency [1].OFDM is used to divide the transmission channel into a number of sub channel, can get high bit rate and good spectrum efficiently [2]. In this paper is discussed as follows: OFDM modulation schemes are discussed in section II, Gray scale image in section III, Results and Discussion in section IV and Conclusion in section V.

Cite this article as: M.Gnanesh Goud, N.Naresh, B. Purender Reddy & Dr.D.Nageshwara Rao, “Image Transmission through OFDM System under the Influence of AWGN Channel”, International Journal & Magazine of Engineering, Technology, Management and Research, Volume 5, Issue 4, 2018, Page 35-41.
II. OFDM:
In wireless communication system Orthogonal Frequency Division Multiplexing (OFDM)[11] is a new modulation system for its several advantages and it is as shown in fig.1. In multi carrier communication system, transmit more than signals at same time through separate channels at lower data rate or sub carriers. In single carrier communication system transmit more than one signal through same transmission media, are interfere each other, but in multi carrier system due to sub carriers the signals are do not interfere with other, and from each sub carriers the transmitted signals are recovered[1]. In single carrier transmission the symbol rate of ‘Ts’ symbols per second, the bandwidth required this is equal to twice the nyquist rate To transmit higher data rate in single carrier transmission, it required wider bandwidth. However, as the symbol rate increases, the signal bandwidth becomes larger. In wireless channel the signal bandwidth is larger than the coherence bandwidth, the link suffer from multipath fading, occurring the Inter symbol interference (ISI) [3][4].

OFDM is a parallel transmission scheme, where a high-rate serial data stream is split up into a set of low-rate sub streams, each of which is modulated on a Separate SC (FDM). Thereby, the bandwidth of the SCs becomes small compared with the coherence bandwidth of the channel; that is, the individual SCs Experience flat fading, which allows for simple equalization. This implies that the symbol period of the sub streams is made long compared to the delay spread of the time-dispersive radio channels [5]-[14].

III. GRAY SCALE IMAGE:
The Test Image chosen for the evaluation of OFDM[7][8] System for Image Transmission[12][13][14] is shown in Fig. 2. This is one of the default images which is available within the MATLAB Database and most widely used by researchers worldwide. It can be accessed by name ‘Cameraman’, image is available in .JPG format having size as 1024 X 1024. So the total number of pixels are 10, 48,576. Each pixel value is represented in unsigned integer format of 8-bits (uint-8). Initially this image is not in a suitable form for direct transmission through OFDM system. For transmitting this image which is available in matrix or two dimensional signals, we need to do some pre-processing for converting this 2D image into 1D signal. Read the image which is available by default in 1024 x 1024 sizes and represented in uint8 format. Convert it into double format and reshape the data to change from matrix representation of 1024x1024 into vector representation of 1 x 1048576. Now we successfully converted 2D signal to 1D signal. This signal is now partially ready for transmission purpose. In the final step, depending upon the modulation technique used, we need to convert the vector data into suitable form. For example, if we use BPSK modulation, then we need to convert the vector data into binary data (two signaling elements i.e. 0s and 1s). For QPSK modulation, we need to convert the vector data into binary data (four signaling elements i.e. 00, 01, 10 and 11 0, 1, 2 and 3 respectively).

This data is used as source data or input image signal for the OFDM transmitter.

Fig.1 Block Diagram of OFDM system

Fig.2 Cameraman Test Image
At the receiver, after recovering the digital bits, the original image can be reconstructed by performing inverse operations corresponding to the operations as discussed in the above mentioned algorithm. The source data which is in serial form is converted to parallel form by S/P so as to assign the data onto multiple sub-carriers and modulated by any of the M-PSK or M-QAM Technique. After modulation, IFFT operation is performed and finally the signal is converted from parallel form to serial form by using P/S for transmission purpose. At the receiver corresponding inverse operations are performed so as to efficiently recover the transmitted image. Table I. shows the characteristics of the source signal. Table II, shows the properties and corresponding values which are considered in MATLAB simulation.

