FAMU-FSU College of Engineering

Team 301: SDR-SAR

Software Defined Radio - Synthetic Aperture Radar

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Background

The SDR-SAR (Software Defined Radio - Synthetic Aperture Radar) is a device that provides image data of metal objects from a distance of at least 40 feet. Possible use cases for this radar imaging solution include government buildings, airports, or even the battlefield.

This ongoing project, sponsored by Northrop Grumman, had some issues in the past where the RF signal generated would leak between horns on the aperture, producing noise that would hinder accurate detection of objects. Using a software radio instead of a hardware-only platform, our team has the capability of removing that noise using software-based filtering techniques.

Figure 1 – The SAR, which will be used to beam the output of our electronics box to the environment.

Project Scope

Consulting our sponsor, the team determined the needs and constraints of the project. These are as follows:

- The metal object need to be identified from at least a 40 feet range
- Must redesign the SAR to incorporate software defined radios
- The purchased radios must be programmable and full duplex
- Radios must operate on a bandwidth of at least 5 GHz
- Overall limit of $5000 budget for the project
- Individual radios must cost less than $1200
- Limit of two semesters of development, testing, and finalizing time

Figure 2 – The USRP B200 radio used to generate and send the RF signal to the rest of our device.

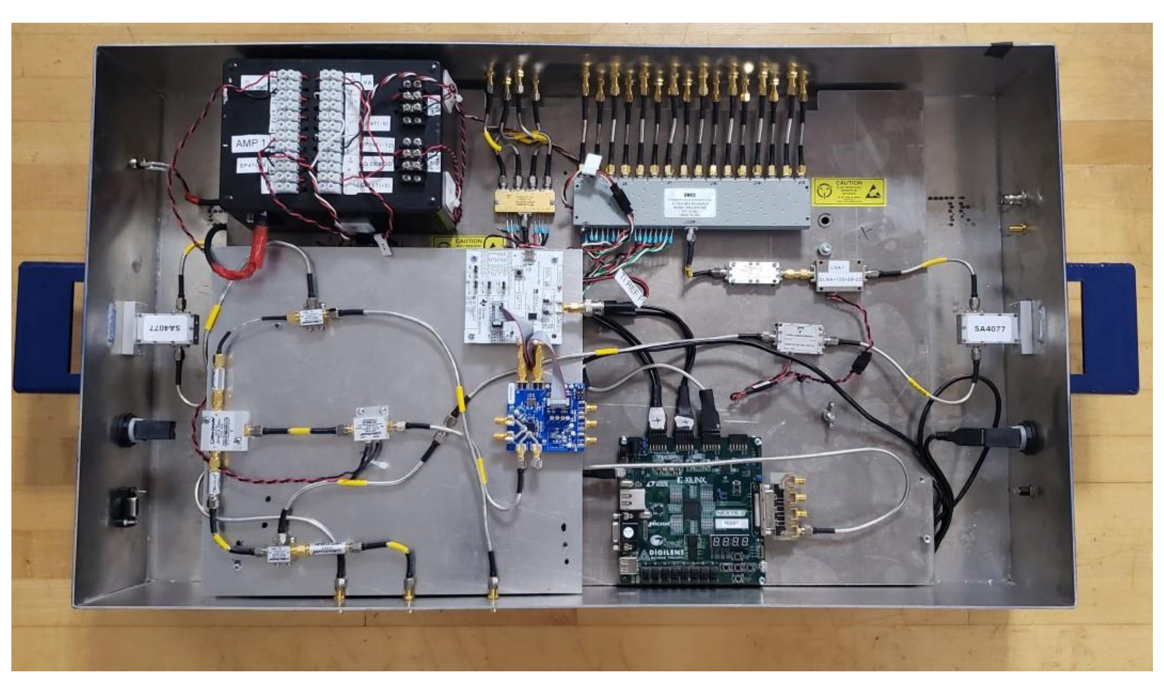

Figure 3 – Inside view of the electronics box with the new plate of components.

Project Outline

Phase I

- Simulate LFM signal transmission and reception in Simulink
- Generate a single-pulse LFM signal on GNU Radio
- Purchase necessary components
- Test and verify LFM pulse transmission and reception using the B200 radios

Phase II

- Create a multiple-pulse waveform in Simulink for use in the radio
- Finish VHDL code that generates PPS reference
- Modify existing VHDL code to utilize a different method for switching between TR paths
- Mechanize RF components

Phase III

- Incorporate a signal integration algorithm to ensure viable a signal to noise ratio
- Test and verify behavior of FPGA code
- Run full system real world tests to verify operation of the SDR-SAR

