# Wideband Spectrum Monitor

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## Objectives

Given a band spectrum of radio frequencies, interpret and analyze the data read from the USRP in order to draw an average Power Spectral Density (PSD). By having the user specify a power threshold, the program will check against this number in order to save information on the frequencies that surpass this threshold. Relevant data is displayed to a remote location as frequencies are being read.

1. Read in a radio frequency and checking each one by .1 MHz
2. If PSD greater than threshold, write information in CSV file
3. Transfer CSV to Raspberry Pi using Secure Shell Protocol
4. Display a notification with signal
5. Displays frequency, timestamp, & PSD

## Materials & Methods

The following materials were required to complete the research:

- USRP 2920
- Raspberry Pi model 3
- PC with LabVIEW Communications 2.0
- Secure Shell Protocol

**SFTP**

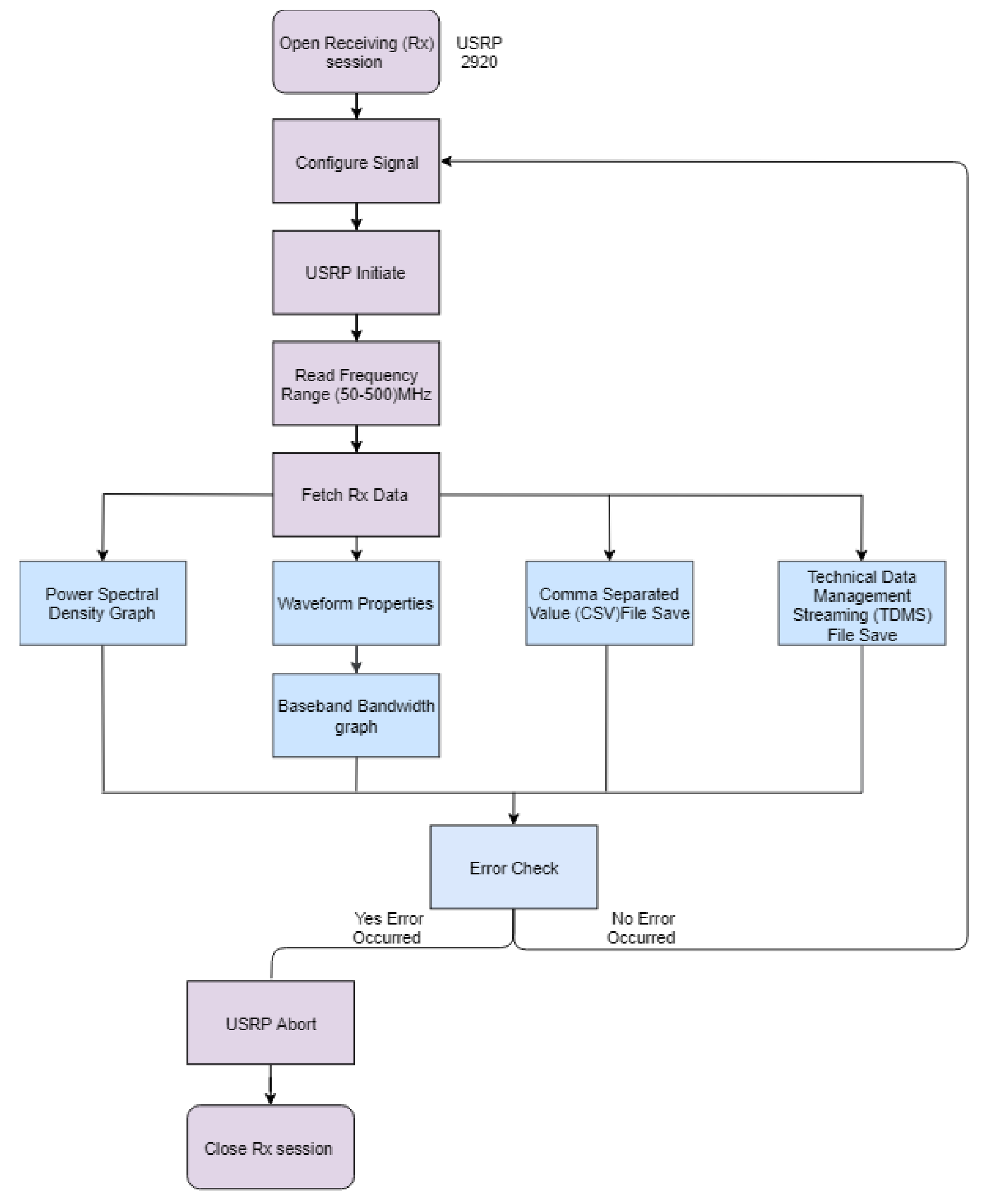
Our project uses SSH File Transfer Protocol in order to allow communication between the signal processing location and a second remote location. Our program was made using the WINSCP .NET Assembly in order to transfer files automatically to any second location with internet access.