### Table: I Characteristics of Cameraman Test Image

| Property                              | value                  |
|---------------------------------------|------------------------|
| Original Image Size                   | 1024 x 1024            |
| Total Pixels                          | 1048576                |
| Each Pixel Data Size                  | 8-bits                 |
| For BPSK Transmission Size of Source Signal Data or Signal Elements | 1048576*8 = 8388608    |
| For QPSK Transmission Size of Source Signal Data or Signal Elements | 8388608/2 = 4194304    |
| For 16-PSK / QAM Transmission Size of Source Signal Data or Signal Elements | 8388608/4 = 2097152    |
| For 256-PSK / QAM Transmission Size of Source Signal Data or Signal Elements | 8388608/8 = 1048576    |

### Table: II MATLAB Simulation Parameters

| Property                              | Value |
|---------------------------------------|-------|
| Total Number of Sub-Carriers & FFT Size | 512   |
| Type of Guard Interval inserted after IFFT at Transmitter | Cyclic Prefix |
| Modulation Schemes                    | BPSK, QPSK, 16—QAM, 64-QAM |
| Channel                               | AWGN  |
| Range of SNR in dB considered for evaluating BER | 0-40dB |

### IV.AWGN:

Additive white Gaussian noise (AWGN)[6] is a basic noise model used in Information theory to mimic the effect of many random processes that occur in nature.

The modifiers denote specific characteristics:
- **Additive** because it is added to any noise that might be intrinsic to the information system.
- **White** refers to the idea that it has uniform power across the frequency band for the information system. It is an analogy to the color white which has uniform emissions at all frequencies in the visible spectrum.
- **Gaussian** because it has a normal distribution in the time domain with an average time domain value of zero.

Wideband noise comes from many natural sources, such as the thermal vibrations of atoms in conductors (referred to as thermal noise, shot noise, black body radiation from the earth and other warm objects, and from celestial sources such as the Sun. The central limit theorem of probability theory indicates that the summation of many random processes will tend to have distribution called Gaussian or Normal. AWGN is often used as a channel model in which the only impairment to communication is a linear addition of wideband or white noise with a constant spectral...
density and a Gaussian distribution of amplitude. The model does not account for fading, frequency selectivity, interference, nonlinearity or dispersion. However, it produces simple and tractable mathematical models which are useful for gaining insight into the underlying behavior of a system before these other phenomena are considered. The AWGN channel is a good model for many satellite and deep space communication links. It is not a good model for most terrestrial links because of multipath, terrain blocking, interference, etc. However, for terrestrial path modeling, AWGN is commonly used to simulate background noise of the channel under study, in addition to multipath, terrain blocking, interference, ground clutter and self interference that modern radio systems encounter in terrestrial operation.

V. RESULTS AND DISCUSSION:
The comparison of recovered images at different SNRs i.e. 0 dB to 40dB respectively is corresponding to different modulation techniques as shown in Table. III. The signal constellation diagrams for 16-PSK and 16-QAM both at transmitter and at receiver as shown in Fig. 3, and Fig. 4. The performance of OFDM system in terms of total errors and achieved BER[10] at different SNRs corresponding to different modulation schemes are shown in Table III.

Table: III Comparison of Recovered Images at the OFDM Receiver

| SNR In dB | RECOVERED IMAGES |
|-----------|------------------|
| 1         | ![Recovered Images](image1) |
| 10        | ![Recovered Images](image2) |
| 20        | ![Recovered Images](image3) |
| 30        | ![Recovered Images](image4) |
VI. CONCLUSION:
The OFDM system has been implemented with different modulation techniques for Image Transmission through AWGN channel. The quality of the recovered image is better at reasonably high SNR values irrespective of the modulation technique used. At low SNR, the quality of the recovered image is very less due to the presence of high amount of AWGN noise. It is found that the OFDM system with 16-QAM modulation technique provides less number of errors, less BER, and high quality of the recovered image at the receiver than compared with the OFDM systems implemented with rest of the techniques.

VII. REFERENCES:
[1] N. S. Sai Srinivas, “OFDM System Implementation, Channel Estimation and Performance Comparison of OFDM Signal,” Proceedings of IEEE 13th International Conference on Electromagnetic Interference and Compatibility (INCEMIC-2015), IEEE EMC Society and SEMCEI, pp. 461 – 466, Visakhapatnam, India, July 2015.

