DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
UNIVERSITY OF CENTRAL FLORIDA

INITIAL PROJECT PROPOSAL

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Sponsored by: Mainak Chatterjee

GROUP 6

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Introduction

Modern day society exists in the Information Age, with unparalleled access to most human archives, through a means of wireless communications. Current technology provides various resources for communication between individuals across the span of thousands of miles with no noticeable delay on either end. An integral component in this process of broadcasting endless streams of data is the ability to connect to a signal at a sufficient strength.

College campuses are among the densest areas when it comes to a need for individuals to be able to connect to various signals. Dr. Mainak Chatterjee has expressed the necessity for a device that is able to scan various frequency bands, sense signal strengths, and send the data to a server to display a real-time heat map of the signal strengths across the University of Central Florida. The implemented device is intended to provide a cheap alternative to using several overkill spectrum analyzers, whilst also displaying the data in real-time. The scope of this project entails the implementation of a device that scans and measures the signal strengths in a defined frequency band, along with the software realization that receives the data and displays an intuitive display to show the signal strengths at various locations.

To achieve these tasks, we will design a device incorporating a microcontroller, several sensors, wireless network connectivity, and mobile power distribution for the circuit. The microcontroller will control how the sensors change their frequency bands and poll signal strengths, whilst also controlling when and how data is sent from the wireless network module to the intended server. Additionally, LED indicators will be implemented to help troubleshoot any issues the modules may run into post deployment.

Project Goals

The goal of our project is to design a sensor that can read the signal strength of different frequency bands in common use. We intend for this design to be easy to reproduce to be able create a large network of sensors to be used throughout campus. A large-scale network of sensors will allow us to analyze the signal strength of frequency bands across campus and store it in a server that allows the data to be visualized in a user-friendly webpage. The data created from this project should be able to kick start new research on signal strength throughout college campuses.

Potential Customers

- Researchers in need of frequency strength data around certain areas
- Internet service providers looking to improve their network coverage
- IT technicians looking for the most optimal way to set up a Wi-Fi mesh

Specifications

- The design shall be no bigger than 10” wide x 6” long x 6” high
- The design shall have a watertight enclosure
- The design shall have an external power source (i.e. not plugged into a receptacle)
- The design shall withstand temperatures up to 140°F
- The design shall poll the strength of the cellular frequencies (850/900 MHz)
- The design shall poll the strength of the Wi-Fi frequencies (2.4 GHz)
- The design shall poll the signals with a step size of 1MHz
- The design shall transmit data wirelessly
- The design shall have the server receive and store data from the devices
- The design shall include a user-friendly webpage to display the data

Constraints

- The total design cost shall be less than $170
- The time to take this project shall take no more than 2 semesters
- The design must be able to withstand Florida’s showers, extreme heat, and humidity
- The system should be able to work wirelessly for at least 24 hours

Standards

- IEEE 802.11
- IEEE Standard for Software Unit Testing

Software Considerations

- Website / Server framework will be creating using the LAMP stack
- Website will be constructed to work at least on a google chrome browser
- Website will be accessible to many users at a time
- The data from the sensors should be stored at a minimum for 1 day

