Bioelectric Smartwatch

Group 1

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Jelani Foy	EE
Bailey Morgan	EE
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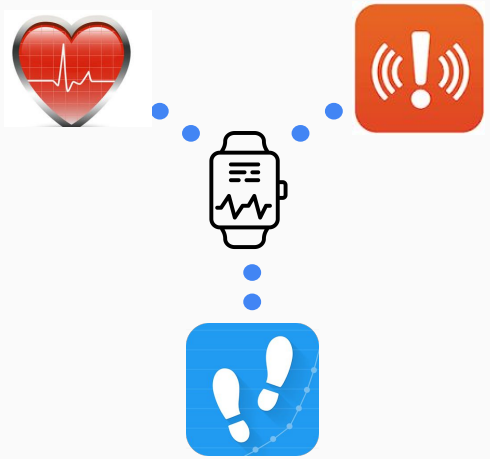
Motivation

- Integrate lifestyle improving characteristics and emergency GPS system
- Assist elderly and people with chronic illnesses maintain a healthy lifestyle
- Idea suggested by Dr. Zaurin
- Market Audience:
  - Elderly
  - General public

Goals and Objectives

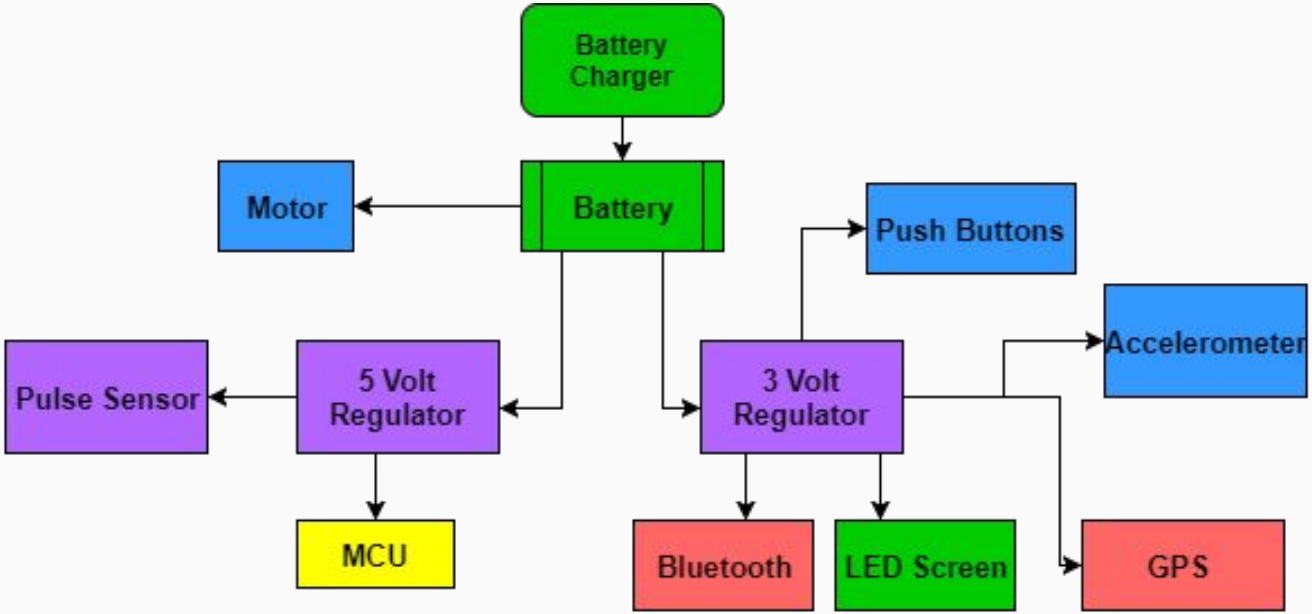
- Bioelectric Smartwatch Features
  - Pulse
  - Steps taken
  - Emergency beacon
- A mobile web application
  - Saves activity progress
  - Send alerts and notifications to authorized personnel



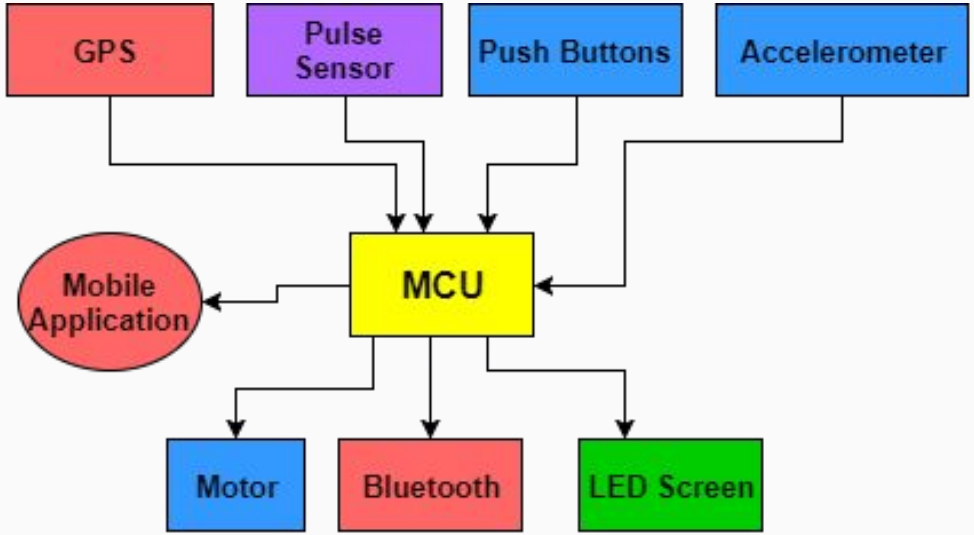
Specifications

Component	Parameters	Design Specification
Battery	Charge/Discharge Time	2hrs/12hrs
GPS receiver	Accuracy	3m
Bluetooth	Range	5m
Pulse	Accuracy	+/-3 Bpm
Accelerometer	Accuracy	+/- 0.1g
Watch Dimension	Size	100x70mm

Power Block Diagram



Communication Block Diagram



Krystal Folkes

Bailey Morgan

Collaboration

Jelani Foy

Niabelle Thelemaque

Components

Microcontroller Comparison

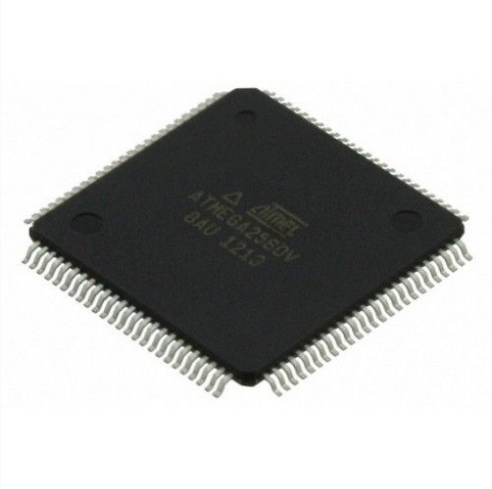
Comparison of Microcontrollers Considered

