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Implementation of OFDM (Orthogonal Frequency Division Multiplexing) Using MATLAB Simulink

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ABSTRACT:
Our project "Implementation of OFDM Using MATLAB Simulink" is primarily intended to develop a MATLAB-based simulation of OFDM, i.e. Orthogonal Frequency Division Multiplexing, Orthogonal Frequency Division Multiplexing or OFDM is a modulation format that is being used for many of the latest wireless and telecommunications standards. Orthogonal frequency division multiplexing has also been adopted for a number of broadcast standards from DAB Digital Radio to the Digital Video Broadcast standards, DVB. It has also been adopted for other broadcast systems as well including Digital Radio Mondale used for the long medium and short wave bands. Although OFDM, orthogonal frequency division multiplexing is more complicated than earlier forms of signal format, it provides some distinct advantages in terms of data transmission, especially where high data rates are needed along with relatively wide bandwidths.

In classical parallel data system, the total signal frequency band into N non-overlapping frequency sub channel. Each sub channel is modulated with a separate symbol and then N sub channels are frequency multiplexed. Results in a High bandwidth occupancy, inter symbol interference (ISI) and multiple fading.

OFDM transmission system offers possibilities for alleviating many of the problems encountered with single carrier systems. It has the advantage of spreading out a frequency selective fade over many symbols. Dividing an entire signal bandwidth into many narrow sub-bands cause the frequency response over individual sub-bands to be relatively flat, because sub-bands are smaller than the coherence bandwidth of the channel.

1. INTRODUCTION:

Our selection of the OFDM transceiver design project is motivated by the relevance of its achievement to students with a common interest in the communications field.

This project provides an opportunity to learn out of the classroom the implementation of real-time processing software for a complete digital communication system based on the principle of wireless technology modelling - Orthogonal Frequency Division Multiplexing (OFDM).

It will serve the purpose of an educational tool to supplement communication theory studies. The development of the synchronization method included the use of algorithms commonly used in the construction of digital transceiver, such as FFT. The concept of orthogonality allows carriers to be separated from each other in recipients. Proper use of spectrum and thus reduced the need for bandwidth.

Orthogonal Frequency Division Multiplexing is a type of multicarrier switch ready to be transmitted via a scattering channel. In this case the different carriers are orthogonal to each other, dependent on each other. Orthogonal Frequency Division Multiplexing (OFDM) is a wideband rotation system, designed to solve multiple acceptance problems. In addition, the selected blurring channel wideband frequency is divided into many smaller channels with a smaller band. If the number of small channels is high, each sub-channel can be considered flat. This is because we transmit multiple digital signals separately, within a single wide band.

The demand for high-level data services is growing in communication technology. New flexibility schemes are needed to provide high data quality, minimum permissible error rate and minimal delay. One of them is OFDM. The OFDM transfer system offers the opportunity to alleviate many of the problems encountered with single network company plans. It has the advantage of minimizing the impact of ISI, reducing the effect of multi-channel blurring, leading to saving bandwidth.

The start of the cycle enables the effects of the distortion between symptoms to be reduced. Some of OFDM's applications are digital audio streaming, high definition television. The OFDM approach will have an impact on the future of communication. With the recent growth of digital communication processes, the need for high-speed data transmission has grown. It is only recently that the development of integrated global technology has made a special start

The cyclic prefix enables the effects of inter-symbol interference to be reduced. Some of the applications of OFDM are digital audio broadcasting, High definition television. The OFDM technique will have an impact on the future of communications. With the recent expansion of digital communication processes, the demand for high-speed information transmission has grown. It is only recently that advancements in integrated world technology have made the specific implementation.

The development of the OFDM system can be explained by dividing it into three parts. The three components are Frequency Division Multiplexing, Multicarrier Communication and Orthogonal Frequency Division Multiplexing. Frequency Division Multiplexing is a type of signal duplication that involves assigning segments of not more frequencies or channels to different signals or to each medium user.

A security band or gap is left between each channel to ensure that a single channel signal should not exceed a signal from a nearby station. Multicarrier communication incorporates signal separation to give a number of signals over that range of frequency. Each of these signals has changed individually and is broadcast on the channel. On the receiving side, these signals are sent to the demultiplexer when they are integrated and lowered to receive the original signal.