## Introduction

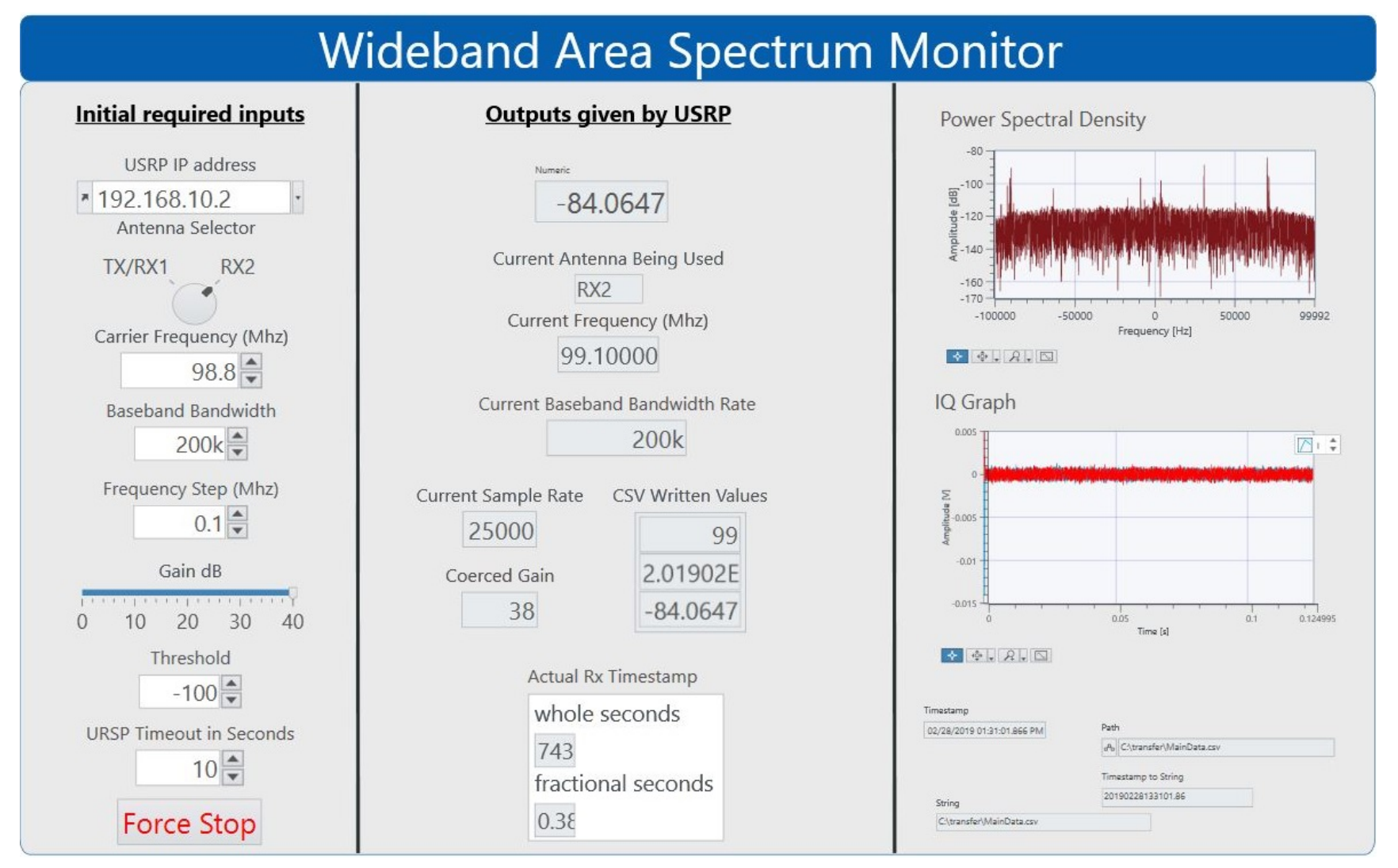
The Wideband Spectrum Monitor reads in radio frequency using Universal Software Radio Peripheral [USRP] 2920. Using LabVIEW Communications 2.0, there is a program built that sorts out the frequency information. LabVIEW also creates a Comma Separated Value [CSV] file to store the necessary data required. The file is then transferred using Secure Shell Protocol to the Raspberry Pi. The Raspberry Pi then detects once the CSV file been transferred and shows a notification "Signal Detected", with a preview of the information.