Microcontroller	ATmega2560	ATmega 328
Flash Memory	256kB	32kB
Operating Voltage	4.5-5.5V	1.8V-5.5V
I/O pins	86	14
Cost	$12.21	$2.14

Microcontroller- ATmega2560

Purpose: Synchronizes all of the peripherals and performs computations

- Raspberry PI used for prototyping
  - Broadcom BCM2835
- Reasons for choosing ATmega2560
  - Compatibility with peripherals
  - Memory
  - Number of pins



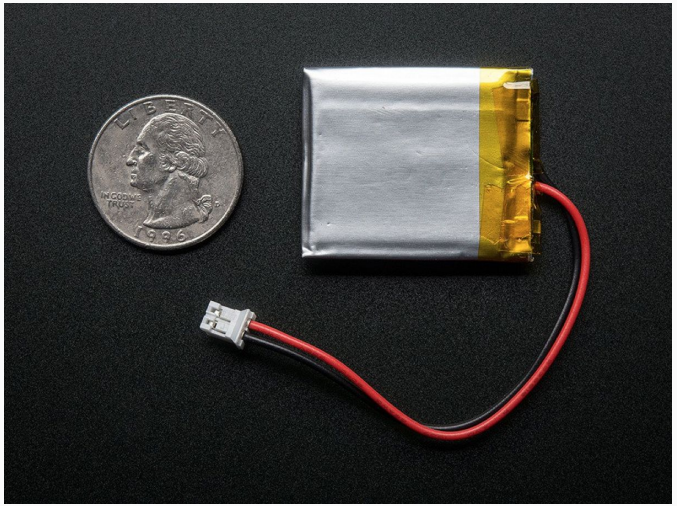
Battery Comparison

Battery	Advantages	Disadvantages
Lithium Ion Polymer	Slender profile	Lower power capacity
	Light weight	Faster Discharge
	Protection Circuit	
Lithium Ion	Higher power capacity	Heavier
	Low maintenance	Bulky
	Slower discharge	

Lithium-Ion Polymer Battery

Purpose: Supply power to the smartwatch

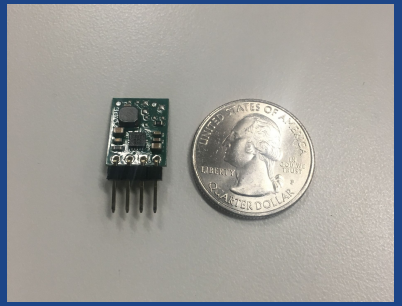
- Benefits: Thin, Light and Powerful
- Voltage: Output ranges from 3.2V to 4.2V
- Battery Capacity: Capacity of 500mAh
- Dimensions: 1.15” x 1.4” x 0.19”
- Weight: 10.5g



3.3 Voltage Regulator

Name	102-2758-ND	U1V11F3
Manufacturer	Digi-Key	Pololu
Max Current (A)	0.200	1.2
Max Voltage (V)	5.5	5.5
Min. Voltage	4.5	0.5
Unit Price	$4.31	$4.95

3.3 Voltage Regulator-U1V11F3



Purpose: Provides voltage for most peripherals

- Most of the peripherals require a constant input of 3.3 Volts
- Input Voltage Range: 0.5-5.5V
- Shutdown pin

Cases	Voltage Supply	Input Voltage	Output Voltage
1	1.02	1.02	3.33
2	2	2.04	3.33
3	3	2.96	3.32
4	4	4.01	3.34

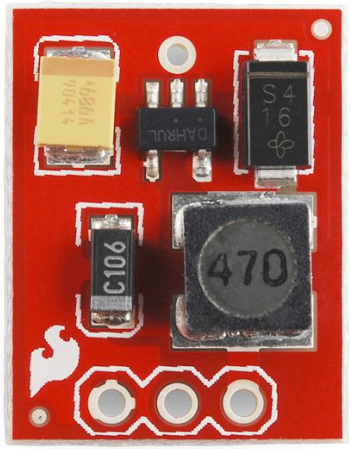
5 Voltage Regulator

Name	LMR61428	NCP1402
Manufacturer	Texas Instruments	Sparkfun
Max Current (A)	2.85	0.130
Max Voltage (V)	14	5
Min. Voltage	0.65	0.8
Unit Price	$1.82	$0.77

5 Voltage Regulator-NCP1402

Purpose: Provides voltage for the microcontroller and pulse sensor

- Microcontrollers and pulse sensor require a constant input of 5 Volts
- Doesn’t require many other components
- Chosen due to spacing on PCB



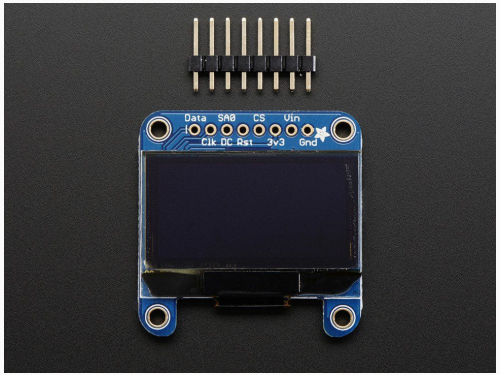
Display Comparison

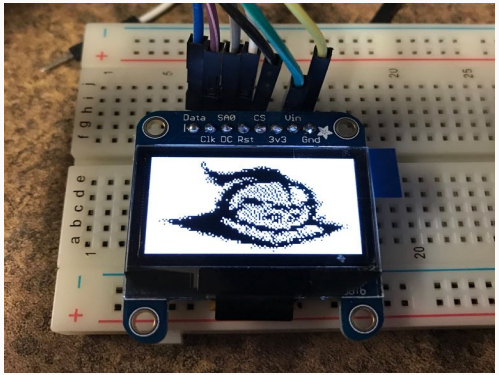
Categories	Monochrome OLED	TFT LCD	SHARP Memory
Cost	$19.95	$19.95	$39.95
Display Size	1.30”	1.80”	1.30”
Display Resolution	128x64	128x160	96x96
Weight	2.18 g	2.75 g	2.55 g
Current Draw	40mA	50mA	4 uA
Power Supply Voltage	3.3V or 5V	3.3V or 5V	3.3V or 5V

OLED Display

Purpose: Exhibits various outputs and functionalities of the device

- 1.3" diagonal
- Easily readable due high contrast
- Uses about 20mA on average





Functionality Visual

Table	
1)	Emergency Button
2)	Power Button
3)	Screen Toggle Button
4)	Date
5)	Time

Button Functionality

Button #1: Emergency

When pressed and held, emergency beacon will send the user's location to assigned/ authorized personnel

Button #2: Power

Once the button has been pressed and held down, the watch will turn off. If the button is pressed once, the watch will turn on and resume operation