[2] H. Schulze and C. Luders: "Theory and Applications of OFDM and CDMA Wideband Wireless Communication”, John Wiley, 2005.

[3] Nasheet Fatima. Image Transmission over OFDM System using Trigonometric Transforms. 2015 International Conference on Communication,
[4] Zain ul Abidin Jaffri, Muhammad Tahir, Sundas Rauf, “Evaluating the performance of OFDM transceiver for image transfer using 16PSK and 16QAM modulation schemes”. IJSET@2014.

[5] Kanchan Sharma Anurag Mishra Asok De. 2012 25th IEEE Canadian Conference on electrical and Computer Engineering (CCECE) 978-1-4673-1433-6/12/$31.00 ©2012 IEEE.

[6] Reeta Charde, “Image Performance over AWGN Channel Using BPSK System,” International Journal of Engineering and Innovative Technology (IJEIT), vol. 2, no. 1, 2012.

[7] Soham Bhavsar, Harshit Pandey, Prithviraj Chouhan“ Design and Implementation of OFDM Trans-Receiver for IEEE 802.11(WLAN)“. IJMER Vol. 4 Iss. 1 Jan. 2014 55.

[8] Anurag Pandey, Sandeep Sharma” BER Performance of OFDM System in AWGN and Rayleigh Fading Channel”. International Journal of Engineering Trends and Technology (IJETT) – Volume 13 Number 3 – Jul 20.

[9] Nirmalendu Bikas, Sinha R Bera,”Hybrid Technology for Next Generation Broad band Mobile Radio Communications”.IEEE 2009.

[10] Ramjee Prasad, “OFDM for Wireless Communications Systems”.Artech House, Incorporated, 2004.

[11] Saroj Kanta Pattanaik, Shubhendu Kumar Sarangi,” Performance of BER in OFDM System Using Different Channels and Modulation Techniques”. International Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue 4, Jul-Aug 2013, pp. 447-451.

[12] Ms. A K Jesna,”IMPROVED PERFORMANCE IN IMAGE TRANSMISSION WITH OFDM”, IJAICT Volume -1, Issue-1, May 2014. ICMAEM-2017 IOP PublishingIOP Conf. Series: Materials Science and Engineering 225(2017) 012217 doi:10.1088/1757-899X/225/1/012217.

[13] Mr.P.Ratna Bhaskar, K.Mounika,” Implementation of OFDM System For Image Transmission”, International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169 Volume: 3 Issue: 5 3187 – 3191.

[14] Shadbhawana Jain and Shailendra Yadav,“Image Transmission Using 64-QAM Modulation Technique in Digital Communication System”, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 12.

VIII.AUHTORS BIODATA

M.Gnanesh Goud
Received his B.Tech degree in Electronics and Communication Engineering from Jawaharlal Nehru Technological University in 2012, and he completed his M.Tech from Jawaharlal Nehru Technological University in 2014. He worked as Assistant professor in TKR College of Engineering and technology, Hyd.

N.Naresh
Received his B.Tech degree in Electronics and Communication Engineering from Jawaharlal Nehru Technological University in 2011, and he did his M.Tech in Communication Systems from Jawaharlal Nehru Technological University in 2014, currently he
is working as Assistant professor in TKR College of engineering and technology, Hyd.

B.Purender Reddy

Received his B.Tech degree in Electronics and Communication Engineering from Jawaharlal Nehru Technological University in 2010, and he did his M.Tech in Digital Electronics Communication Systems from PES University in 2014, currently he is working as Assistant professor in TKR College of engineering and technology, Hyd.

Dr.D. Nageshwar Rao

Received the B.E degree in Electronics Engineering from Shyamlal college of Engineering, SRTMU Nanded, in 1999 and M.Tech with specialization DSCE from J.N.T.U College of Engineering, JNTU HYD, in 2004. He completed Ph.D at GITAM University, Vishakapatnam in 2014. His doctoral research is directed towards the design of a low voltage, low power VLSI analog circuits. His area of research is Low power VLSI, Image Processing & Video Processing. Presently he is working as Professor in TKR College of Engineering & Technology, Meerpet, Hyd.