## LabVIEW Flow Chart

This is a quick overview of how our LabVIEW program works together with the USRP-2920. In the beginning we have our initialization functions which configure and fetch information from then we can save this information and repeat this cycle.


Open Receiving (Rx) session
USRP 2920
Configure Signal
USRP Initiate
Read Frequency Range (50-500)MHz
Fetch Rx Data
Power Spectral Density Graph
Waveform Properties
Comma Separated Value (CSV)File Save
Technical Data Management Streaming (TDMS) File Save
Baseband Bandwidth graph
Error Check
Yes Error Occurred
No Error Occurred
USRP Abort
Close Rx session

## Result


Wideband Area Spectrum Monitor

**Initial required inputs**

USRP IP address: 192.168.10.2
Antenna Selector: TX/RX1 RX2
Carrier Frequency (Mhz): 98.8
Baseband Bandwidth: 200k
Frequency Step (Mhz): 0.1
Gain dB: 0 10 20 30 40
Threshold: -100
URSP Timeout in Seconds: 10
Force Stop

**Outputs given by USRP**

Numeric: -84.0647
Current Antenna Being Used: RX2
Current Frequency (Mhz): 99.10000
Current Baseband Bandwidth Rate: 200k
Current Sample Rate: 25000
CSV Written Values: 99, 2.01902E, -84.0647
Coerced Gain: 38
Actual Rx Timestamp: whole seconds 743, fractional seconds 0.38