Button #3: Screen Toggle

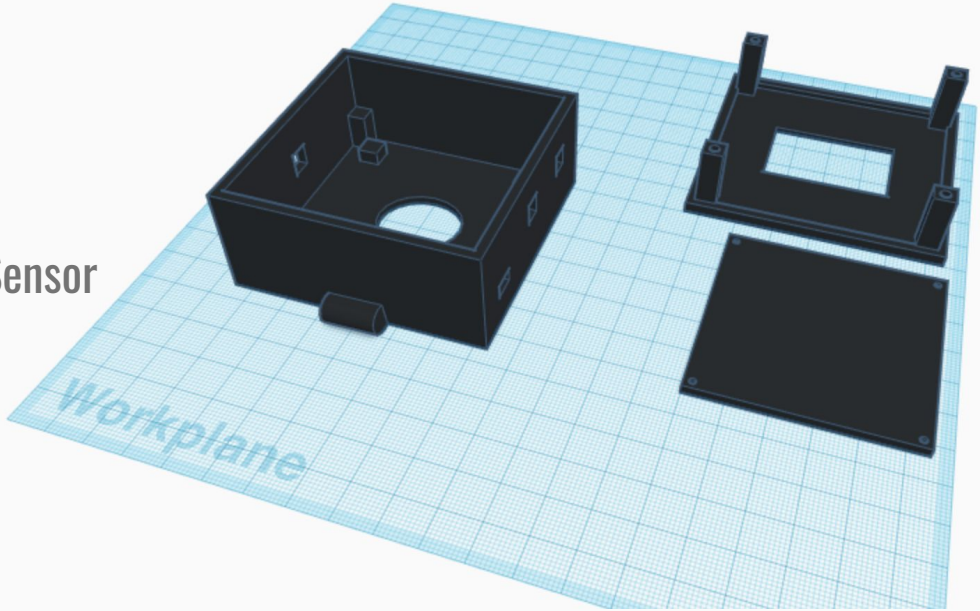
Toggles from the home screen to the health data screen

Watch Casing

Material: 3D printed watch case

Software: TinkerCAD

- Holes on bottom of case
  - Direct contact with skin- Pulse Sensor
- Holes for USB and buttons
- Comfortable strap



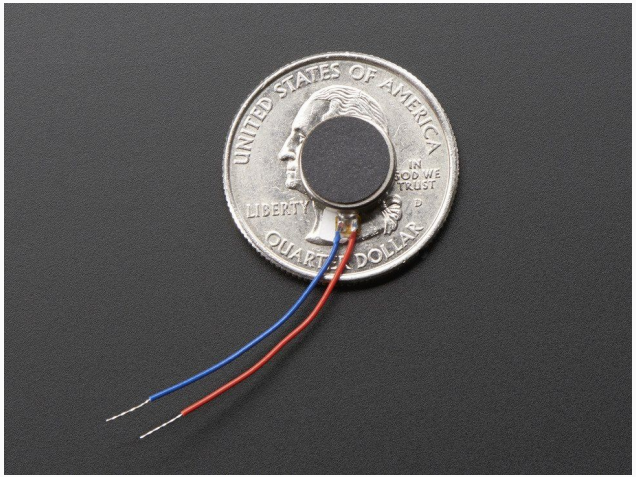
Notification System- Motor

Name	Vibrating Mini Motor Disc	Vibrating Mini Motor Disc
Manufacturer	Adafruit	Tinkersphere
Voltage (V)	2.0-5.0	1.5-3.0
Weight	0.9g	N/A
Unit Price	$1.95	$1.99

Notification System-Vibrating Mini Motor Disc

Purpose: Vibrates to alert the user

- Operating Voltage: 4V
- Vibrates when watch turns on
- Vibrates to notify user that emergency beacon has been pressed



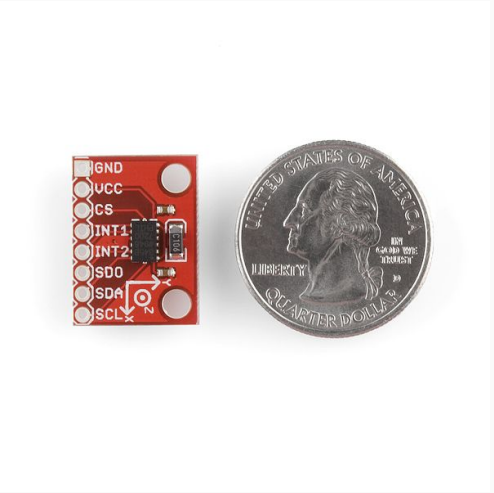
Accelerometer

Name	LIS3DH	ADXL345
Manufacturer	Sparkfun	Sparkfun
Supply Voltage Range (V)	1.7-3.6	2.0-3.6
Resolution	10 bit	13 bit
Unit Price	$4.95	$8.06
Availability	OBSOLETE	STOCKED

Accelerometer - ADXL345

Purpose: Count user's steps

- 3-axis measurements to provide to detect user's arm swing, and increment steps
- Sends interrupts based on acceleration thresholds



Pulse Sensor

Name	SEN0203	AFE4400
Manufacturer	DFRobot	Texas Instruments
Supply Voltage(V)	3.3-6.0	3.0-5.25
Operating Current	<10mA	<670μA
Unit Price	$16.00	$6.64

Pulse Sensor- SEN0203

Purpose: Measures the user's pulse periodically

- Dimensions: 28 x 24mm
- Placed directly on user's wrist
- Pulse Oximetry technique
    - Sensor illuminates the skin and measures changes in light absorption

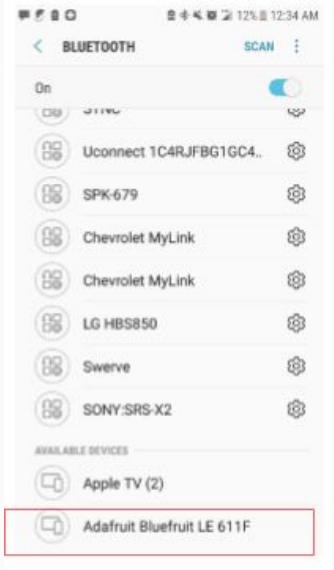
Wireless Communication

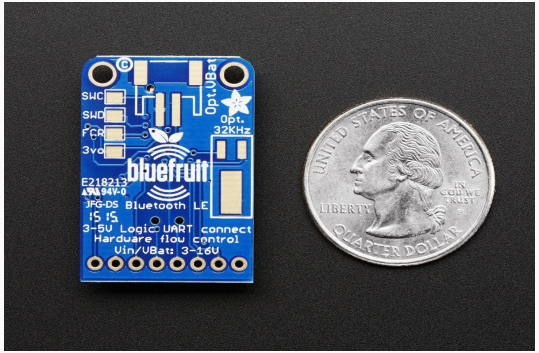
Name	Bluefruit LE UART Friend	HUZZAH ESP8266 Breakout
Manufacturer	Adafruit	Adafruit
Communication Type	Bluetooth	Wifi
Supply Voltage(V)	3.3	3-6
Communication Protocols	SPI, UART	SPI, I2C, UART
Memory	256KB flash memory	N/A
Unit Price	$17.50	$9.95

Bluetooth - Bluefruit LE UART

Purpose: Sends and transmits data information from the watch to the mobile application

- Enables connectivity between microcontroller and mobile phone via Standard Nordic UART RX/TX
- Low Energy





Software

Programming Microcontroller

Purpose: Microcontroller needs to be programmed to communicate with all peripherals and carry out the watch's functions.