2. PERFORMANCE:

As shown in fig.01, we have used the OFDM Program below

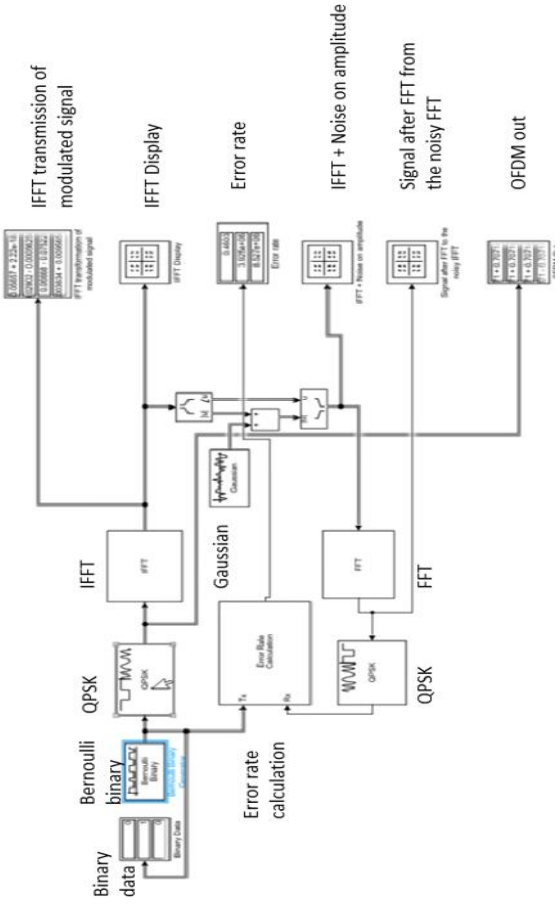


Figure 01: OFDM model used in Imitation.

Input:
Input is provided through binary generator using Bernoulli's in the form of binary data.

QPSK (Quadrature Phase Shift Keying) at Transmitter:
The information signal basically gets added with the carrier wave. It is part of OFDM. Information comes from above layer as a slow stream. It is then encrypted and processed into a brand using QPSK. The information signal receives basically

IFFT (Inverse Fast Fourier Transforms):
We get the observation in scopic display. We get the data in numerical form otherwise normal display is in the form of graph.

The main purpose of taking OFDM and not any other direct QPSK or in GSM form is because there is an error calculation, due to which we will get the loss of power and we can eliminate or reduce it and get the actual original signal as an output. FFT transformation and modulated signal is in complex format, whereas the other output IFFT display is in graphical format.

The IFFT output is given in form of complex to magnitude angle form that is in form of real and imaginary values.
The real values are used for transmission lines, whereas from imaginary values the error is detected.

Complex to Magnitude angle block:
It computes the magnitude and phase angle of a complex signal and provides hardware friendly control system. It calculates the magnitude and phase angle of the input signal, depending on the setting of the parameters. The output is real value of type double. Real value or magnitude is used in the transmission line where as the imaginary are used for the error detection part.

Add Block:
The magnitude part is given positive Gaussian filter. In OFDM we basically work on the magnitude of the signal. It performs addition on its input. The inputs to the add blocks are the real value of type double and the output from the Gaussian filter. Gaussian filter is introduced to reduce the noise in the system. The output from the complex to magnitude will have some random interference to reduce that Gaussian filter is used.

Magnitude angle to Complex block:
It converts magnitude and phase angle input to a complex output, through which we get the graph of IFFT+Noise on amplitude.
The parameters are as follows-:

a) RMS EVM (Error Vector Magnitude)-It tells quality of performance of a digital transmitter or receiver.
b) Peak EVM.
c) Average EVM (Modulation Error Ratio)-It is a measurement of signal to noise ratio in digital modulation.

FFT (Fast Fourier Transforms):
It converts the signal from time domain to frequency domain. The output from the magnitude to complex block is given as an input to FFT. The output of FFT is a frequency domain view of the original time domain signal, through which we get the graph of signal after FFT from the noisy IFFT.

QPSK (Quadrature Phase Shift Keying) at Receiver side:
The output of FFT acts as an input to QPSK which then decodes and demodulates the signal and give it to the receiver.

Error rate calculation block:
It compares the input data from the transmitter with input data from a receiver.

3. PERFORMANCE OUTPUT GRAPHS:

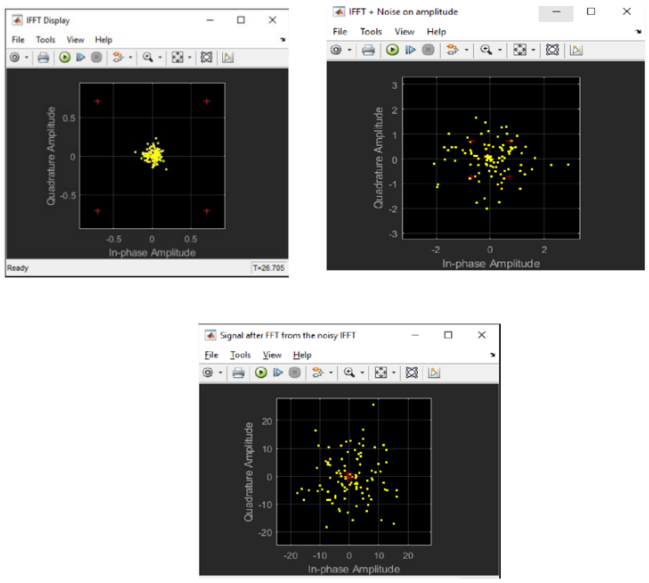


Figure 02: Simulation Output Graph.