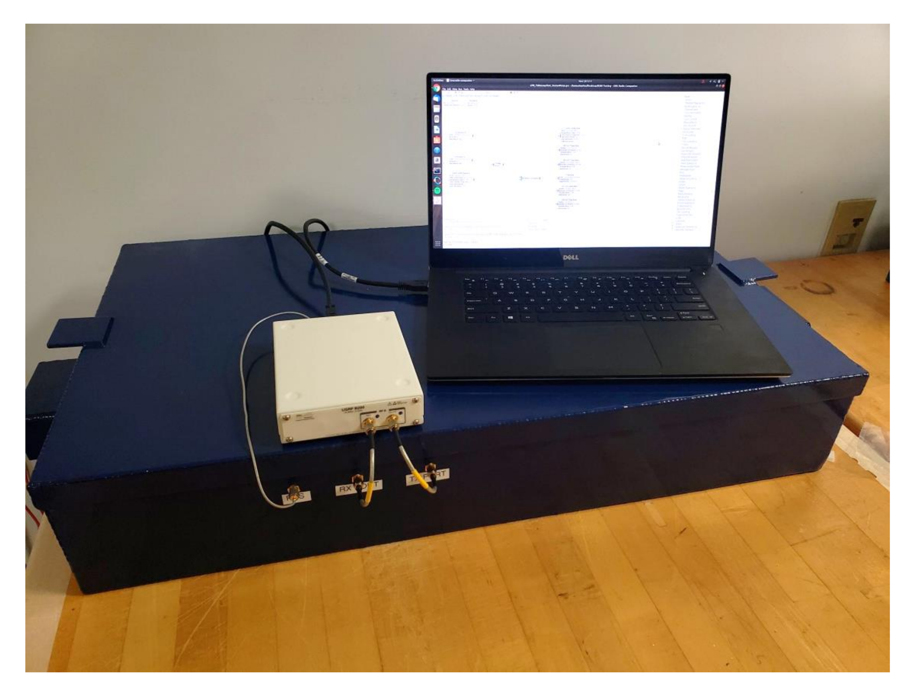

Figure 4 – The software radio connected to the updated electronics box.

Testing and Verification

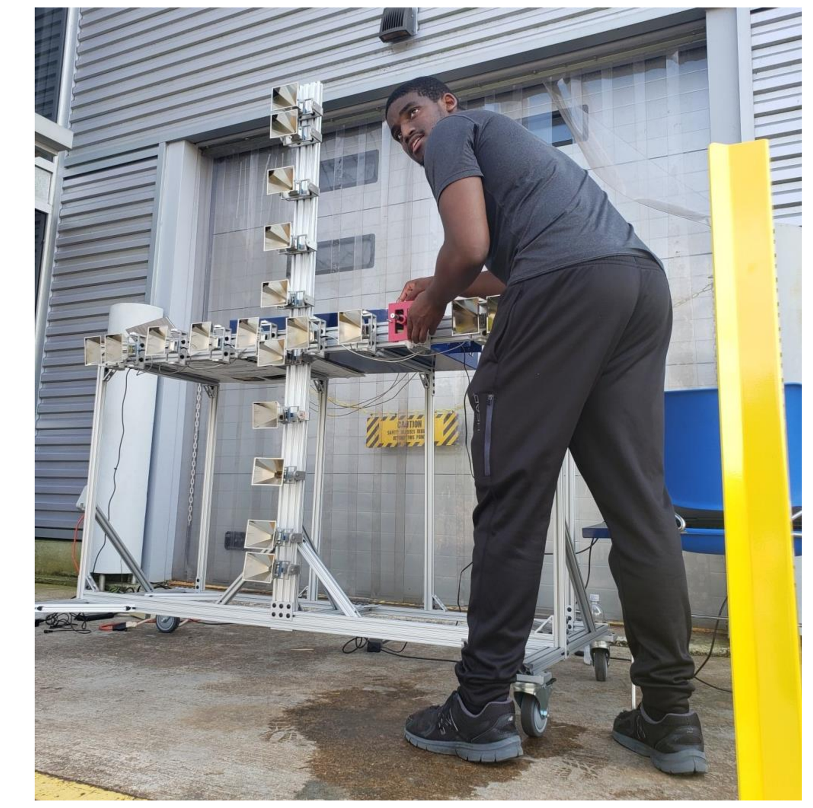

Figure 5 – Calibrating the SDR-SAR before a data collection. This data is then processed through MATLAB for the final imaging results.

As of today, the team successfully completed the main objectives of our three phase plan. Some major goals that were accomplished include:

- VCO Verification
  - Obtained a 7.8GHz center frequency using TICS Pro
  - Verified the VCO can be tuned for a power output of at least 4dBm
- RF Component Integration
  - Generated a CAD model to determine the size for a metal plate needed to mount the components
  - Configured the components into an accessible layout and mounted them on the board
- FPGA Switch
  - Verified transmit and receive switching can be performed with modified PPS code
  - Successfully synchronized the FPGA switching logic to the SDR pulse transmission
- Full System Verification
  - Performed outdoor testing of the full system, using metal reflectors as targets to be detected

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