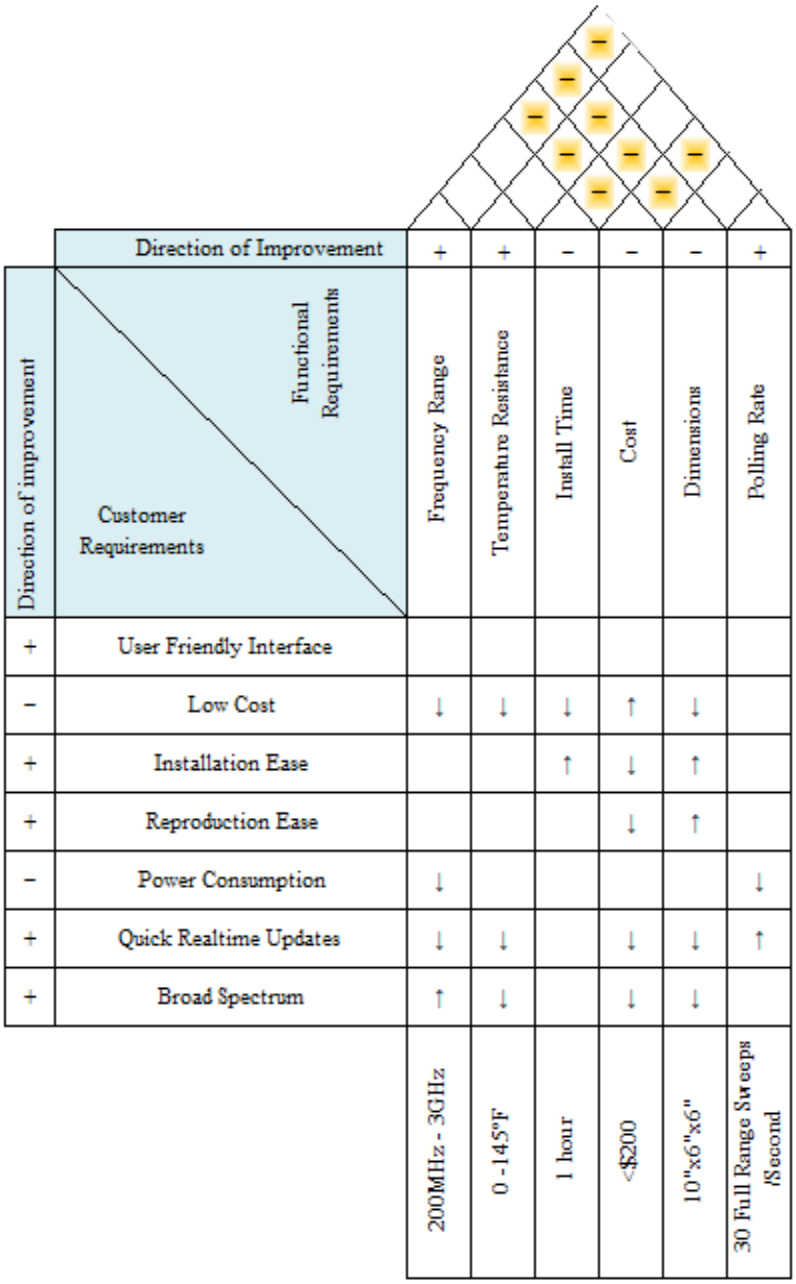
Frequencies Sensors Table

Frequency Range	Sensor	Comments
850/900 MHz	RFM22B/23B	- Low cost - Capable of receiving lower frequencies
2.4 GHz	TI CC2500	- Low cost - Plenty of documentation and tutorials - Very commonly used

Table 1 - Frequencies Sensors Table

House of Quality

As the development of the project continues, it is important to make distinct tradeoffs between marketing and engineering requirements. This will facilitate the process of making appropriate decisions that path the way to a successful project. The house of quality table (Figure 1) will be the tool used when orchestrating the development and construction of the project to maintain our highest priority goal: to provide a high-quality product to our client(s).



Direction of Improvement		+	+	−	−	−	+
Direction of improvement	Customer Requirements \ Functional Requirements	Frequency Range	Temperature Resistance	Install Time	Cost	Dimensions	Polling Rate
+	User Friendly Interface						
−	Low Cost	↓	↓	↓	↑	↓	
+	Installation Ease			↑	↓	↑	
+	Reproduction Ease				↓	↑	
−	Power Consumption	↓					↓
+	Quick Realtime Updates	↓	↓		↓	↓	↑
+	Broad Spectrum	↑	↓		↓	↓	
		200MHz - 3GHz	0 -145°F	1 hour	<$200	10"x6"x6"	30 Full Range Sweeps /Second

