ELECTRONIC FLIP SIGN

Group 16 - Blue Team

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1. Project Narrative

The electronic flip sign is a handheld lightweight LED display that will allow the user to preprogram their message via computer interface so that it can be visible for others to see with ease. This will allow the user to communicate their short messages to people around them. This device will be used for communication and entertainment. The ideal use for this device will be to allow the user to communicate in situations like at a sports events, in traffic, or even as an idle display for a game room. This sign is able to hold custom messages and can display any capital letters, numbers and even a few emojis. The flip sign can help with people in workplaces that have difficulties with hearing or communicating with others. For example, the flip sign can be used to direct construction works while they are operating loud machinery. The device will be composed of 2D surface mounted LED matrix display and will be configured via micro USB and Bluetooth through a software interface. The micro USB cable provided will also allow the user to charge the battery in the device.

The goal of this project is to create a device that can be used to convey messages that can be changed and used in a variety of areas. To accomplish this currently, items like paper signs or LED displays are used, but each of these have their own issues. There are various other LED signs out on the market. Some of these signs are programmable with text and icons, but they have to either be plugged in or mounted somewhere. The key reason why there is a need for our sign is due to a lack of portable LED signs. One that you can be used with one hand, on the go and without being plugged in. The problem with the current LED displays on the market is that some are not battery operated and the ones that are do not have portability in mind since most are for a sitting wall display. We are taking what the current LED signs have and making it not only portable, but also making it easy to change the display on the go as well as other features added to make using the device on the go easier and more efficient than anything on the market today.

This project's goal is not just to make a single working model. This project is to make a prototype for a production model that can then be sold at mass market. Making a product that can be used as a prototype for involves using parts that can be sourced for a much cheaper price in order to lower the bulk price. Other things that also have to be considered include the materials being used as well as the type of battery. Each of these things are done to lower production cost as well as make a better quality product for the consumer. Below is an example of an LED sign that is already out on the market.

Figure 1: Eletechsup's 64X16 dot Matrix LED

2. Prototyping and Modeling

This section includes the dimensions and constraints of the 3D model of the electronic LED sign. The design specification 10"wide by 4" tall by 1" thick(inches). Another modeling constraint is that the device has to weigh no more than 8 ounces. The second photo is a mock device created that passes the size and weight constraints to give an idea of the dimensions for reference.

What Comes With the Device

- The Sign with battery and handle
- Micro USB Cable

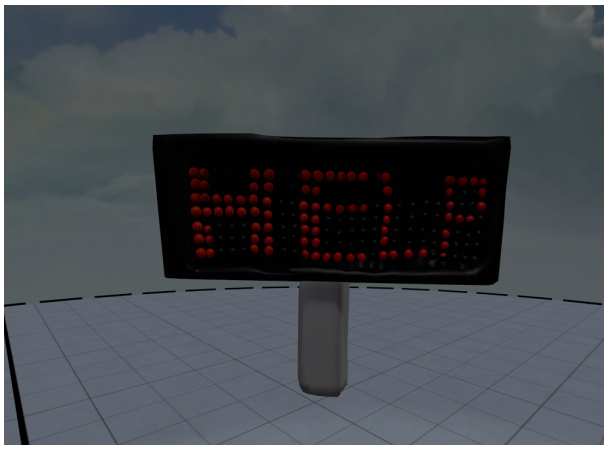


Figure 2: Front View of Simulation (3D)

