A report

on

DESIGN OF SDR FOR HD VIDEO COMMUNICATION

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MIMO-OFDM, Polar codes, USRP, HD Video communication, DVB, H.264, H.265

Project Areas:
Wireless communications, Digital communications, Software defined Radio, Video codecs

Abstract:
The project aims to implement a MIMO-OFDM + Polar coding system using USRP for HD video communication. The video is processed using the H.264 / H.265 codecs, and the system supports both transfer and streaming of the video. A power amplifier is also selected in order to improve the system's performance.

Student Signature **Mentor Signature**

Contents

1 About the Project

1.1 Objectives

The project aims to implement a MIMO-OFDM system using USRP n210s and b210s [1],[2],[3],[4],[5]. The link will employ polar coding as the channel coding scheme [6]. The video is compressed using the H.264 / H.265 standards and transmitted through the implemented link [7]. The receiving end must be able to both store the video as well as stream the same. Lastly, a power amplifier is to be selected for extending the range of the wireless link.
The project involved the following sub-problems:

- Modelling of a MIMO-OFDM link [8],[9],[10],[11],[12], [13],[14],[15]
- Implementation of Polar coding [16],[17],[18]
- Translation of the above models into HDL, and configuring the SDR [19],[20],[21],[22]
- Incorporation of H.264 and H.265 codecs
- Selection of suitable power amplifier

1.2 Expected Learning outcomes

1. Proficiency with MATLAB, and the communications toolbox
2. A background in wireless communications
3. A strong background in digital communications
4. A better understanding of 4G, and 5G communication standards
5. A strong understanding of MIMO-OFDM
6. A strong understanding of Polar coding
7. Insight into video codecs
8. Familiarity with SDRs
9. Selection of electronic components via market surveys

1.3 Project work plan & progress

The project was decoupled into two independent sets of problem statements, and the work was done as shown below :

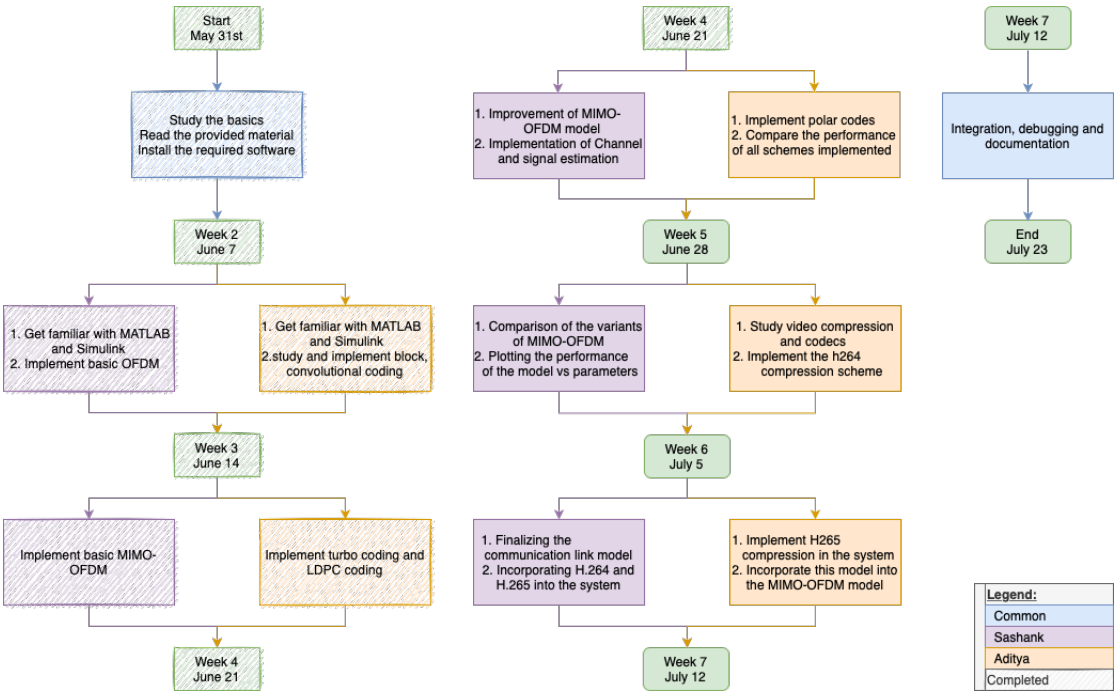

Figure 1: The work split and plan followed by the team

1.4 Objectives addressed

A predominant portion of the time so far was spent learning the relevant basics. Hence, we have met less than half of the requirements of the project. The objectives met so far are:

1.4.1 Modelling of a MIMO-OFDM link

A model has been put together such that we can progress in other fronts without losing out on anything. The model is still incomplete, and requires the channel estimation to be implemented more properly.

1.4.2 Implementation of Polar codes

Polar codes have been implemented in a system that transmits randomly generated bits. Various channel coding techniques were initially implemented in Simulink to compare their performance when transmitting videos. The polar codes implementation will be extrapolated in a similar manner to make comparisons and transmit videos.

