Implementation of OFDM System For Image Transmission

Mr.P.Ratna Bhaskar (Assistant professor)
Electronics and Communications Engineering Department
SRK Institute of Technology
Vijayawada, India
ratnabhaskar.prb@gmail.com

K.Mounika(UG scholar)
Electronics and Communications Engineering Department
SRK Institute of Technology
Vijayawada, India
mounika.kasaraneni9@gmail.com

Abstract— Orthogonal frequency division multiplexing (OFDM) is a special case of frequency division multiplexing where a single data stream is transmitted over several lower rate subcarriers, which are placed orthogonal to each other. Now a day's OFDM is becoming the chosen modulation technique for wireless communications. It provides large data rates with optimum bit error rate and enough robustness to radio channel impairments. In this paper, we analyze the performance of OFDM system using MATLAB simulation. Here image is transmitted using M-ary PSK. Magnitude and phase characteristics of input and output data are calculated.

Keywords- *OFDM, M-ary PSK, MATLAB*

*****

I. Introduction

In order to avoid inter-symbol interference (ISI) in a single carrier communication system, the symbol period must be much greater than the delay time. As data rate is inversely proportional to symbol period, having long symbol periods means low data rate and communication inefficiency. In a multicarrier system such as FDM (Frequency Division Multiplexing), the total available bandwidth in the spectrum is divided into sub-bands for multiple carriers to transmit in parallel. An overall high data rate is achieved by placing carriers closely in the spectrum. But, inter-carrier interference (ICI) will occur due to lack of spacing to separate the carriers. So to avoid inter-carrier interference, guard bands are placed in between any adjacent carriers, which results in lowered data rate.

OFDM (Orthogonal Frequency Division Multiplexing) is a multicarrier digital communication scheme which can solve both issues [2]. It can combine a large number of low data rate carriers to construct a composite high data rate communication system. Lower data rates of each carrier imply a long symbol period, which greatly diminishes inter-symbol interference.

In this paper, the concept and feasibility of an OFDM system are demonstrated, and how its performance is changed by varying some of its major parameters is investigated. These objectives are met by developing a MATLAB program to simulate a basic OFDM system [1].

II. BACKGROUND

A .OFDM basics

Information is expressed in the form of bits in digital communications. The term symbol is referred as a collection, in various sizes, of bits. Using M-PSK, QAM etc, OFDM data are generated by taking symbols in the spectral space and convert the spectra to time domain by taking the Inverse Discrete Fourier Transform (IDFT). As Inverse Fast Fourier Transform (IFFT) is more cost effective to implement, it is usually used instead. Once the OFDM data are modulated to time signal, in order to fully occupy the available frequency bandwidth all carriers are transmitted in parallel [1]. In order for the received signal to be in sync with the receiver, OFDM symbols are divided into frames during modulation, so that the data will be modulated frame by frame. Even though long symbol periods diminish the probability of having Inter-symbol interference, they could not eliminate it. A cyclic extension is added to each symbol period to make ISI nearly eliminated. An exact copy of a fraction of the cycle, which is typically 25% of the cycle is taken from the end and is added to the front. Thus the demodulator can capture the symbol period with an uncertainty of up to the length of a cyclic extension and still obtain the correct information for the entire symbol period.

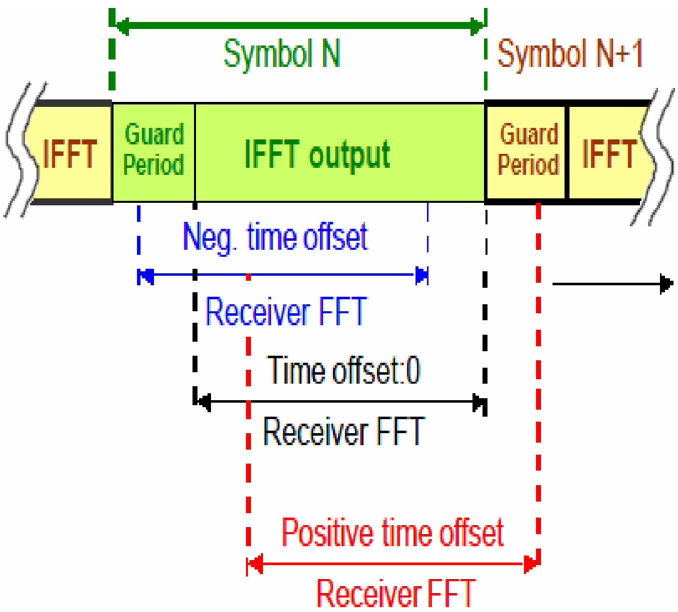

Fig 1: cyclic extension tolerance

As shown in the figure 1, a guard is the amount of uncertainty allowed for the receiver to capture the starting point of a symbol period, such that the result of FFT still has the correct information.