Figure 3: MOCK UP DESIGN

3. Design specifications/Constraints

- **Dimensions**: LED display approximately 10” x 4” x 1”
    - Handle at bottom of display to hold it and enable one handed operation
    - Dimensions approximately 5” x 1.5” x 1.5”
- **Ambient Light Sensor:** The sensor located on the top of the device
    - Sensor will adjust the brightness according to the ambient light
    - Brightness will be adjustable manually and via sensor
- **Battery:** Able to operate the display at full brightness for 15 minutes
    - Rechargeable via USB port to PC port or wall adapter
- **Connectivity:** Bluetooth and USB interfaces
- **Removeable Handle:** Allows the sign to be used as a wall mount display
- **Weight**: approximately 8 ounces in total not including USB cable
- **Visibility**: Readable from 35ft away
- The device will be programmable via PC and or phone app which will allow the user to easily program each button to the desired text
- **Durability**: device will be able to be held, waved, and handle rough use without breaking
- **Cost**: thousand unit price must be under $40
    - Cost for prototype about $200
- **Power Switch:** Three section switch located on the left side of the device near the top.
    - **Section 1 (Down): OFF**, the device is inactive
    - **Section 2 (Up): ON**, the device is on and running but the display will only turn on once a display button is pressed
- **Dim Control:** Dimming is controlled by holding the top left button then using the lower 3 buttons to control the dimness.
    - **Lower Left:** Decreases brightness
    - **Lower Right:** Increases brightness
    - **Lower Middle:** Sets the brightness to automatic
- **Button Array:** There are 6 buttons labeled 1-6 layed out in 3 columns and 2 rows just above the handle and these will each display a pre programmed message (see programing) on the LED display upon being pressed.
- **Display Operation:** When **ON** upon the press of one of the **Display Buttons** the message will display for the programed amount of time, this time will reset each time it is pressed and will be overridden by another input. To clear the display hold the bottom right button for 2 seconds. A triple press of a **Display Button** will display that text indefinitely until display is cleared or other input is given to override.
- **Power Light:** This includes an LED that is located on the back of the device lower left and will be on when if the display is on.
- **Micro USB Port:** This is a micro USB port that will use the provided USB cable to plug into a computer USB port to charge the device and can be used to program it as well
- **Software:** A user interface accessed from either an app or PC program. This allows the user to be able to preset the messages they want to display at each given button using the features that are available below.
    - **Characters**: All capital letters, !, @, #, $, and 4 emojis

- **Multilane:** This will be an option for the user to choose either one line of text and two lines of text, each line of text will have a given number of characters per line.
- **Scrolling:** This option allows the user to be able to set their messages as text that moves across the screen. This can only be done with single lined text, but with the text moving across the screen, the user will be able to fit longer messages. The scrolling feature will also allow the user to adjust the rate at which the scrolling is moving.
- **Preview:** When the device is connect when reprogramming the device it will actively display the message on the display so the user has a real time understanding of what it is going to look like.
- **Time Display:** The amount of time each display is shown for on a single press can be customized to the users desire.
- **Reverse Text:** This function would allow the user to be able to create a message that can be read while viewing in through a mirror.
- **Flashing Text:** Allows the user to make their message flash at a rate pre-set.

4. Block Diagrams

The electronic device incorporates a built in LED display approximately 64 x 16 2D matrix panel, and a controller with a built in pulse width modulator. This modulator will adjust the LED brightness depending on the user use of the device indoors or outside. Brightness will be adjustable manually and via a ambient light sensor. Partnering modern day microcontroller chips and a LED display, the electronic flip sign offers solution to demanding networks of entertainment and mass communication.

Architecture
The device is composed of a power supply (the battery) that delivers power to the LED's and the system where a voltage regulator feeds a constant voltage to the micro controller. The power supply will be powered by a rechargeable battery via USB. As depicted in figure4, the signal is bidirectional, sending data communication to the controller in response to regulating the voltage across each diode. Bluetooth communication is incorporated to the controller design via UART to also receive and send information to the device.

Multiple push buttons will be built onto the board in order to alter the LEDs that will be connected to the controller. And a PID controller with a photo sensor will be implemented to adjust the brightness of the screen. When sensor receives a high intensity of light the LED voltage will maximize and if the intensity is not met by that threshold the led brightness will alter its max value.

