UCF Senior Design 1 Spring 2019

"Long-Range Wireless Texting Device"

University of Central Florida

Department of Electrical and Computer Engineering

Dr. Samuel Richie & Dr. Lei Wei

Divide & Conquer Assignment

Group 10

Brandyn Brinston	
bbrinston@knights.ucf.edu	Computer Engineering
Caleb Phillips	
calebphillips@knights.ucf.edu	Computer Engineering
Michael Sedlack	
m.sedlack@knights.ucf.edu	Electrical Engineering
Justin Tuggle	
jtuggle@knights.ucf.edu	Electrical Engineering

Project Narrative

In today's technologically-driven world we are more connected than ever. Communication has long been at the center of many emerging technologies. As we continue to advance our ability to communicate with innovations that bring connectivity to the farthest reaches of our big blue planet, there are still some areas that are, quite frankly, hard to reach.

With modern cellular and satellite communication we are able to establish wireless connections on opposite sides of the Earth. These solutions, however, are not always ideal. With cellular communication we are able to send vast amounts of data at very high rates, with very low latency. However, cellular networks are only as good as the quality and distribution of their towers. There still exist significant swaths of the United States that do not have cellular service coverage; rural areas, parks, and nature reserves, to name a few. As such, it is desirable to have a method of electronic communication that does not rely on cellular services while in these locations. In these areas, one of the technologies that has seen fairly extensive use thus far is satellite communication. While often slower than cellular networks, satellite provides true coverage of almost the entire surface of the Earth. Unfortunately, this comes at a high price, and often requires much larger equipment; in addition, it is susceptible to atmospheric interference.

We are seeking to create a device that will facilitate communication for those who are in these very areas or situations that do not allow for easy and accessible cellular communication. We are seeking to create a reliable way for individuals to remain connected without any need for outside networks such as cellular towers or satellite connections. The device we plan to create will also be capable of sustaining operability for long periods of time by collecting its own power via solar panels. Another goal of our project is that it will be able to maintain a connection over a long range.

While defining our project goals we considered a number of different scenarios in which such a device would be useful. One major contributor in this area was for outdoorsmen in rural areas. Whether it be a long section of the Appalachian Trail, the untamed wilderness of Alaska, or even the vast expanse of the Sahara Dessert, there are often times when some form of communication is either vital or at a minimal very useful. Maintaining a line of communication also provides an inherent security. Without communication a minor injury in the wilderness could become a major problem, for example.

A couple of methods of communication to this end were considered, and the conclusion was reached that text rather than voice was going to be the most reasonable communication method – the reason for which is bandwidth. The reason CB and HAM radio suffer so badly in requiring large, non-portable equipment is due to their high power and bandwidth capabilities; if we remove the ability to transmit audio – a relatively bandwidth-intensive feat – we can have a greater range using far less power, all while using equipment that is significantly more portable.

As such, the purpose of this project is to develop a wireless communications device capable of transmitting point-to-point (P2P) text messages of 16 or more characters across a relatively long distance. With this aim in mind, there are a few key points we would like to address in order to express our expectations of the design and functionality of the device.

Requirements

Electrical & Power Requirements

- Device should be capable of battery operation for at least 4 hours
- Device should be capable of being recharged via cable within 2 hours
- Transceiver frequency should be approximately 900-930 MHz
- Power rating of the modules should be approximately 0.5-3 watts
- Solar panels used can generate up to a watt used for recharging the batteries

Software Requirements

- Associated software will conform to code space limitations posed by MCU
- Embedded software shall be designed to communicate efficiently to all connected devices and hardware
- Ensuring that embedded software is designed to support low-power use and high-performance solutions shall be emphasized
- Transmitted and received messages shall not exceed a sixteen-character limit—to be increased if capabilities allow
- Messages shall be composed of ASCII characters

Mechanical Requirements

- The weight of each produced device shall not exceed 10 pounds
- Each device shall be easily transportable and reasonably ergonomic
- Should be capable of withstanding a drop from 3 feet onto dirt/grass
- The total cost of production for an individual device shall not exceed $250

Federal Standards and Regulations

- Each module will conform to FCC Maximum Permissible RF Exposure Regulations
- The modules used will adhere to the regulations enforced by the CPSC

Project Budget and Financing

The following is a table encompassing all planned project expenditures as they relate to the three Long-Range Wireless Texting modules to be developed. The total cost for all three modules is estimated to be $452.00, with the cost for production of each individual module to be $138.39 when neglecting the cost of the Microcontroller Development Kit. The project is currently without a sponsor—therefore, all four members have agreed to personally provide funds during the duration of the project's lifetime. A shared fund will be created that will be used only for procurement and maintenance purposes. Should a team member commit to the acquisition of a part to be used in development, they will first have to append an entry to a log containing a record of all parts and materials procured using the shared fund. Both the log and the shared fund will encourage transparency between team members as well as provide a clear table of records to aid in regulation and status of funds.

