

Test-bed Development for Geo-location of RF Emitters

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1. Introduction

The ability to accurately detect the location of radio signals provides a wide variety of uses ranging from determining the location of a distress signal from a party or individual in need of help to locating an interfering signal that is jamming communications. There are various techniques that may be used to discover radio signal. One such method includes using a directional antenna hooked to a device such as Universal Software Radio Peripheral (USRP) and sweeping through an area looking for peaks in radio Received Signal Strength (RSS). As the antenna is swept through the area, all of the data collected from the USRP is sent via Wi-Fi to computer running software which logs all of the data point and by using algorithms that help to “*paint a picture*” of the emitters location. Although useful in some circumstances, the unit has its limitations. For practical purposes, an individual is limited to testing from the ground; additionally, it can be time consuming moving from point to point logging RSS data points and then having to map the data to try and pin point the location.

2. Technical

The goal of our approach is to make the system as dynamic as possible and therefore make use of technology known as Universal Software Radio Peripheral (USRP). By correctly selecting the proper USRP unit or more technically, selecting the proper RF daughter board module for the USRP, one will have a radio which is capable of being a transceiver of any frequency within the band of the selected daughter board module. The particular frequency band specification for this project is $1 - 250\text{ MHz}$. We shall seek to fulfill this by utilizing the Ettus Research USRP1 unit with a BasicTX daughter module. The USRP units will be synced together to measure signal phase, which will give a rough estimate for angle of arrival of the signal.

B) GNU Radio Companion

In order to process the information gathered by the USRP units, it is necessary to utilize a software development toolkit to provide signal processing blocks to implement the software radios. We have chosen a free and open source software for this purpose named GNU radio companion.

C) Wireless Network

The USRP units will be controlled from and send received data over a wireless network using standard Wi-Fi frequencies (2.4 GHz) and protocols. The interface unit between the USRP and the Wi-Fi network will be a BeagleBone development board.

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D) Antenna Rotation

For optimal results, the design will require a mechanical component/motor to rotate our antenna; Binding of the antenna cable will become an issue, so we propose to use a motorized antenna unit.

3. Budget

SENSOR SUB-SYSTEM		PRICE
USRP1		\$700.00
BasicTX Daughterboard 1-250 MHz Tx		\$75.00
SMA-SMA Cable		\$30.00
BeagleBone Board		\$88.95
Wifi Adaptor		\$11.95
6V Battery 12 Ah. 4.3 lb		\$16.19
Motorized Antenna		\$170.00
Misc		\$100.00
Total cost for one sensor		\$1,192.09

4. Framework components

- Communication protocol between sensors and/or hub
- User interfaces
- Algorithm deployment
- Result analysis

5. Proof of concept

- Single sensor
- RSS detection

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- WiFi communication
- 1-250 MHz frequency band detection

6. Time Line

1. Propose a suitable solution for Geo-locating RF emitters and submit a budget for equipment needed. 2-6-2014
2. Bench test sensor to Wi-Fi network communications. 2-14-2014
3. Establish a wireless network between sensor and central node. 2-21-2014
4. With GNU Radio Companion software facilitate necessary communications with USRP units. 2-28-2014
5. Code program to utilize algorithm for information from sensor to determine location of emitter signal. 3-14-2014
6. Code User Interface program. 3-21-2014
7. Field test units within a 100 m² area and test for accuracy of system. 4-4-2014

7. Conclusion

Using commercially available equipment, our team will construct a sensor, which will receive a specified radio signal. With the central sensor, we will use an antenna to collect various data and wirelessly transmit this information to a central node containing GNU radio companion software. With this, we will construct a series of algorithms with the GNU radio companion software on the central node by performing analysis on the data to determine the location of the sensor as accurate as possible under the hardware constraints forced by budget limitations. Our design will be a framework for RSS sensors to test proposed RF algorithms and will develop a single minimally functional proof of concept.