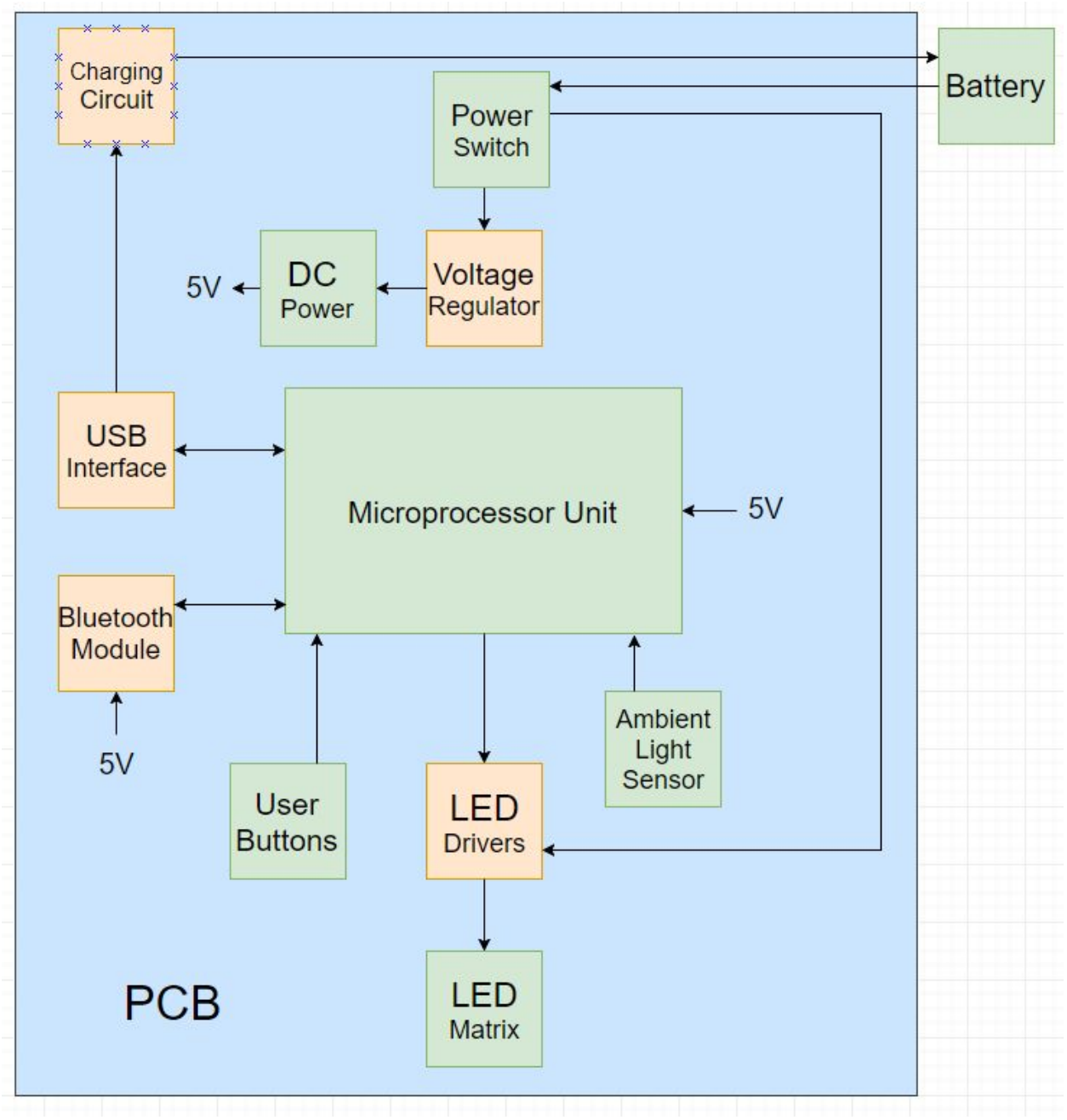


Figure 4: Hardware Block Diagram

LEGEND Hardware Block Diagram	
Richard [Green]	Dominick [Orange]
Power Switch (To be acquired) Used to power on and off device	Charging Circuit (Research) Components used to charge the battery
Battery (To be acquired) Used to power device	Voltage Regulator (Research) Converts unregulated battery power to regulated power
Microprocessor Unit (To be acquired) Chip used to processes information and control the device	USB Interface (Research) Components that allow for a USB connection and communication
User Buttons (To be acquired) User input on the device	Bluetooth Module (To be acquired) Components allowing bluetooth accesses
Ambient Light Sensor (To be acquired) Sensor that reads the brightness	LED Drivers (To be acquired) Chips that control the LED's in the array
LED Matrix (To be acquired) An array of LED's in a 2D rectangle	PCB [Both] (Design) The board that connects all the components
DC Power (To be acquired) Distributes DC power	