Part Name	**Quantity**	**Price (x1)**	**Price (All)**
PCB	3	$ 50.00	$ 150.00
Electrical Components	AS REQ.	$ -	$ 50.00
Microcontroller	3	$ 10.00	$ 30.00
Microcontroller Development Kit	2	$ 18.42	$ 36.84
Solar Panel	3	$ 19.95	$ 59.85
Rechargeable Battery	9	$ 2.11	$ 18.99
Transceiver Kit	1	$ 99.00	$ 99.00
LCD Character Display Module	3	$ 2.44	$ 7.32
		Total Cost	$ 452.00
		Total Cost Per Board/Module	$ 138.39

Table 1: Project Budget

Block Diagram and Project Layout

A general layout for the hardware that will be used for this project has been developed, and responsibility for developing each subsystem has been determined. This is established in the block diagram below:

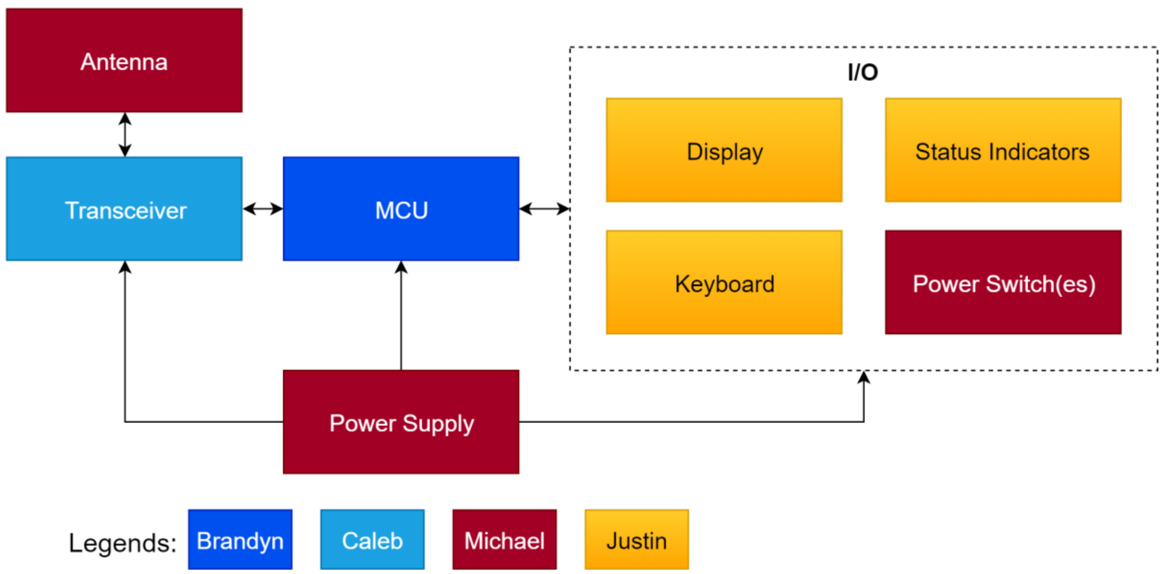

Figure 1: Block Diagram for Project Hardware

Altogether, we have a microcontroller (MCU) that is tied to our transceiver, antenna, and I/O devices. Since message input and output to and from a user are both required, communication between the MCU and the I/O are bi-directional. Each subsystem then receives power from a power supply unit (PSU) capable of charging and discharging rechargeable batteries. Currently, work is being done in determining a transceiver module and MCU that have sufficient capabilities for our purposes. For the transceiver specifically, we want something that is of a considerable power output, enabling a potential for communication over long distances. Ideally, we want to incorporate mesh networking into the design such that no singular node is dependent upon centralized transmissions. A general guide for software modules is shown below:

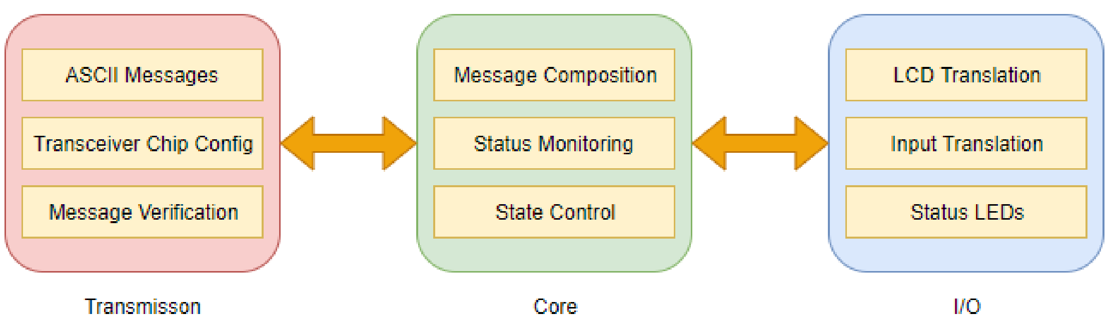

Figure 2: Anticipated Programming Blocks (Subject to Change)

Block Descriptions

Antenna:

Description: This block will increase the send and receive range of the unit.