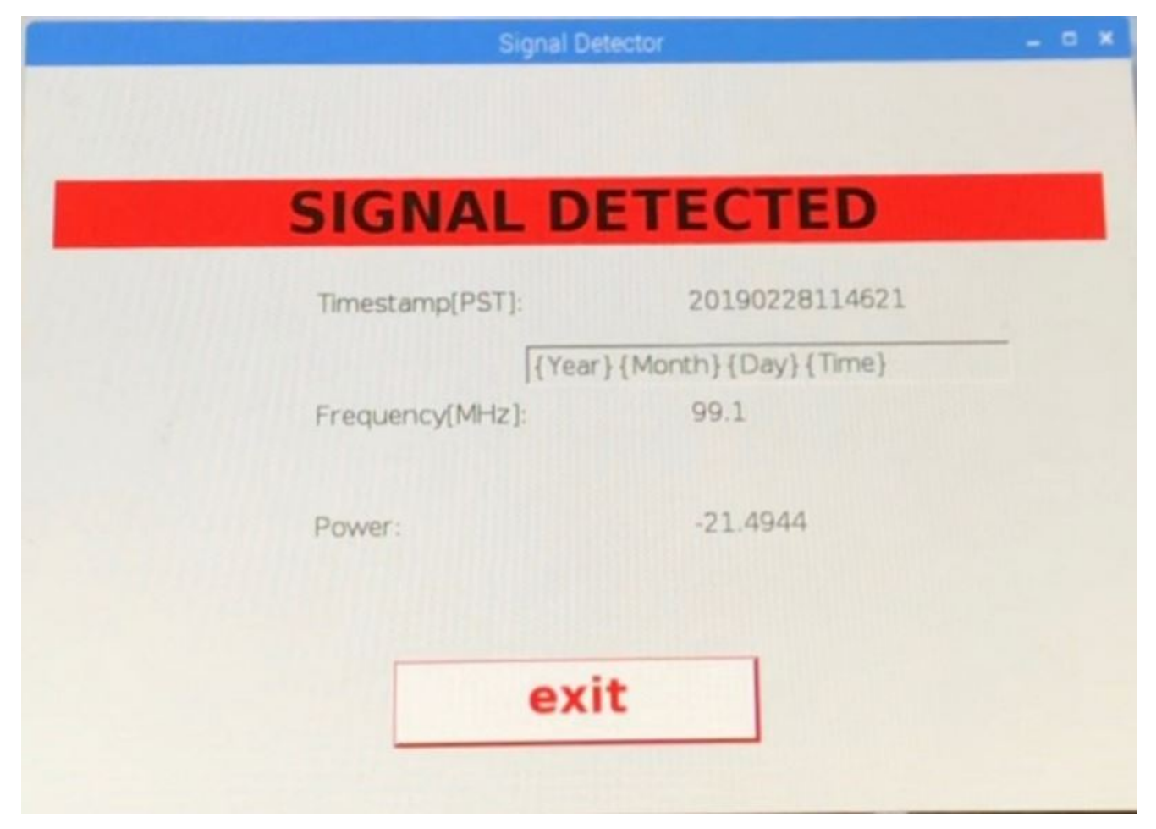
Power Spectral Density
IQ Graph
Timestamp: 02/28/2019 01:31:01.866 PM
Path: C:\transfer\MainData.csv
Timestamp to String: 20190228133101.86
String: C:\transfer\MainData.csv

**Figure 1:** Signal Processing User Interface

We used two USRPs to test. USRP 1 was used to transmit a signal [99.1 MHz] and USRP 2 was used to receive and analyze.

In order to test we set our receiving station to start looking for signals at 98.8 MHz and increase at a step size of .1 MHz. We set a threshold of -100 dB and were able to read in all of the signals from 98.8 to 99.3 MHz and output data to our CSV file.

Using the data gathered from the first test, we raised our threshold to -25 dB. We were able to pinpoint our transmitted signal based on its power output and transmit a file to a remote user station. That file delivery triggered our alarm application and displayed the time stamp, frequency, and power of our recorded data.