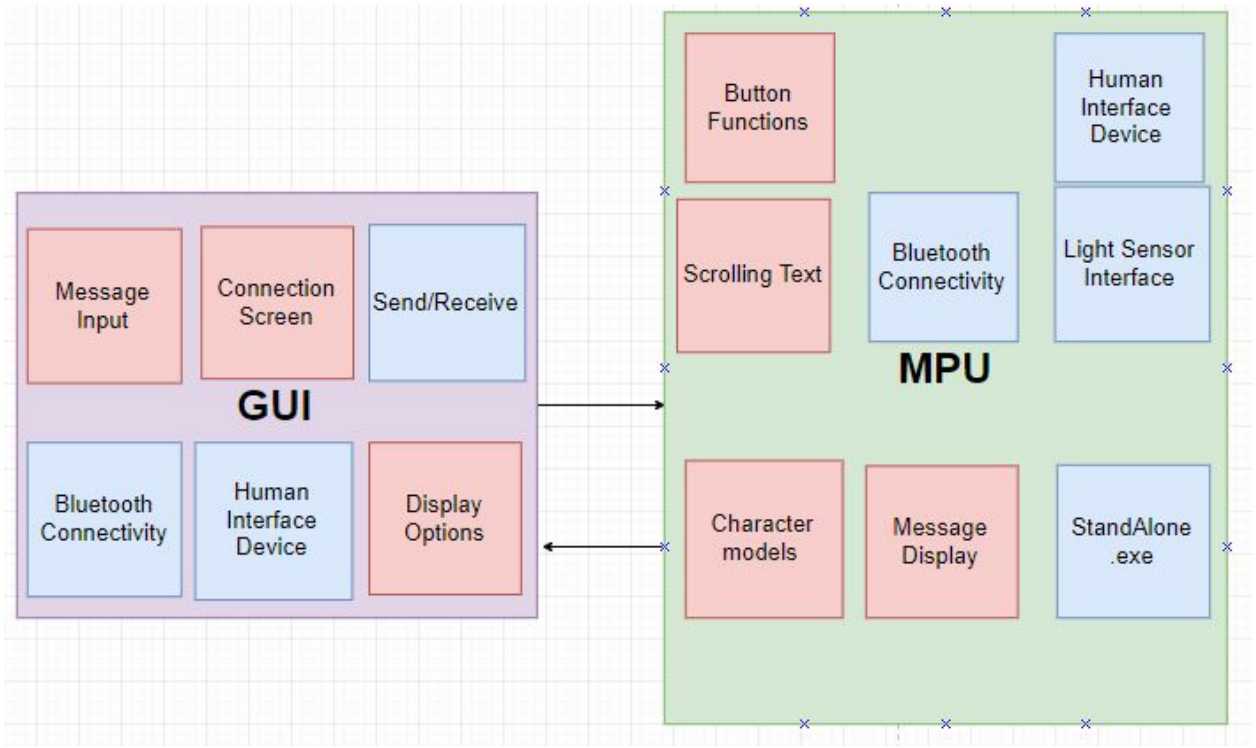


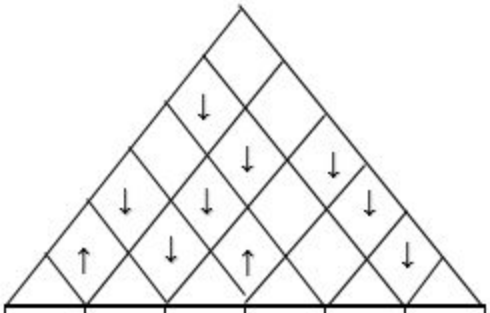
Figure 5: Software Block Diagrams

LEGEND	
Brennan [Blue]	John [Red]
Send/Receive (Design) • Transferring data between device and computer • Inputs/Outputs: Transmits between computer and device.	Button Functions (Design) • Buttons that are used to select message to be displayed • Input from user • Output to MPU
Bluetooth Connectivity (Research) • Sets device as discoverable and allows device to be connected to another bluetooth enabled device • Inputs/Outputs: transmits between computer and device	Character Models (Design) • LED patterns for each charter • Input GUI • Output display

Human Interface Device (Research) • Gives computer ability to recognize and use device • Input: device to computer • Output data to device from computer	GUI – Graphic User Interface (Design) • The application that the user will use to program the device • Input from user • Output computer interface and memory
Light Sensor Interface (Research) • Adjusts brightness of LED display • Inputs ambient light level • Outputs data for light level	Message Display (Research) • Sending the message to the display • Input GUI • Output display
Stand Alone .exe (Research) • Loads program upon connection program is used to send custom messages to device • Input: device • Output:Program to computer	Scrolling Text (Research) • Allows the text to move across the display • Input display message • Outputs scrolling message
Message Input (Design) • Takes in the desired text to display • Input user • Output display	Display Options (Research) • Allows the input for all available options • Input user • Output GUI
