Research Project Week 3 Report

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1 BACKGROUND

This report marks the third week of our ongoing USRP research project. Over the past two weeks, our focus has been on studying and analyzing the three parts of ISO15693. This standard delves into various aspects related to the modulation and demodulation techniques employed in identification cards. It provides insights into the signals that are transmitted to these cards, as well as the signals that can be expected to be received from them.

2 INTRODUCTION

In this weekly formal report, we will outline the progress made during the third week of the project, highlighting key findings, challenges encountered, and any notable developments. The report will serve as a comprehensive record of our research activities, providing a foundation for future discussions, analysis, and decision-making. The main focus of this week was getting everything set up and figuring out how to use MATLAB in conjunction with the USRP.

3 METHODS

The first item tackled this week was installing MATLAB and all the necessary add-ons for communicating with the USRP. Five add-ons were installed to assist with this: Communications Toolbox, Communications Toolbox Support Package for USRP Radio, DSP System Toolbox, Signal Processing Toolbox, and Simulink.

After installing MATLAB and the add-ons, it was decided that I should first use the card reader to send a signal to the USRP receiver and then analyze this signal. To do this, the card reader needed the ISOStart+ software to be installed. This allows the card reader to begin transmitting a signal at the specified 13.56 MHz frequency.

Once this setup was completed, the USRP receiver needed to be connected correctly and configured in the Windows internet adapter settings. The connection process is as follows:

- USRP Gigabit Ethernet to Router
- Router Ethernet to Computer
- Antenna to USRP RF2 (or RF1 for transmitting)

The Windows adapter settings goes as follows:

- IP address: 192.168.10.1 (this is the routers IP address)
- Subnet Mask: 255.255.255.0
- Default Gateway is left blank
- DNS fields can be left blank

After completing these steps and powering on all the devices, the command "findsdru" can be run in MATLAB to check the connection to the USRP (if there are two USRPs connected, then the command will return with blank fields, indicating successful device connection).

Now that the USRP receiver was successfully connected, it was time to analyze the transmission from the card reader and the card. The following Simulink diagrams were used to analyze the waveform in the frequency domain and the time domain:

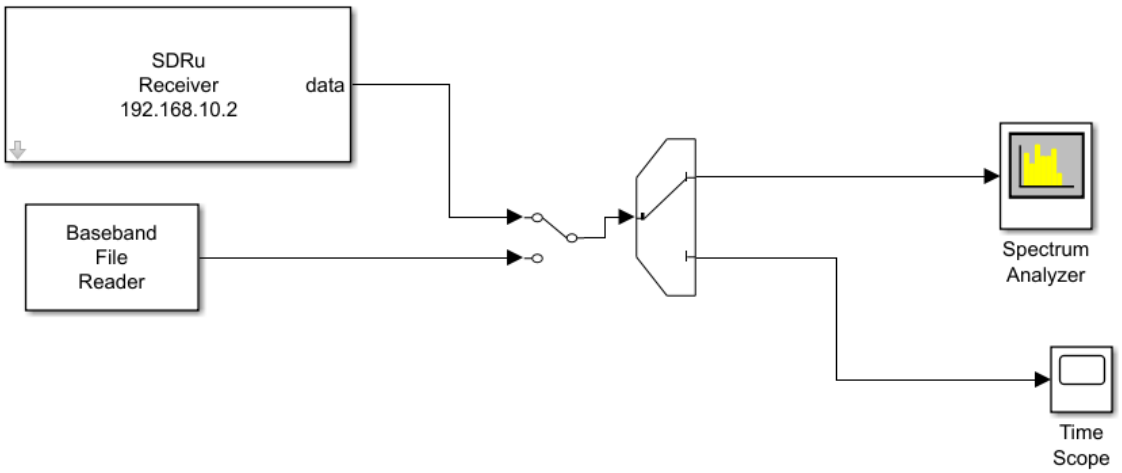

Figure 1: Simulink Reader

This Simulink diagram enables spectrum analysis or time domain analysis directly from the receiver or from a baseband file. To create the baseband file, the following Simulink diagram was used:

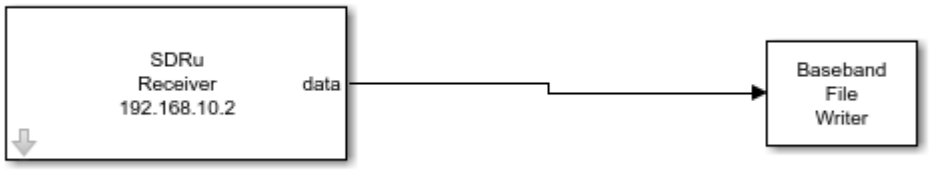

Figure 2: Simulink Writer

The last implementation involved transmitting a sine wave from the transmitting antenna and receiving it on the receiver antenna. To do this, the next two Simulink diagrams were used:

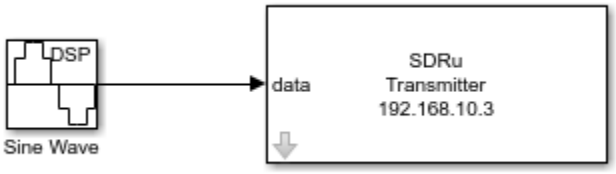

Figure 3: Sine Wave Transmitter

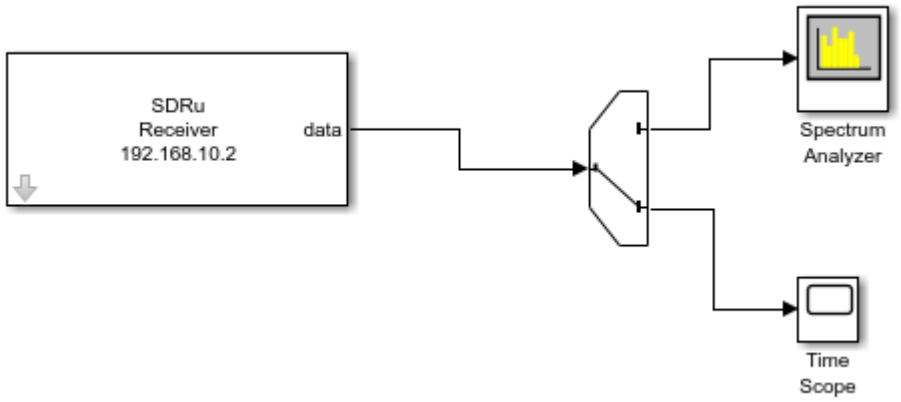

Figure 4: Sine Wave Receiver

4 DISCUSSION OF RESULTS

After sending a signal over the 13.56 MHz frequency with the card reader device, I was able to observe a spike in activity on the receiver USRP in the spectrum analyzer. When the same signal was analyzed from the time domain using the time scope, the signal appeared to be jagged and disorganized. This is believed to be due to incorrect setup of the sampling rate. It is logical to assume that if the sampling rate is not set correctly, the receiver will not fully capture the transmitted waveform.

To address this issue, I attempted to transmit a sine wave and receive it with the antennas. I successfully achieved this over the 13.56 MHz frequency. When the antennas were brought closer together, the amplitude of the sine wave increased, whereas moving them further apart resulted in a decrease in amplitude. I also examined frequencies around 13.56 MHz and found that the amplitude decreased as the frequency moved further away from 13.56 MHz.

Although I successfully transmitted and received the sine wave, I believe I may not have set it up correctly to determine the sampling rate required for receiving the signal from the card reader. At the beginning of week 4, I will attempt this approach again to determine the correct sampling rate.

5 CONCLUSION

The first week of using the USRP devices presented more challenges than initially anticipated. However, each day I gained a better understanding of how the signals and devices function. With an improved understanding of sampling and device operations, I hope to make faster progress this week.

6 REFERENCES

Communications toolbox support package for USRP Radio. Communications Toolbox Support Package for USRP Radio Documentation. (n.d.). https://www.mathworks.com/help/supportpkg/usrpradio/

. Example List - MATLAB & Simulink. (n.d.). https://www.mathworks.com/help/supportpkg/usrpradio/examples.html?s_tid=CRUX_topnav

Platform. Receive data from USRP device - MATLAB. (n.d.). https://www.mathworks.com/help/supportpkg/usrpradio/ug/comm.sdrureceiver-system-object.html