- We made use of imported libraries, example functions, and functions created for the project

Microcontroller Libraries and Functions

Imported Libraries	Functions
“avr/sleep.h”	startScreen()
“avr/power.h”	logo()
"SparkFunLIS3DH.h"	healthScreen()
"Wire.h"	homeScreen()
"SPI.h"	powerDownScreen()
“Adafruit_GFX.h”	GPSemergencyScreen()
“Adafruit_SSD1306.h”	BTfunction()
"DFRobot_Heartrate.h"	BTGPSfunction()
“SoftwareSerial.h>”	keepingTime()
"Adafruit_BLE.h"	configIntterupts() - Sparkfun
"Adafruit_BluefruitLE_SPI.h"	GPSfunction()
"Adafruit_BluefruitLE_UART.h"	main()
"BluefruitConfig.h"	loop()

Code References

Component	Site
Screen	https://learn.adafruit.com/monochrome-oled-breakouts/downloads
Accelerometer	https://learn.sparkfun.com/tutorials/lis3dh-hookup-guide
Bluetooth	https://learn.adafruit.com/introducing-the-adafruit-bluefruit-le-uart-friend/software
Pulse	https://www.dfrobot.com/wiki/index.php/Heart_Rate_Sensor_SKU:_SEN0203
Microcontroller	http://playground.arduino.cc/Learning
GPS	https://forum.arduino.cc/index.php?topic=381256.0; http://playground.arduino.cc/Tutorials/GPS

Mobile Application

Android

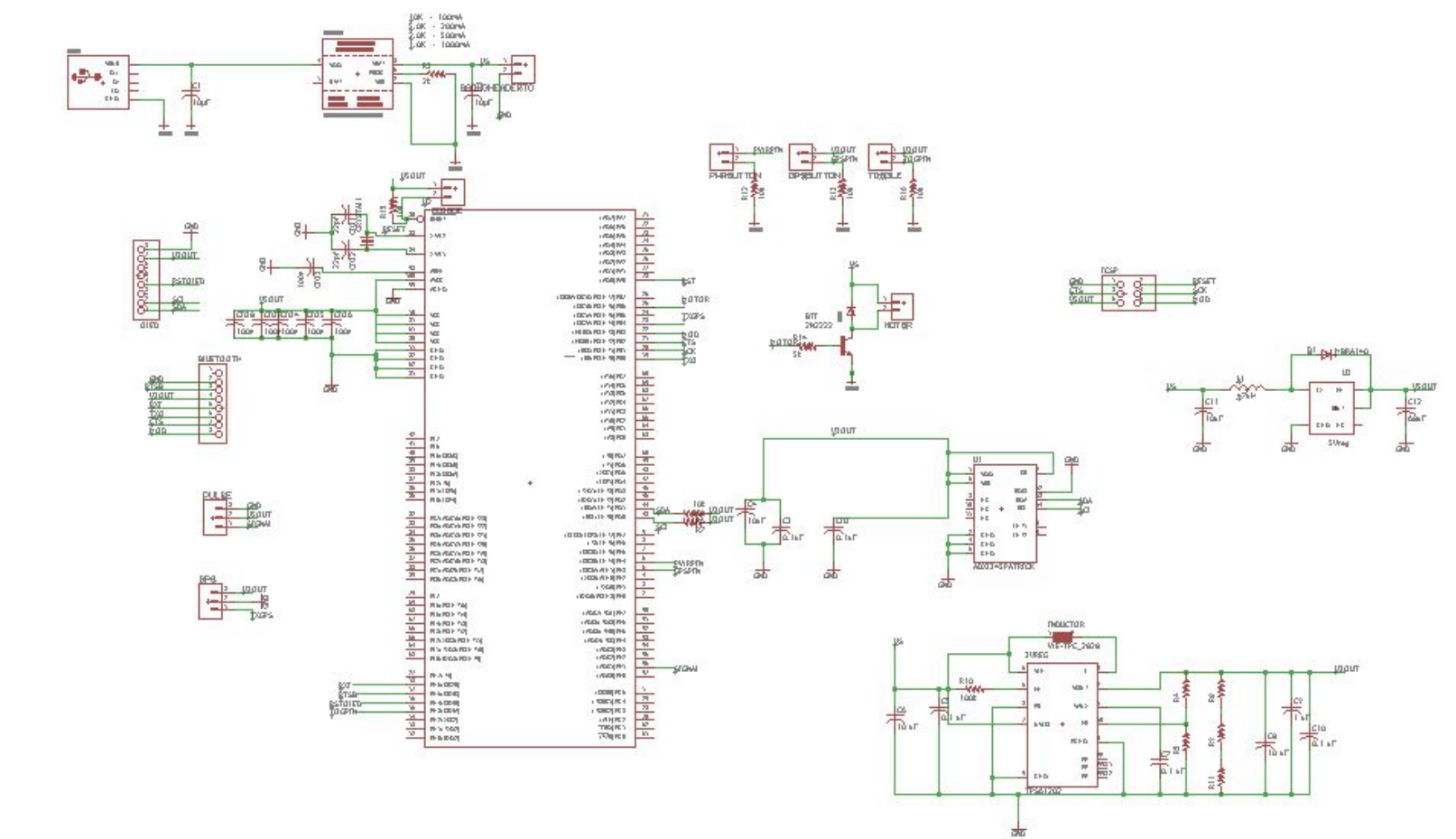
Mobile Libraries and Functions

Major Imported Libraries	Functions
SmsManager	sendMessage()
BLEManager	runBlePermissions()
Andriod.ViewsUI	onCreate()
"Uart.BLE"	onAlert()

Code References

Component	Site
Adafruit Bluetooth LE	https://github.com/adafruit/Bluefruit_LE_Connect_Android
Android Developers	https://developer.android.com
Online Forums	https://stackoverflow.com