MPU - Micro Processing Unit (To be acquired) • Runs internal program that will be used to provide function to the device • Inputs: Buttons • Outputs: Message Displayed	Connection Screen (Design) • Interface to input all data • Input user • Output GUI

5.

House of Quality



Direction of Improvement		+	+	-	-	-	+
Customer Requirements (What)	Design Requirements (How)	Brightness	Battery	Dimensions	Weight	Cost	Durability
Improve +	Viewing Distance	↑↑	↑↑	↓	↓	↓↓	
	Quality	↑↑		↑		↓↓	↑↑
	Ease of Use			↑	↑↑		
	Use Time	↓↓	↑↑	↓	↓	↓	
Reduce -	Weight	↓	↓↓	↑	↑↑		↓↓
	Size		↓	↑↑	↑		↓
	Cost	↓	↓			↑↑	↓
Targets for Engineering Requirments		Very Bright	2000 mAh	10" x 4" x 1"	0.5 lbs	$40 Prouction	Rough Use

Figure 6: House of Quality

6. Plan
Senior Design 1

Milestones	Completed (Y/N)	Week Due Completion*	Responsible
Hardware Selected	N	6	EE
LED Display Design	N	7	EE
Prototype Schematic	N	8	EE
Embedded Code	N	10	CE
Basic GUI	N	10	CE
Module Testing	N	10	EE
Prototype MPU	N	12	All
Breadboard Prototype	N	13	EE
Working Prototype	N	15	All

Course Documentation	**Description**	**Due Date**
Group creation	Team created	8/25/17
Project Idea	Project defined	9/1/17
Initial Project Paper (10 Page)	Document giving details and constraints of the project	9/22/17
Table of Content	List to of topics to be covered in the final paper	10/6/17*
First Draft Document (60 Page)	Rough draft of final paper	11/3/17
Second Draft (100 Page)	Draft of final paper	11/17/17
Final Document	Final documentation full details of the project	12/4/17