Negative correlation	↓
Positive correlation	↑
Positive polarity	+
Negative polarity	-

Project Block Diagram

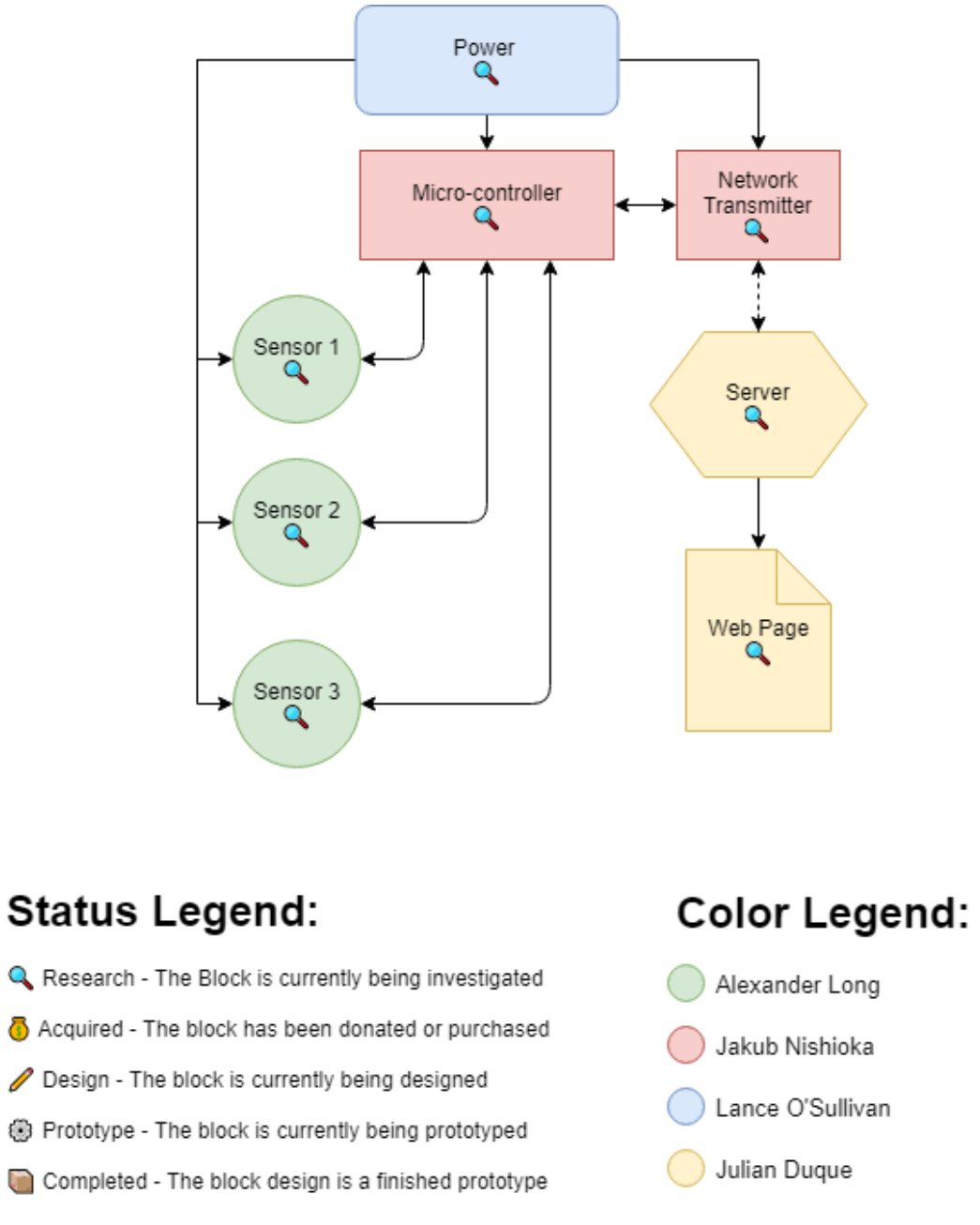


Figure 2 – Project Block Diagram

Microcontroller Software Logic Diagram

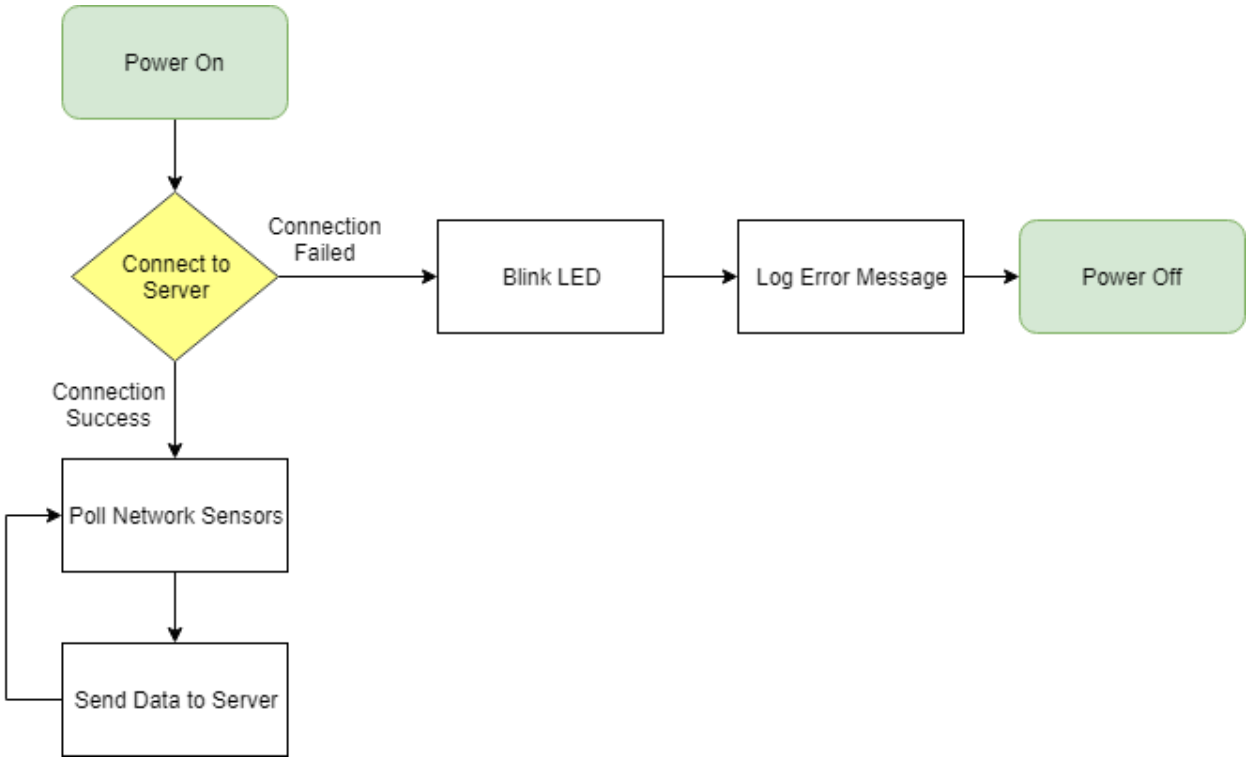


Figure 3 - MCU Software Logic Diagram

Website / Server Diagram

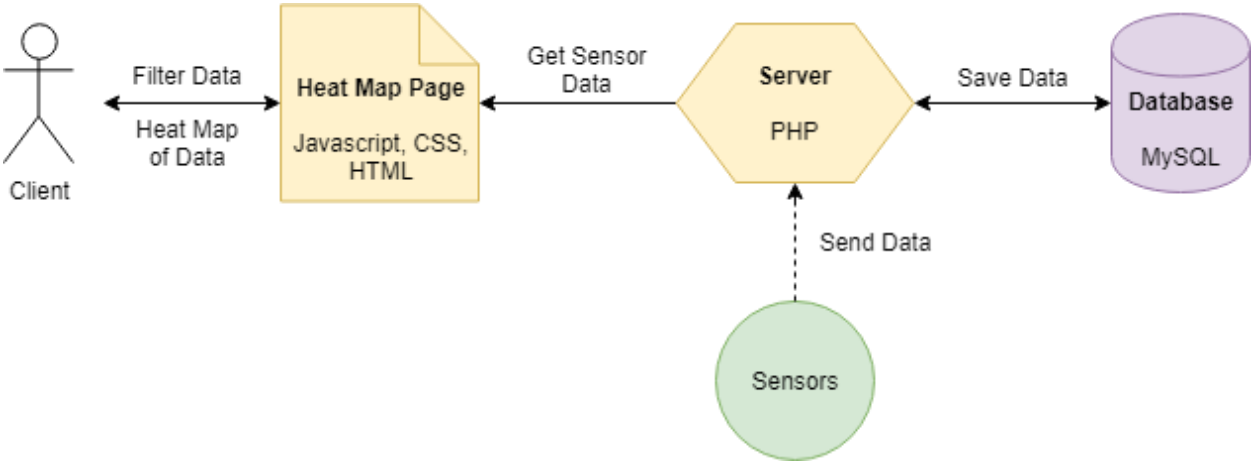


Figure 4 - Website / Server Software Diagram

Senior Design 1 Schedule

Description	Duration	Dates
Idea's research	2 Weeks	5/16/18 - 5/30/18
Project selection	1 Weeks	5/30/18 - 6/6/18
Divide and Conquer	2 Days	6/6/18 - 6/8/18
Updated Divide and conquer	1 Week	6/8/18 - 6/15/18
Research and Documentation	3 Weeks	6/15/18 - 7/6/18
60 Page Draft	1 Day	7/6/18
Research and Design	2 Weeks	7/6/18 - 7/20/18
Final Document	1 Day	7/20/18
Proof of Concept	3 Weeks	7/30/18 - 8/20/18