Schematic Diagram



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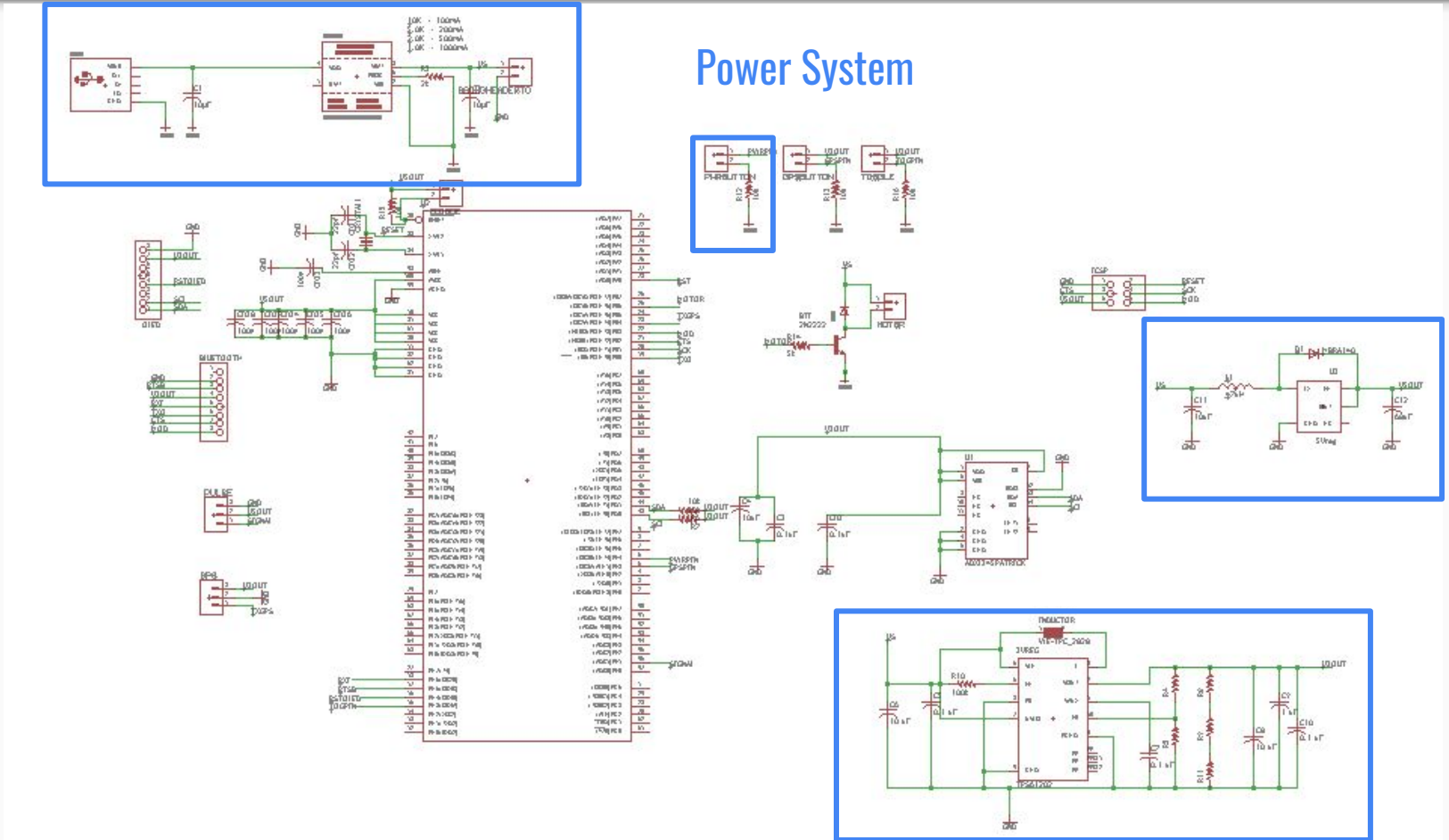

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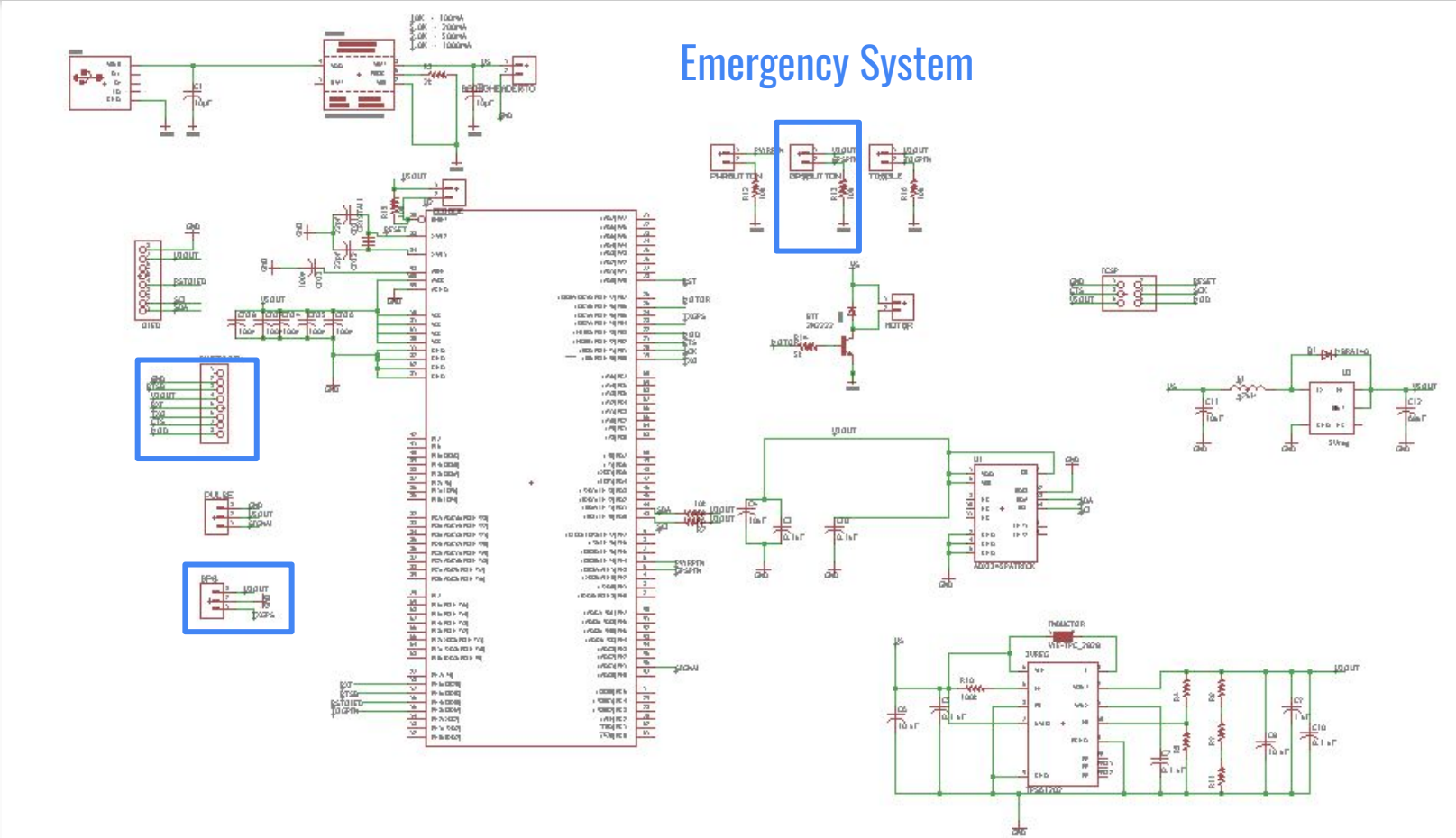

