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Department of Electronics and Communication Engineering

Project Synopsis

On

"Implementation of OFDM on SDR using GNU Radio"

Under guidance of

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ABSTRACT

As the primary objective of our project, we intend to design and implement an OFDM system using GNU Radio. We will design this system so that it can transmit and receive data over a wireless channel. The system will be tested for various parameters such as bit error rate, throughput, and latency. In addition to QPSK, 16-QAM, and 64-QAM modulation schemes, the system will be tested with various modulation schemes. The results of the tests will be compared to the theoretical values to validate the system. The project will be divided into two main parts. The first part will involve the design and implementation of the OFDM system on GNU Radio. As part of this process, the transmitter and receiver blocks will be designed, the selection of the modulation scheme, and the implementation of the OFDM system. The second part will involve the testing of the system. This will include the testing of the system for various parameters such as bit error rate, throughput, and latency. The results of the tests will be compared to the theoretical values to validate the system. The project will be implemented in Python and C++. The GNU Radio development environment will be used for the implementation .The project will be tested on a USRP B210 radio. The results of the tests will be documented and presented in a report. This project will provide a better understanding of the OFDM system and its implementation in GNU Radio. It will also provide an insight into the performance of the system in a wireless environment. The results of the tests will be useful for further research and development in the field of wireless communication.

Keywords: OFDM, GNU Radio, Digital signal Processing, Modulation, Demodulation, Channel coding, Interference Cancellation.

INTRODUCTION

OFDM (Orthogonal Frequency Division Multiplexing) is currently one among the most commonly used modulation techniques in present wireless communication systems.It is a multi-carrier modulation technique that divides the available frequency spectrum into multiple orthogonal sub-carriers, each of which carries a portion of the transmitted data. OFDM is found in many wireless communication systems such as Wi-Fi, LTE, and 5G. OFDM is a modulation technique employed in both 4G and 5G networks. It is used to divide a wide frequency band into multiple narrow sub-bands, allowing for more efficient use of the available spectrum. OFDM is used in both 4G and 5G networks because it is a very efficient way of transmitting data over a wide frequency band. It is also very robust against interference, making it an ideal choice for wireless networks. Implementing an OFDM transceiver with GNU Radio is a very effective way to learn about the fundamentals of OFDM and gain hands-on experience with the technology. Software-defined radios and signal-processing systems can be implemented using GNU Radio, which provides signal processing blocks for open-source developers. It can be combined with external RF hardware in order to design software-defined radios, or without using hardware in a simulation-like environment. Besides being widely used in research, industry, government, and hobbyist environments, it can also be used for real-life radio communication systems. Using GNU Radio to implement an OFDM transceiver requires a basic understanding of the OFDM modulation technique and the GNU Radio environment. The first step is to create a flow graph in GNU Radio Companion (GRC) that implements the OFDM transceiver. This flow graph will contain blocks for the transmitter and receiver, as well as blocks for signal processing and data manipulation. Once the flow graph is created, it can be tested using software-defined radio (SDR) platforms. Once the flow graph is tested and verified, it can be used to transmit and receive data over the air. This is a very practical way to gain hands-on experience with OFDM and to learn more about the fundamentals of communication systems. Implementing an OFDM transceiver through GNU Radio is a very effective way to gain a deeper understanding of the technology and to gain valuable experience with communication systems.

LITERATURE SURVEY

1. **“Performance Analysis of MIMO-OFDM System with Transceiver Hardware Impairments”**

   Presented by Anuj Singal,Deepak Kedia, Naveen Jaglan of GJUS&T Hisar Haryana in 2017,pg no. 102-106.

   This paper aims to improve channel capacity and SNR multiplexing gain through MIMO-OFDM, with and without hardware impairments. Channel capacity and SNR are compared using MIMO-OFDM at various SNR levels.

