Easy Park

Group 26

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Motivation

- For years on end, students and faculty complain about on campus parking.
- To alleviate the stress of parking during peak times.
- To reduce the amount of time to find parking.
- To relieve traffic congestion around campus.

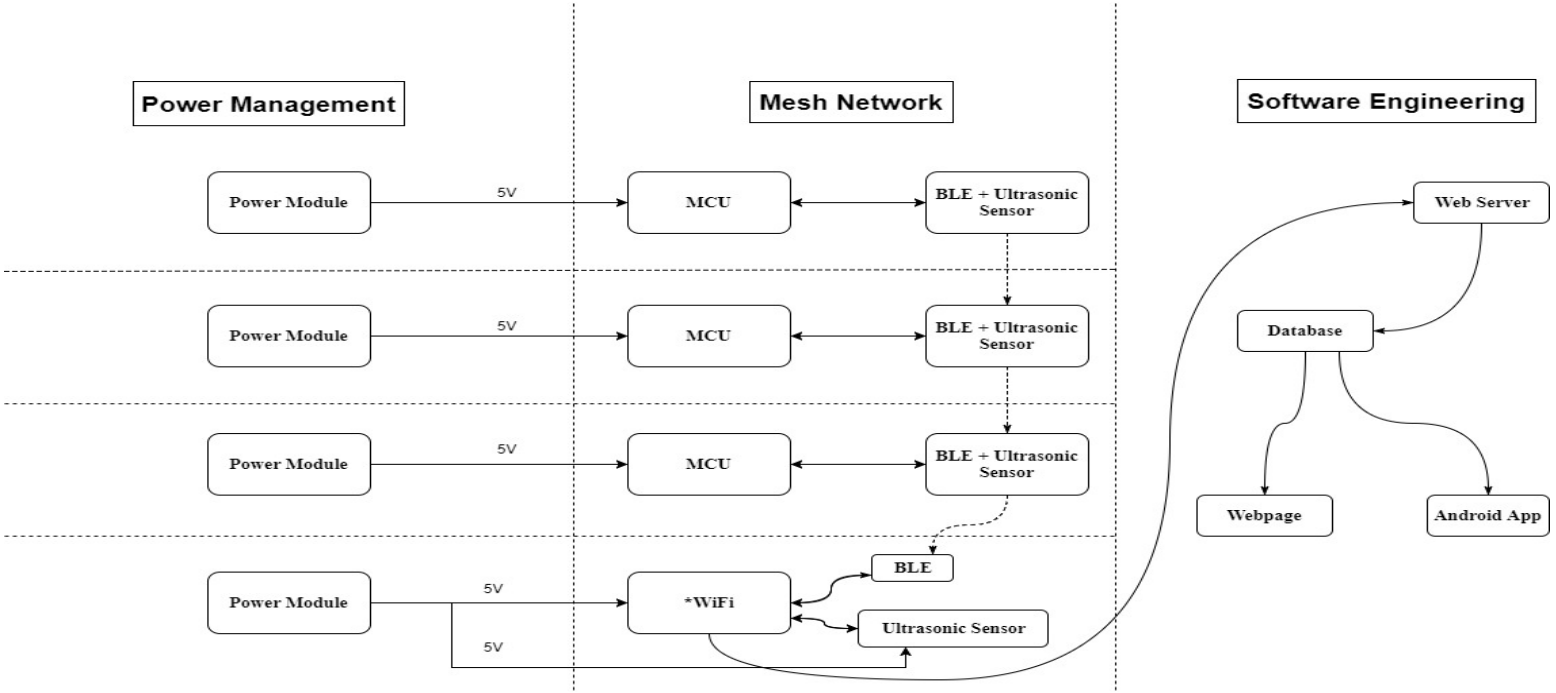
Goals & Objectives

- Implement the use of sensors, or a deep learning algorithm, to detect occupied parking spaces.
- Retrieve the data from the low-powered microcontroller back to a server of any parking space(s) available.
- Design a system that is low cost and low-powered.
- App capability for monitoring parking occupancy in real time.
- Energy harvesting without using power provided by UCF.
- Low maintenance frequency.