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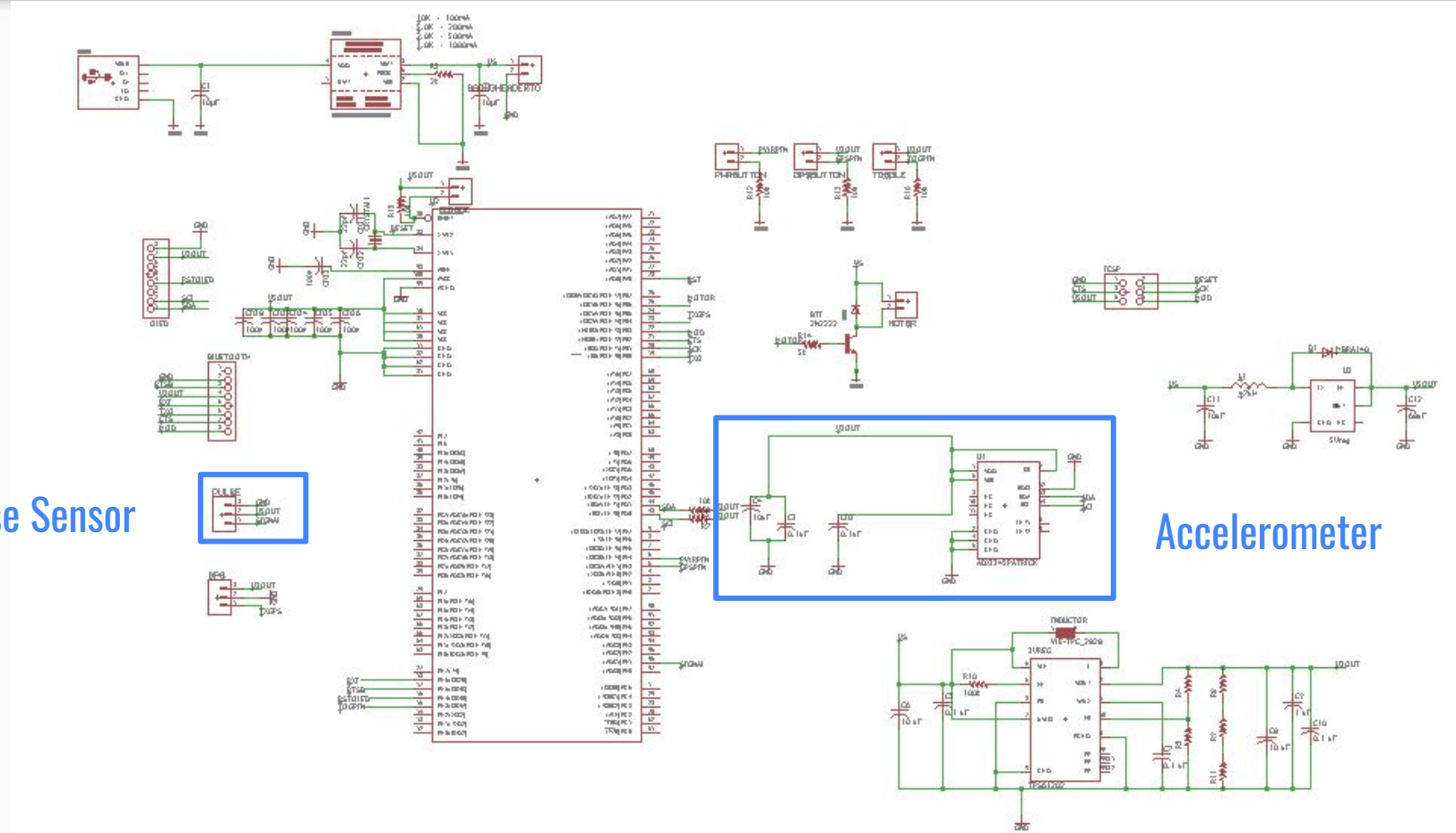

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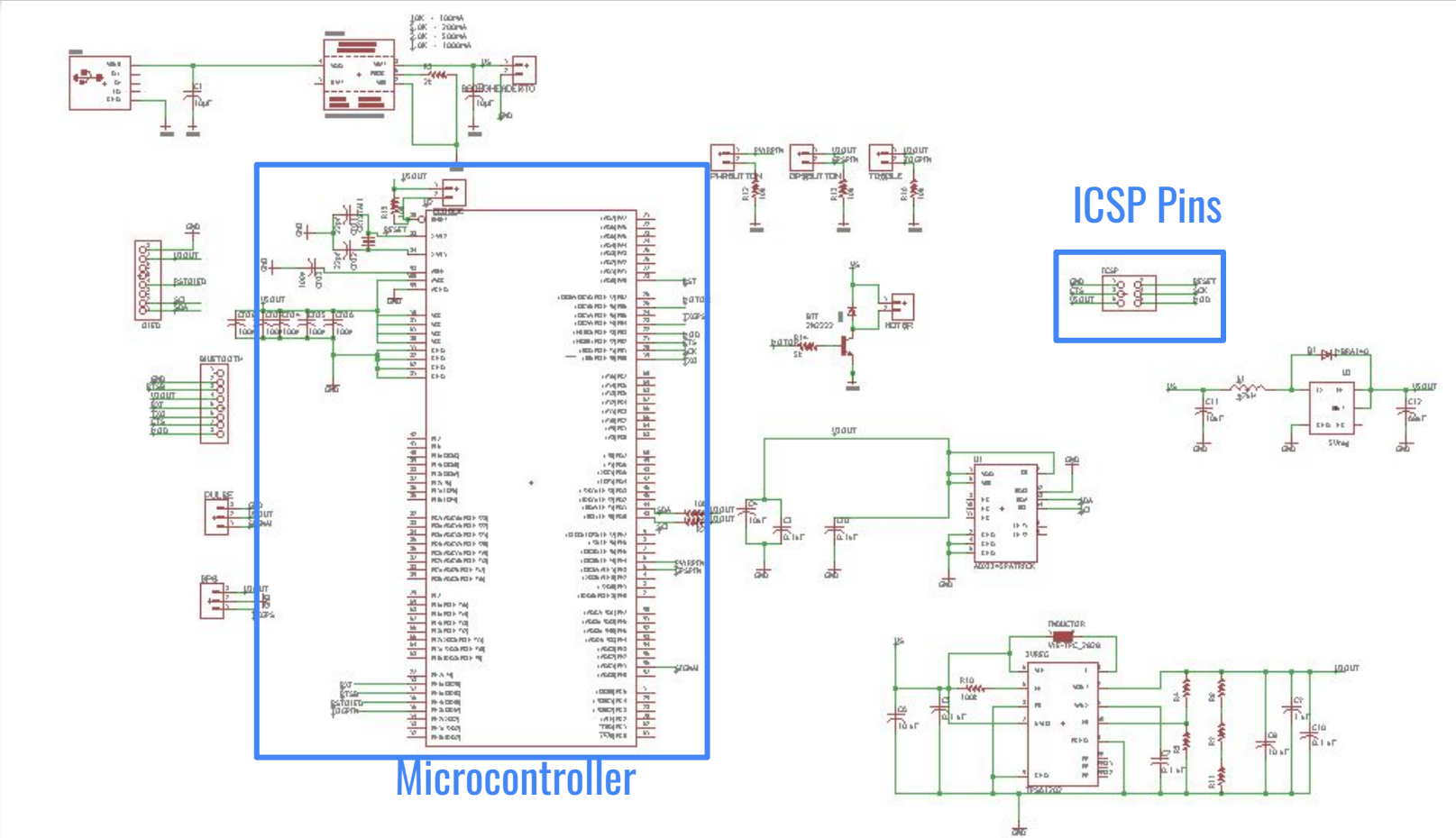