2. **“A Review on Design and Analysis of 5G Mobile Communication MIMO System with OFDM”**

   Proposed by Saurabh B.Ramteke,A Y Deshmukh, Prof. K N Dekate of G H, Raisoni College of Engineering, Nagpur, India.

   In this paper channel capacity was increased using MIMO and OFDM with AODV routing protocol. BDMA and FDMC modulation techniques were also used in order to improve channel capacity.

3. **“5G New Radio, Prototype Implementation Based on SDR”**

   Presented by Loma Y. Hosni, Ahmed Y. Farid, Abdelrahman, A. Elssadany, Mohammad A. Safwat.

   In this paper, the Physical Downlink Shared Channel (PDSCH) of 5G NR is implemented on an SDR. The design incorporates LDPC and NOMA techniques..

4. **“Software Defined Radio Prototype with Visual C++ Express and Code Composer Studio”**

   Proposed by Sverre Wichlund in 2012.

   This document shows a demonstration of a IEEE 802.11a processor scaled down to 6kHz on the DSK6713 using C++ coding. Limited bandwidth and slow process.

5. **“Performance Evaluation of OFDM Based 256- and 1024-QAM in multipath Fading Propagation Conditions”**

   Presented by Tomoki Ota, Mitsutoshi Nakamura, Hiroyuki Otsuka in 2017.

   In this paper simulation of an OFDM-based transmission model with 256- and 1024- QAM under multipath fading propagation conditions. No real-world applications.

6. **“OFDM System Implementation in DSP Platform TMS320C6678”**

   Proposed by Rafael Masashi Fukuda, Taufik Abrao in 2016.

   This paper presents the basic OFDM implementation on a DSP and the evaluation of DSP resources by sending image data.

PROBLEM STATEMENT

In the literature summary, Paper-I compared the channel capacity and SNR of MIMO-OFDM systems with the goal of improving these two properties. However, no hardware was considered in the analysis of these systems. In addition, Paper- II uses the AODV routing protocols to improve the throughput of systems with MIMO-OFDM, which was verified by simulation tools.

Paper- III explores the possibility of creating a 5G New Radio on an SDR platform. 5G New Radio is a new generation of mobile communication technology that offers faster speeds and more efficient use of available spectrum. It also enables a higher number of connected devices and improved support for advanced applications. But the system is verified only with the PDSCH ignoring all other channels.

Paper IV and Paper VI use a digital signal processor to implement an OFDM system. IEEE 802.11a is implemented and downsampled to a lower frequency on the DSK6713 due to processing limitations. This standard uses OFDM for higher channel capacity and transmission rates. Paper VI uses a simple OFDM implementation for analysis on a DSP.

The problem we want to solve is the low channel capacity of SDR systems. By implementing OFDM on SDR, we hope to increase the channel capacity and improve the overall system performance. This requires careful planning and execution, as well as thorough testing to ensure the successful implementation.

OBJECTIVES

Our objective in this project is to implement a OFDM system and evaluate performance on an SDR using GNU Radio.