2 Research Methodologies

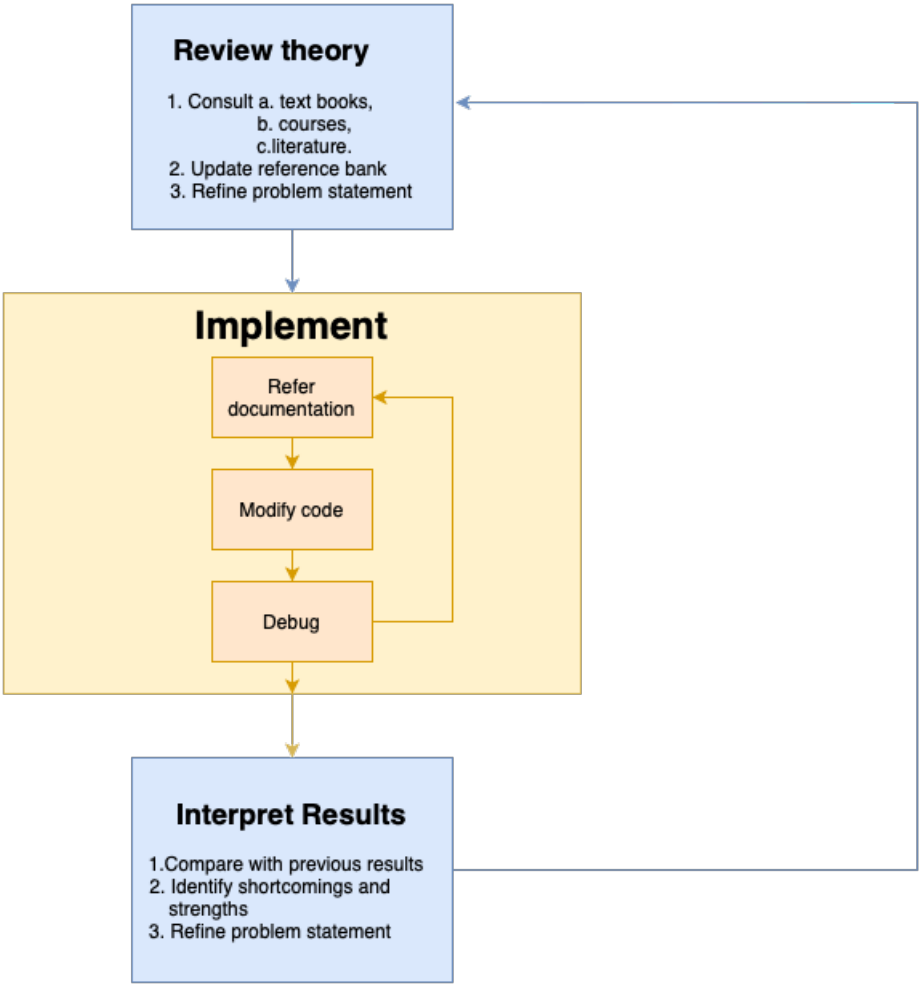

Figure 2: Research Methodology followed

3 Results

As of the writing of the mid-term report, a simple test bench was implemented for the comparative study of the various schemes available. A simple setup for varying parameters and extracting BER plots was established, and the BER for different MIMO-OFDM schemes were plotted. A similar test bench was implemented for the study of different channel coding schemes at standard parameters.

4 Conclusions and Future Scope

The project aims to implement a MIMO-OFDM system with Polar coding using a USRP for HD video communication. This report lists the objectives we have covered so far, the research methodology we are following, and the results we have obtained so far.

The system we have designed has shown acceptable results so far in our simulations. However, there is a lot that we can do to improve the system to achieve competitive results.

Our projects' future goals and scopes are :

1. implementing video compression and transmitting it with polar coding into the MIMO-OFDM system.
2. Deployment of the system on the target hardware
3. Field testing and extending the range by selecting a suitable power amplifier

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6 References

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7 Appendix

The drive linked to below contains the appendix. Refer to the individual sections below for the individual folders.

Appendix drive

7.1 MIMO-OFDM implementation

The drive linked to below contains a script implementing MIMO-OFDM as described below, and the outputs it generates for 1x1 and 2x2 systems.

MIMO-OFDM implementation drive

The linked implementation implements baseband MIMO-OFDM modulation, passes the signal through a Rayleigh fading channel, adds noise, performs signal estimation using the **ideal** channel estimate, and followed by ideal baseband demodulation. The upgrade to incorporate the RF carrier, and to incorporate channel estimation from the pilot carriers is pending.

The key contents of the script can be duplicated, and the same operations can be performed twice in the same loop, but for different setups. This way, one can compare the performance of the various setups.

7.2 Polar codes implementation

The drive linked below contains a sample program for the implementation of polar codes in MATLAB using the 5G Toolbox.

Polar codes implementation drive

The linked drive also contains a figure that compares the theoretical performances of Hamming, Reed-Solomon and Convolutional codes at standard parameters by plotting their bit error rates(BER) against signal to noise per bit. This plot will soon be updated to reflect the performances of Turbo, LDPC, and Polar Codes.