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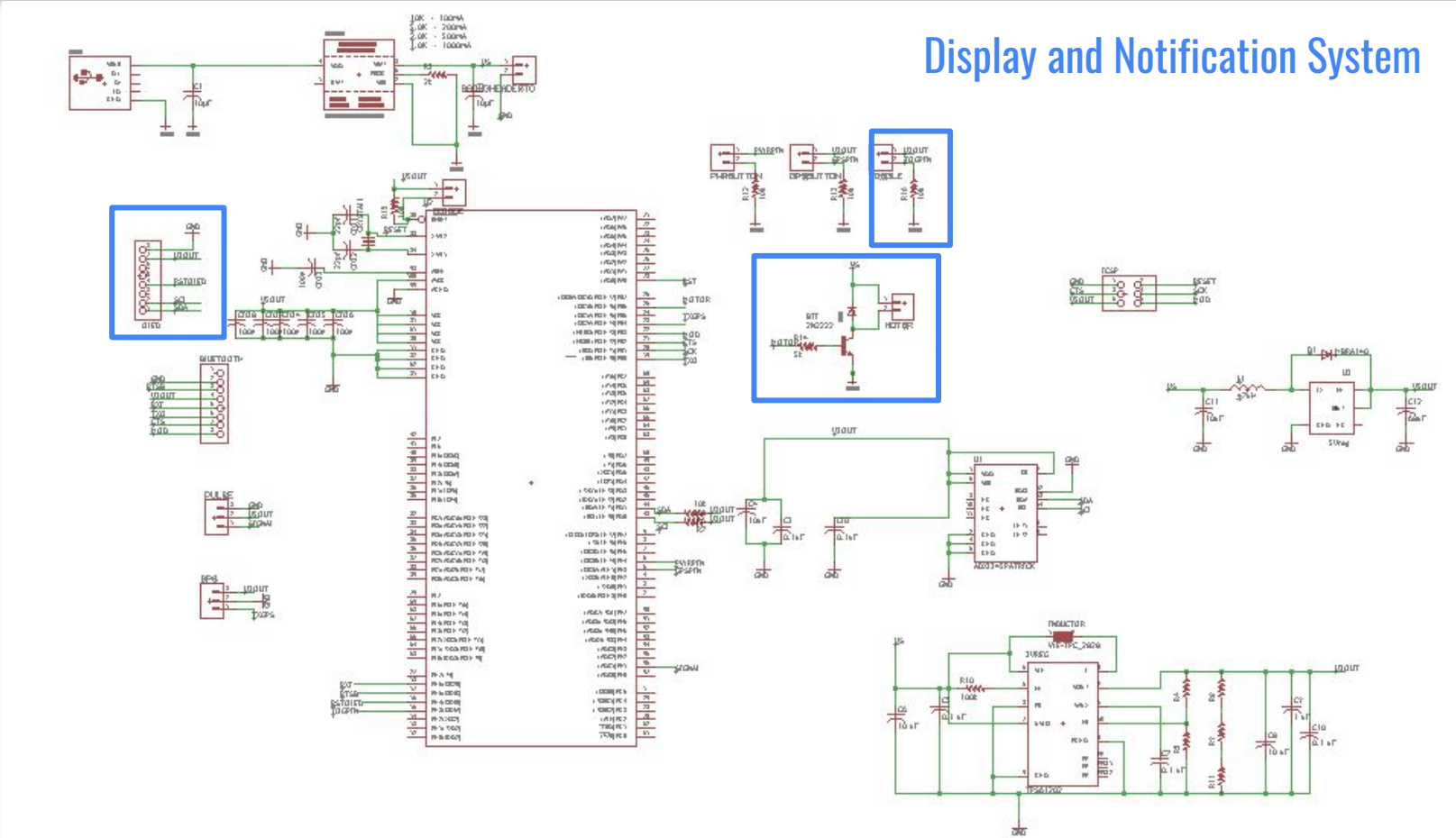


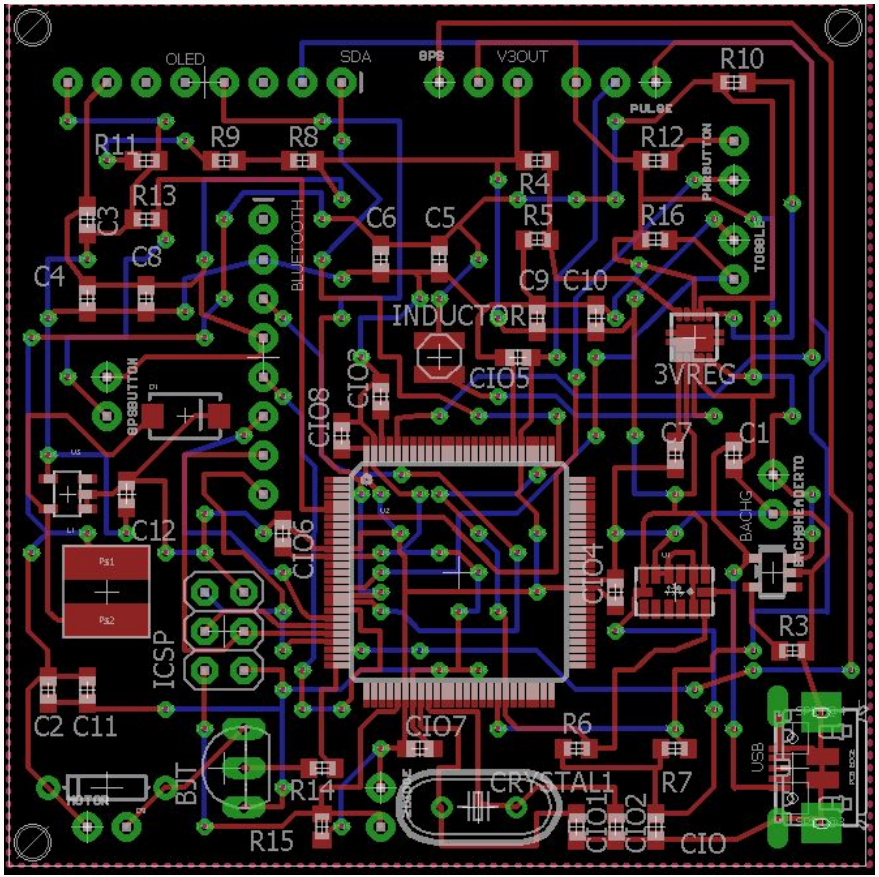
Final PCB

Original PCB Size- 3.2x2.5 in

Final PCB Size- 2.2x2.18 in

Alterations include:

- Changing connections
- Analog voltage sources
- Additional components
- ICSP pins
- Decoupling capacitors



Administrative Content

Work Distribution

Legend	
X	Primary
O	Secondary

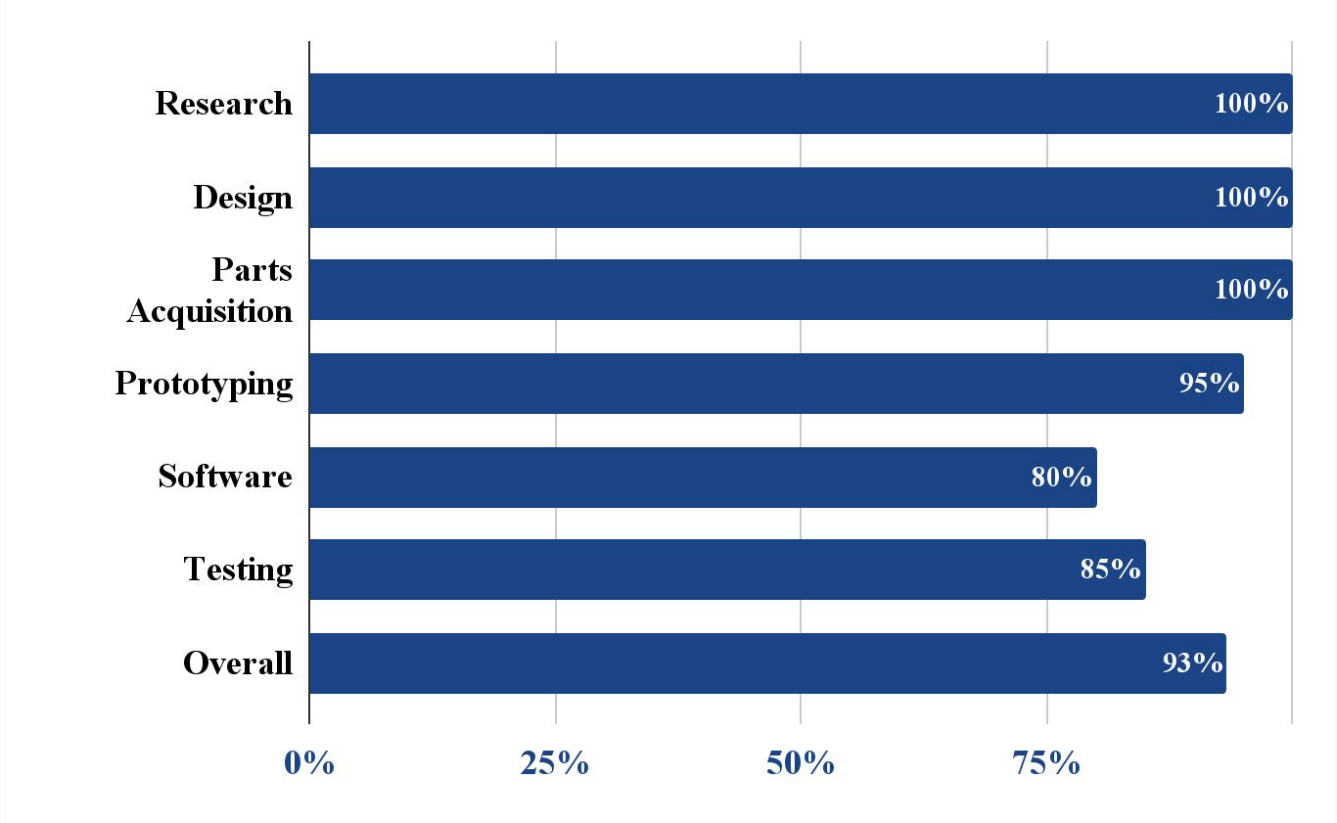
Name	PCB Design	Mobile Application	Case Design	Prototyping
Bailey		O		X
Jelani	O		X	
Krystal		X	O	
Niabelle	X			O

Budget and Financing

Item	Manufacturer	Price/Unit	Unit	Total
Accelerometer	Sparkfun	$8.06	1	$8.06
OLED Display	Adafruit	$19.95	1	$19.95
Motor Disc	Adafruit	$1.95	1	$1.95
Pulse Monitor	DFRobot	$16.00	1	$16.00
Lithium Ion Battery	Adafruit	$7.95	1	$7.95
Voltage Regulators	Pololu/ Digikey	$8.99	1	$8.99
Button Switch	Adafruit	$0.27	3	$0.81
Battery Charger	Adafruit	$6.95	1	$6.95
GPS Receiver	Sparkfun	$15.95	1	$15.95
Bluefruit LE UART	Adafruit	$17.50	1	$17.50
PCB	PCB Way	$28.00	1	$28.00

Total	$132.11

Current Progress



Design Issues

- Changing microcontrollers halfway through Senior Design 2 created PCB issues
- Surface mount components made prototyping difficult
- Difficult to adjust accelerometer using breadboard
- Pulse sensor and Bluetooth Dev Board
- Breadboard Demo

Special Thanks

We would like to thank Dr. Ricardo Zaurin for suggesting the original senior design idea of smartwatch that recognizes the patterns for people like his mother, suffering from Parkinson's Disease.

Our senior design requires each person to contribute 30 independent ideas. Then groups of four students will evaluate around 100 ideas and select one or two. After that, we wrote 10 pages for 2 ideas that we picked best. The watch for Parkinson's Disease was one of the ideas we submitted. During 1/2 hour meeting, Dr Wei pointed out that it is difficulty to differentiate Parkinson vibrating movement from walking vibrating movement. Dr Wei pointed out certain difficulties so the group decided to have two sensors: one to measure pulse and the other to record the amount of steps taken. This is how this project idea came to be.

Krystal Folkes also would like to express her appreciation to Dr. Wisniewski for two independent studies and one summer REU opportunity. Our team was made aware of Dr. Wisniewski and her team's NSF funded project for Carebit, a health monitoring app, similar to our project. Her project is to do a feasibility study.

Questions/Comments?