Signal Detector

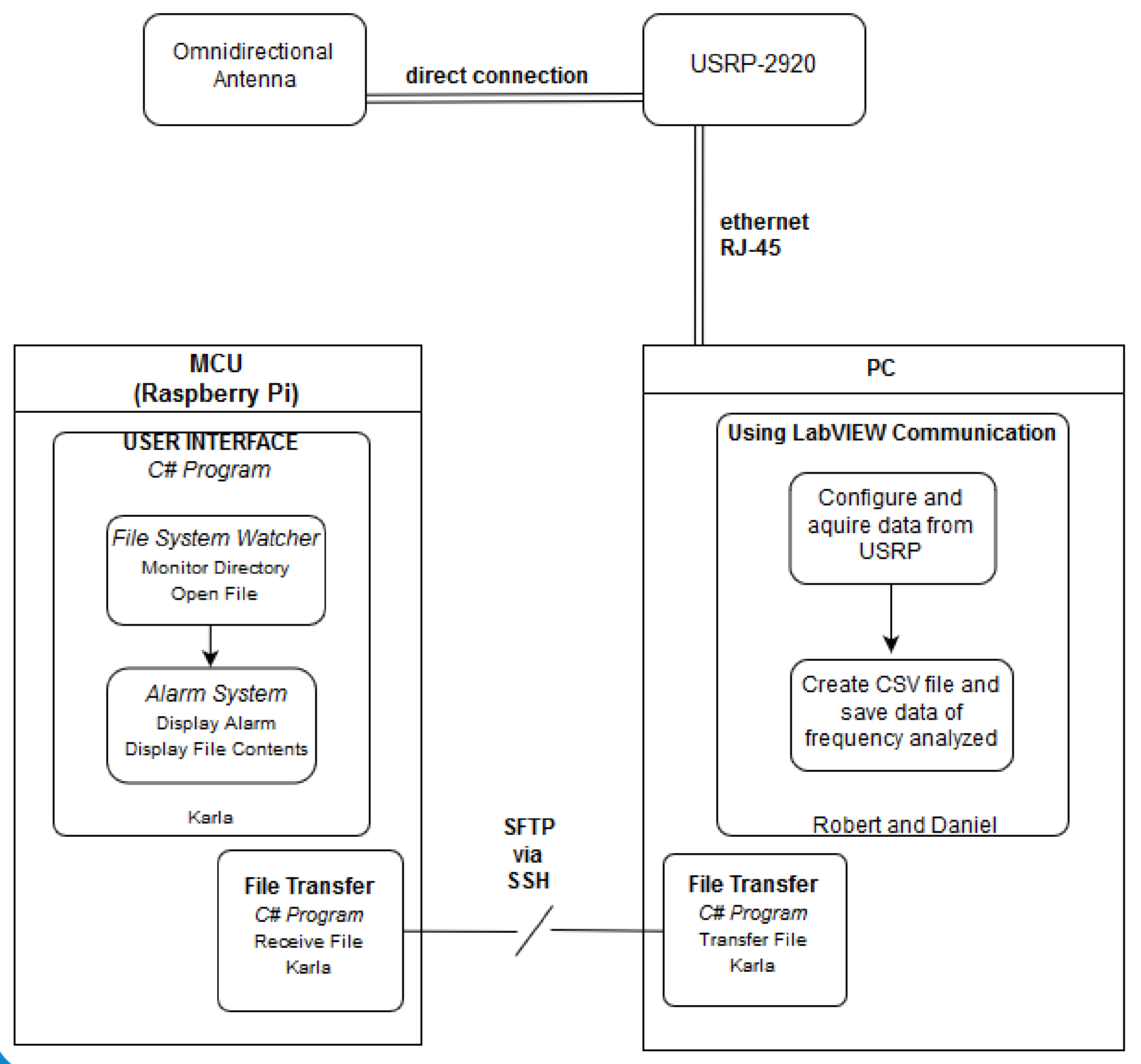
SIGNAL DETECTED

Timestamp[PST]: 20190228114621
{Year} {Month} {Day} {Time}
Frequency(MHz): 99.1
Power: -21.4944

exit

**Figure 2:** Remote System User Interface

## Conclusion



- Created a project which reads in a range of radio frequency
- Processes the frequency data being read by the USRP
- Can save the frequency data in a TDMS(Technical Data Management Streaming) file
- User can change the values of frequency, gain, frequency step, baseband bandwidth, & threshold
- Saving starts when the PSD is greater than the threshold
- Create & Transfer the CSV file to a Raspberry Pi through Secure Shell Transfer Protocol
- Display a notification on the Raspberry Pi
- Display file contents on user interface

## Graphical User Interface

Our user interface program works as an alarm system, triggered by directory monitoring and outputs only the timestamp, frequency, and PSD. It can run on most operating systems.

## Future Work and Research

For the next steps, we would want to make the system more mobile for either/both stations by introducing solar power and secure mobile stations for use anywhere in the world.

In addition we would also like to increase the capabilities by either using a different antenna or a different USRP in order to broaden our frequency range and reduce our data processing rates.

## Contact Information

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