4. EXPLENATION OF THE OUTPUT GRAPH:

Quad Amplitude Vs In-phase Amplitude:
It is a signal in which two carrier shifted in phase by 90-degree phase difference, they are in quardature.QAM utilize both amplitude and phase component to provide a form of modulation that is able to provide high level of spectrum usage efficiency.

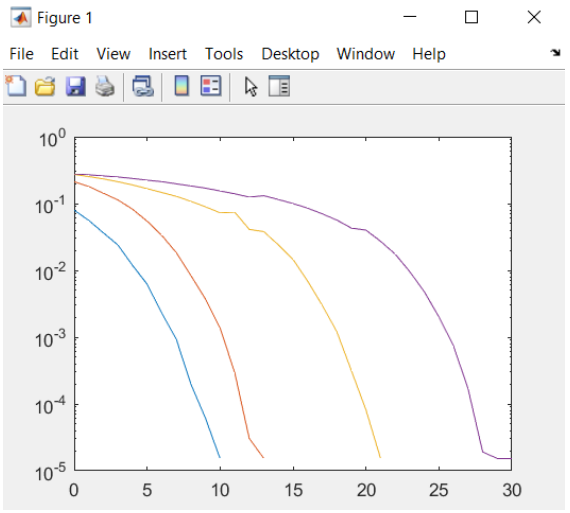
In-phase Amplitude is the position of the amplitude crests and troughs of two wave forms.

In-phase Amplitude is the position of the amplitude crests and troughs of two wave forms. If the peaks of two signal with the same frequency are in exact alignment at same time they are said to be in phase.

5. MATLAB CODE:

```
clear all;
close all;
clc;
data= randi([0 1], 2^16 ,1);
for i=6:1:9
for j=1:1:4
if j<3
mod_data= pskmod(data,2^j);
elseif j==3
mod_data= qammod(data,16);
elseif j==4
mod_data= qammod(data,64);
end
mod_data=reshape(mod_data,[2^i,((2^16)/(2^i))]);
mod_data=ifft(mod_data,2^i);
k=1;
for l=0:1:40
h=1/(sqrt(randn(1,1)+i*randn(1,1)));
channel_rayleigh=h*mod_data;
noise_gaussian=awgn(channel_rayleigh,l,'measured');
rec_mod_data=inv(h)*noise_gaussian;
rec_mod_data=fft(rec_mod_data,2^i);
rec_mod_data=reshape(rec_mod_data,[2^16,1]);
if j<3
rec_demod_data=pskdemod(rec_mod_data,2^j);
elseif j==3
rec_demod_data=qamdemod(rec_mod_data,16);
elseif j==4
rec_demod_data=qamdemod(rec_mod_data,64);
end
[number,ratio]=biterr(rec_demod_data,data);
err(k)=ratio;
k=k+1;
end
m=0:1:40;
semilogy(m,err);
hold on;
end
hold off;
figure();
end
```

6. CODE OUTPUT:



7. APPLICATION:

High Definition Television:
Commercial television station is first published by England. There exist three mechanisms about the digital terrestrial television broadcasting system in European (COFDM), North America (8-VSB), and Japan (BST-OFDM). The European introduces the COFDM modulation scheme into the system structure. American develops the system based on 8-level vestigial side-band (8- VSB) modulation scheme. Japan is zealous to develop the band segmented transmission Orthogonal Frequency Division Multiplexing (BST-OFDM) system, which nature is based on COFDM modulation scheme.

LTE (Long Term Evolution):
In Nov. 2004, 3GPP began a project to define the long-term evolution (LTE) of Universal Mobile Telecommunications System (UMTS) cellular technology. Higher performance Improving spectral efficiency Lowering costs, improving services and use of new spectrum opportunities with improved quality of service.

Digital Audio Broadcasting:
DAB is a digital technology offering considerable advantages over today's FM radio, both to listeners and broadcasting. DAB's flexibility will also provide a wider choice of programs, including many not available on FM. A single station might offer its listeners a choice of mono voice commentaries on three or four sporting events at the same time, and then combine the bit streams to provide high-quality sound for the concert which follows.

8. CONCLUSION:

The aim of the project is to implement blocks of OFDM system. These blocks have been simulated using MATLAB, data patterns/graphs and the results are as shown. This is very basic implementation and has advantage of less complexity and processing time requirement.

OFDM solves the problem of ISI through use of a cyclic prefix due to
high data rates. It also provides other advantages like high spectral efficiency, Low implementation complexity etc.
Some of the major applications of OFDM include digital audio broadcasting digital video broadcasting, local area networks, WiMAX etc.

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