ISSN: 2321-8169
3187 – 3191

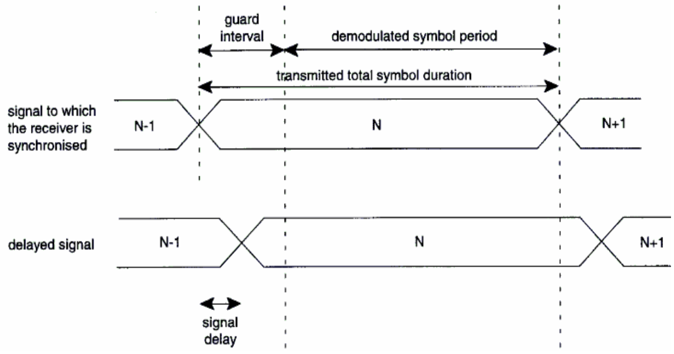

Fig 2: effectiveness of cyclic extension

In Figure 2, a comparison between a precisely detected symbol period and a delayed detection is performed and this illustrates the effectiveness of the cyclic extension.

B. OFDM Parameters and Characteristics

Not only the available spectral bandwidth, but also the IFFT size limits the number of carriers, which is determined by the complexity of the system. The relationship between these two is described by: number of carriers ≤ ((ifft –size)/2) -2.

M-PSK modulation varies the data rate and Bit Error Rate (BER). Higher the order of PSK, larger the symbol size, thus lesser the number of symbols needed to be transmitted, and higher the data rate. But this leads to higher BER since the range of 0-360 degrees of phases will be divided into more sub-regions, and the smaller size of sub-regions is required, thereby received phases have higher chances to be decoded incorrectly. The peak-to-average ratio of OFDM symbols is high, thus OFDM symbols have a relatively high tolerance of peak power clipping due to transmission limitations [5].

C. Orthogonality

Maintaining orthogonality of carriers is the key to OFDM. Two signals are said to be orthogonal to each other if the integral of the product of two signals is zero over a time period [4].

III. EXPERIMENTAL DESIGN

In the present study block scheme of an OFDM is designed. As shown in Fig, block diagram represents the whole system model. The block system is divided into 3 main sections namely the Transmitter, Channel and the Receiver.

a) Source: It generates the information message which is to be transmitted. Here an 8-bit bitmap image is considered as input.

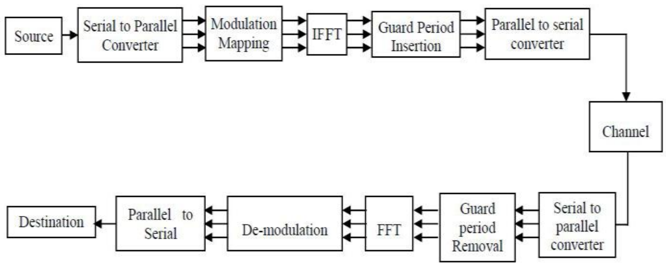

Fig 3: OFDM block diagram

b) Serial to Parallel Conversion: In OFDM system each symbol typically transmits 40-4000 bits, so a serial to parallel conversion is needed to convert the input data to be transmitted in each OFDM symbol. The data that is to be allocated to each symbol depends on the modulation scheme and the number of subcarriers.

c) Modulation Mapping: It is done using a modulation scheme to map data words to a real (In phase) and imaginary (Quadrature) constellation, also known as an IQ constellation. It is useful to define number of bits per symbol. In our paper we perform M-ary PSK modulation techniques.

d) IFFT: It is used for converting the signal to the time domain allowing it to be transmitted. By exploiting the regularity of the operations in IDFT, the IFFT drastically reduces the amount of calculations. By using the radix-2 algorithm, an N-point IFFT requires only (N/2) log2N complex multiplications.

e) Guard Period: The most important advantage of OFDM is its robustness to multipath delay spread, and that is achieved by dividing the input stream in Ns subcarrier, the symbol duration is made Ns times smaller, which also reduces the relative multipath delay spread, relative to the symbol time, by the same factor [3]. In order to eliminate ISI guard time is introduced to each symbol. The component from one symbol is not able to interfere with the next symbol. No signal exists in guard time. Here we come across another problem which is Inter Carrier Interference (ICI). ICI is the cross talk between different subcarriers, which means that they are no longer orthogonal. Thus to eliminate ICI, OFDM symbol must be cyclically extended in the guard time. Thus it is ensured that the delayed replicas of the OFDM symbol always have an integer number of cycles with in FFT interval, as long as the delay is smaller than the guard time. So as a result, all multipath signals with delay smaller than the guard time cannot cause ICI.

f) Parallel to Serial Converter: The operation performed by parallel to serial converter is exactly opposite to serial to parallel converter. Here bits are converted back to serial so that they can be easily transmitted.

g) Channel: In most communication systems AWGN channel is used. The thermal noise in the receivers is characterized as an additive white Gaussian process.

h) Guard Period Removal: Here the cyclic prefix which is attached at the transmitter is removed, which reduces the Inter Symbol Interference (ISI).

i) FFT: The amplitude and phase of each subcarrier is estimated using FFT. Except for a bank of subcarriers, the FFT performs the same operation as the matched receiver for single carrier transmission.