Block Status: To be acquired

Transceiver:

Description: This module should contain a configurable chip that handles networking and transmission of information with simple configuration. Power usage should also be kept to a minimum.

Block Status: Research

MCU:

Description: The MCU will support enough I/O pins for all I/O devices. Software space requirements will also need to be met with an acceptably low power device.

Block Status: Research

Display:

Description: The display - LCD or similar - will be a low power module capable of displaying an appropriate number of characters. Minimizing I/O pin requirements will be a priority.

Block Status: To be acquired

Status Indicators:

Description: A variety of LEDs will be used to display the status of various system functions.

Block Status: To be acquired

Keyboard:

Description: The keyboard will be the primary input for the device. It will need to provide intuitive support for sending and receiving the messages.

Block Status: Design

Power Switches:

Description: This block will consist of switches to control the unit's power, transmission power level, and possibly options for control of the solar and USB power input.

Block Status: Design

Power Supply:

Description: This module will produce the requisite DC voltages for operation of the device. Voltages from battery, solar, and USB input will be managed.

Block Status: Design

Transmission Software:

Description: This code will handle sending the finalized packets to the transceiver module as well as supporting configuration options and verifying packets with checks and ACKs.

Block Status: Research

Core Software:

Description: This section will parse data from the other blocks and produce the proper output. It will also monitor the status of the device as a whole.

Block Status: Research

I/O Software:

Description: This block will contain the code needed to translate key presses from the device input hardware as well as setting the output LCD and LEDs appropriately.

Block Status: Research

Milestones

Deliverables	Term	Date Begin	Date End	Responsible	Status
Initial Ideation Process					
Form Groups	Spring 2019	1/8/2019	1/8/2019	Team	Complete
Project Idea Brainstorming	Spring 2019	1/8/2019	1/22/2019	Team	Complete
Pick final choices for consideration	Spring 2019	1/22/2019	1/25/2019	Team	Complete
Idea Selection	Spring 2019	1/24/2019	1/28/2019	Team	Complete
Research					
Divide and Conquer Document (Initial Project and Group Identification Document)	Spring 2019	1/22/2019	2/1/2019	Team	Complete
Decide general budget and source of funds	Spring 2019	1/15/2019	1/29/2019	Team	Complete
Assign roles	Spring 2019	1/22/2019	1/29/2019	Team	Complete
Determine Official Requirements	Spring 2019	1/31/2019	2/1/2019	Team	Complete
MCU research	Spring 2019	1/29/2019	2/14/2019	Brandyn	In Progress
Transceiver and Antenna research	Spring 2019	1/29/2019	2/14/2019	Caleb	In Progress
I/O research	Spring 2019	1/29/2019	2/14/2019	Justin	In Progress
Power Supply research	Spring 2019	1/29/2019	2/14/2019	Michael	In Progress
Meet with Professor (Divide & Conquer)	Spring 2019	2/5/2019	2/5/2019	Team	To Be Completed
Design					
PCB Layout and Design	Spring 2019	2/7/2019	3/28/2019	Michael/Justin	To Be Completed
Embedded Software Package Plan	Spring 2019	2/7/2019	2/28/2019	Brandyn/Caleb	To Be Completed
Design of Power Supply	Spring 2019	2/7/2019	3/28/2019	Michael/Justin	To Be Completed

I/O Interface Design and Planning	Spring 2019	2/7/2019	3/28/2019	Michael/Justin	To Be Completed
Embedded Software Development	Spring 2019	2/28/2019	4/23/2019	Brandyn/Caleb	To Be Completed
60 Page Documentation Draft	Spring 2019	2/7/2019	3/29/2019	Team	To Be Completed
100 Page Documentation Submission	Spring 2019	3/29/2019	4/12/2019	Team	To Be Completed
Final SD1 Document	Spring 2019	4/22/2019	4/22/2019	Team	To Be Completed
Prototyping, Testing, and Finalization					
PCB Build	Spring 2019	3/28/2019	4/23/2019	Michael/Justin	To Be Completed
Hardware/Software Integration	Spring 2019	4/23/2019	5/6/2019	Brandyn/Caleb	To Be Completed
Debugging and Testing	Summer 2019	4/23/2019	7/19/2019	Team	To Be Completed
Revisions	Summer 2019	4/23/2019	7/19/2019	Team	To Be Completed
Final Report	Summer 2019	5/13/2019	7/26/2019	Team	To Be Completed
Final Presentation	Summer 2019	5/13/2019	7/26/2019	Team	To Be Completed

Table 2: Project Milestones