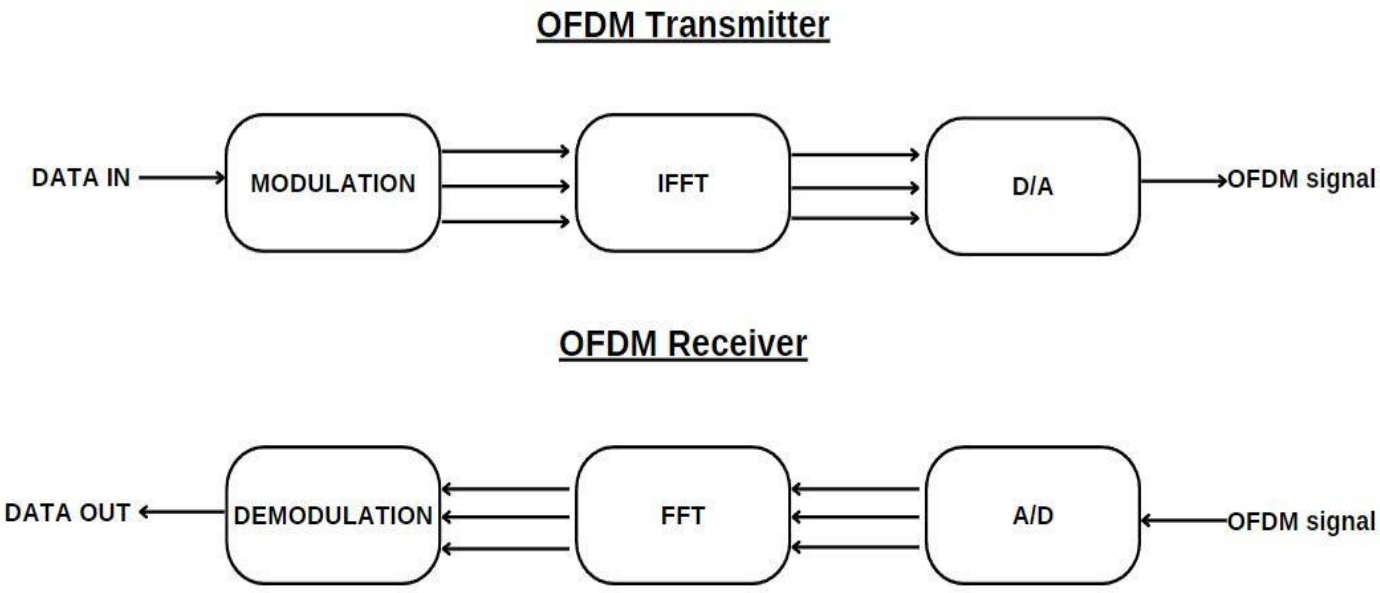
The objectives of this project are

- Understanding the principles of OFDM and its implementation in GNU Radio.
- Comparing the performance of OFDM with other modulation techniques.
- Identifying the effect of various parameters on OFDM performance.
- To reduce the effect of multipath fading and interference on the signal.
- Using multiple antennas for improved performance as well as using multiple modulation techniques.

METHODOLOGY

1. Create a flowgraph in GNU Radio Companion.
2. Add the necessary blocks to the flowgraph,including a source block, a modulator block. a channel model block, a demodulator block and a sink block.
3. Configure the blocks according to the desired parameters, such as the modulation scheme, the number of subcarriers and the type of FEC (forward error correction).
4. Connect the blocks together and run the flowgraph.
5. Monitor the performance of the OFDM system using GNU Radio Companion's built-in tools.
6. The reverse process is carried out on the receiver side.

BLOCK DIAGRAM



SOFTWARE REQUIREMENTS & HARDWARE

1. GNU Radio

The GNU Radio is an open source free software development toolkit used for developing software-defined radios and signal processing.

2. Software Defined Radio(SDR)

The Software Defined Radio is a device used to design and prototype communication systems. The platform is used in a variety of research, commercial, and military projects for prototyping and developing software radio applications

3. Antenna

SDRs and USRP systems rely on antennas to transmit and receive radio signals. The antenna is designed to optimize performance for specific frequency bands and applications.

EXPECTED RESULTS

- System would be an efficient and reliable communication system that can be used for various applications.
- The system should be able to transmit and receive data reliably and accurately, with minimal interference from other signals.

APPLICATIONS

- **Wireless communication** : OFDM can be widely as wireless communication systems such as Wi-Fi, WiMAX, LTE, and 5G
- **Broadcasting:** OFDM can be used in digital television and radio broadcasting, such as DVB-T, ATSC, and ISDB-T.
- **Radar:** OFDM can be used for radar applications, such as Synthetic Aperture Radar (SAR).
- **Vehicular Communications:** OFDM can be used in vehicular communication systems, such as Dedicated Short Range Communications (DSRC).