IV. M-ARY PSK

- PSK is a digital modulation scheme that converts data by changing, or modulating, the phase of a reference signal.
- BPSK: It uses two phases and signal shifts the phase of the waveform to one of the two states either 0 or ∏.
- QPSK: Each symbol consists of two bits and signal transmits among the phases that are separated by 90degrees but used only one bit per channel [3].

Higher order PSK modulation techniques are also used at modulation mapping.

V. IMAGE

A. Gray scale image:

A gray scale image is nothing but a data matrix whose values represent intensities of some range. In MATLAB gray scale image is stored as an individual matrix, with each element of matrix corresponding to one image pixel.

B. Bit map file format:

Image file format is the standardized means of storing and organising images. Bit map file format is a raster graphics image file format used to store bitmap images.

Here an 8bit gray scale bitmap image is given as input at the source.

VI. SIMULATION AND RESULTS

MATLAB code is written and simulated for transmitting and receiving an 8bit gray scale bitmap image by OFDM technique system using m-ary PSK techniques.

Fig 4:original image

For example consider the image to be transmitted is as shown in figure 4.

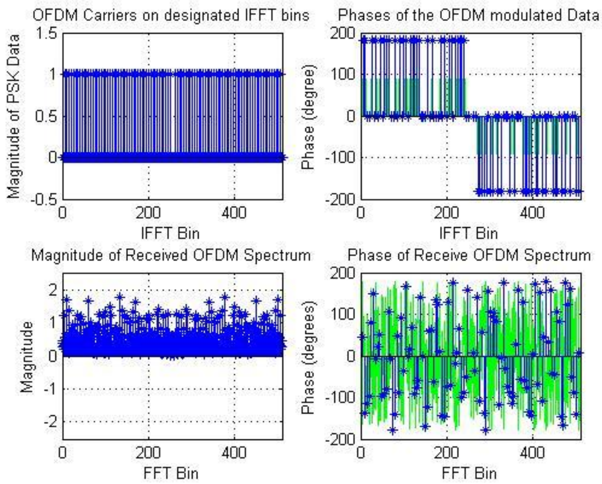

Fig 5: output waveforms for 16PSK when snr =0

Fig 6:output image for 16PSK when snr=0

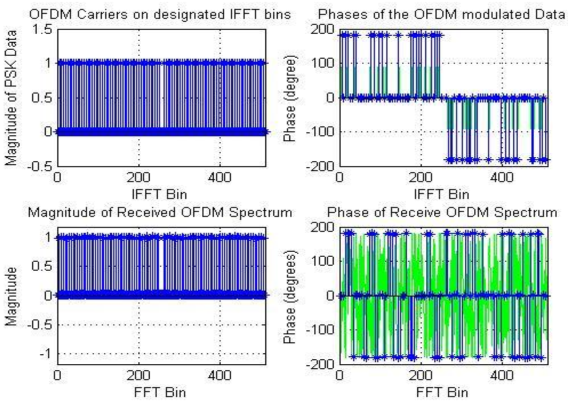

Fig 7:output waveform for 16PSK when snr=30

Fig 8: output image for 16PSK when snr=30

ISSN: 2321-8169
3187 – 3191

MODULATION SCHEME	SNR=0	SNR=15	SNR=30
BPSK			
QPSK			
16PSK			
256PSK			

Fig 9: comparison of outputs

VII. CONCLUSION

An OFDM system is successfully simulated using MATLB. All major components of an OFDM system are covered. This has demonstrated the basic concept and feasibility of OFDM. Other possible future works to improve this simulation program include adding ability to accept input source data in a word size other than 8-bit, adding an option to use QAM (Quadrature amplitude modulation) instead of M-DPSK as the modulation method.

REFERENCEs

[1] Acosta, Guillermo. “OFDM Simulation Using MATLAB” 2000

[2] Understanding an OFDM transmission: http://www.dsplog.com/2008/02/03/understanding-an-ofdm-transmission/

[3] BBC Research Department, Engineering Division, “An Introduction to Digital Modulation and OFDM Techniques” 1993

[4] Minimum frequency spacing for having orthogonalsinusoidalhttp://www.dsplog.com/2007/12/31/minimum-frequency-spacing-for-having-orthogonal-sinusoidals/

[5] [Litwin, Louis and Pugel, Michael. “The Principles of OFDM” 2001

BIBLOGRAPHY

P. Ratna Bhaskar received his B.Tech degree in Electronics and communication Engineering from

DVR & Dr. HS MIC College of Technology, Kanchekacherla in 2006 and M.Tech degree in Communication and Signal Processing from V.R Siddhartha Engineering College Vijayawada, Andhra Pradesh, India in 2009. Now he is working as Assistant Professor in S.R.K Institute of Technology, Vijayawada, Andhra Pradesh, India. His research interests are Telecommunications, Cellular and Mobile Communications, Wireless Communications, and Wireless Communications and Networks.

K.Mounika received her B.Tech degree in Electronics and communication Engineering from S.R.K Institute of Technology, Vijayawada, Andhra Pradesh, India. Now she is going to pursue her Masters at Texas A & M University, Kingsville.