Table 2 - Senior Design 1 Schedule

Senior Design 2 Schedule

Description	Duration	Dates
Build Prototype	4 Weeks	8/20/2018-9/17/18
Testing and Redesign	2 Weeks	9/17/18-10/8/18
Finalize Design	2 Weeks	10/8/18-10/22/18
Peer Presentation	TBA	TBA
Final Report	TBA	TBA
Final Presentation	TBA	TBA

Table 3 - Senior Design 2 Schedule

Cost Analysis

Part	Price
Wireless Transmitter	$40
Sensors	$20
PCB Design	$20
Microcontroller	$20
Batteries	$10
Antennas	$60
Total	$170

Table 4 - Cost Analysis

Our aimed project budget is approximately $200 per unit. Our current cost analysis (Table 3) aims for higher than normal prices to allow plenty of room for unexpected price increases, costs of damaged products, and other fees such as shipping and tax. These values are subject to change due

to possible design changes that may arise throughout the design and research phase. We hope to streamline our design to be able to build multiple sensors in a cost-efficient way.

Sponsors

Our project will be sponsored by Dr. Mainak Chatterjee. Dr. Chatterjee is a researcher who mainly focuses in computer networking. He studies the economic issues of wireless networks, cognitive radio networks, dynamic spectrum access, and network science among other topics.

Outcome

With the completion of this project the desired outcome is to have a system that consists of self-sustaining, low cost, and reliable devices that work with a remote server to allow the collection different radio frequency signal strengths. This collection system will allow researchers to further study the relationship between environments such as urban and university areas and their effects on common radio frequencies used for things such as mobile devices, TV broadcasting, and navigation.