* estimated

Senior Design 2

Milestones	Completed (Y/N)	Week Due Completion*	Responsible
PCB Design & Layout Rev A	N	3	EE
PCB Schematic Rev A	N	4	EE
PCB Manufactured Rev A	N	5	EE
GUI Rev A	N	6	CE
Code Rev A	N	6	CE
Assembled Rev A	N	6	EE
Test Rev A	N	6	EE
PCB Design & Layout Rev B	N	7	EE
PCB Schematic Rev B	N	8	EE
PCB Manufactured Rev B	N	8	EE
GUI Rev B	N	9	EE
Code Rev B	N	9	EE
Assembled Rev B	N	9	All
Test Rev B	N	10	EE
Final Device	N	11	EE
Final Code	N	11	CE

Documentation	Description	Week*
CDR Presentation		2
Conference Paper	Paper to present as summary	5
Middle Term Demo	Draft of product	8
Final Bill Materials	Final total of parts for production and prototype	14
Production Report	information to start production	14
Final Presentation and Demo	Completed project	15
SD Day/Exit Interview	Open demo	16

7. Cost Estimation

One of the objectives of this project is not just to make a working project but to design it for mass production and for the price at mass production levels to be under $40. Listed in the table below is a chart that shows the components needed and then a list of there prices per unit for both buying at a single part by part to build a single device and then the cost of a single unit if enough parts were bought to build 1000 units. The price of each unit greatly differs with the single prototype costing much more than the bulk price, this is good because the goal is to make the cost in bulk as low as possible because to make the device into a production device the prices need to be low so that the price to consumer is lower making it marketable. Though the goal of production price is $40 this is not what the consumer will pay, this is why the price is so low as some of the competitor devices, even though they do not do the same thing, they are priced around $60 and we will have to be in this realm in order to compete in this market

Components	**Rev A Cost Prototype**	**Rev B Cost Prototype**	**Production Cost 1000 units**
PCB	$80.00	$80.00	$3.00
Case	$10.00	$10.00	$2.00
Battery	$4.00	$4.00	$2.00
LED’s	$8.00	$8.00	$6.00
LED Drivers	$20.00	$20.00	$8.00
Bluetooth Module	$10.00	$10.00	$5.20
Ambient Light Sensor	$0.70	$0.70	$0.30
6 Buttons	$3.00	$3.00	$2.00
MPU	$5.00	$5.00	$2.00
USB Port	$0.80	$0.80	$0.50
USB Interface & Cord	$3.55	$1.30	$2.20
Power Switch	$0.50	$0.50	$0.30
Passive Components	$0.75	$0.50	$0.40
Power Circuitry	$1.00	$1.00	$0.60
Total	**$147.30**	**$147.30**	**$34.50**

* All values given are subject to change as design constraints and other variables of compatibility may cause the prices to be higher than the given value as the given values are close to a best case possible and the final price could be +$200 for the prototype and +$20 for the production cost.

8. References

- www.digikey.com - used for Cost Estimation table.
- “Electronic Flip Sign” Project Proposal Powerpoint by Michael Young
- https://www.aliexpress.com/item/Provide-UNO-MEGA2560-code-64x16-dot-Matrix-LED-for-Arduino-AVR-MCU-diy-Christmas-Gifts-Sign/32481337965.html?spm=2114.search0103.3.58.leY9SY&ws_ab_test=searchweb0_0,searchweb201602_3_10152_10065_10151_10068_10130_5490020_5550020_10307_10137_10060_10155_10154_10056_10055_10054_5470020_10059_100031_10099_5460020_10103_10102_10052_10053_10142_10107_10050_10051_10324_10325_5380020_10326_10084_10083_10080_10082_10081_10178_10110_10111_10112_10113_10114_10312_10313_10314_10078_10079_10073,searchweb201603_15,ppcSwitch_3&btsid=2c4541bc-524f-4330-8643-87f30b0d26d9&algo_expid=5ffd914e-9187-4d96-8388-a3f55cb5c4e4-7&algo_pvid=5ffd914e-9187-4d96-8388-a3f55cb5c4e4 - Example of an LED display that is already on the market.
- https://www.aliexpress.com/