Specifications and Requirements

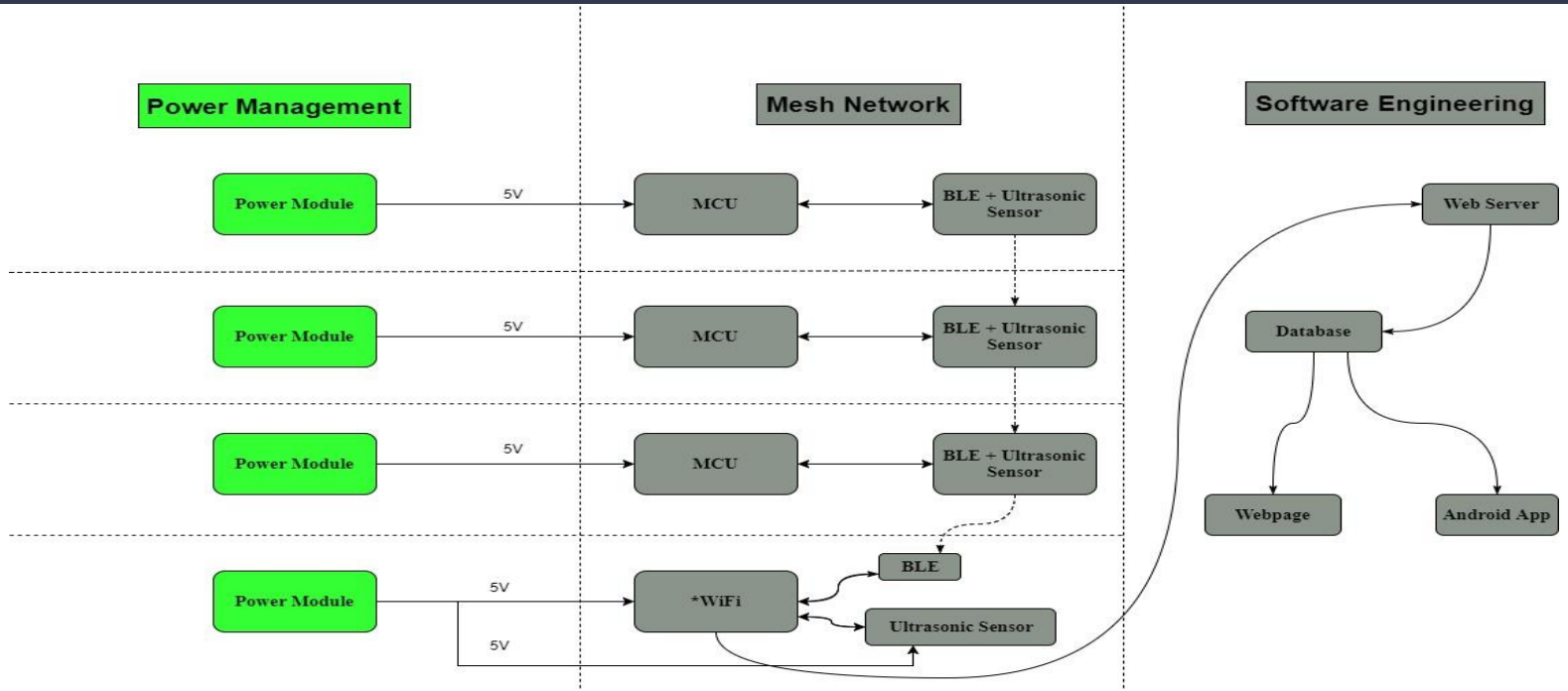
Disk Radius < 8 cm
Thickness < 3 cm
Power Dissipated Max < 0.5W
App update rate <= 5 sec
Durability > 1000 lbs
Sensing Range > 60 cm
Weight < 5 lb

Main Block Diagram



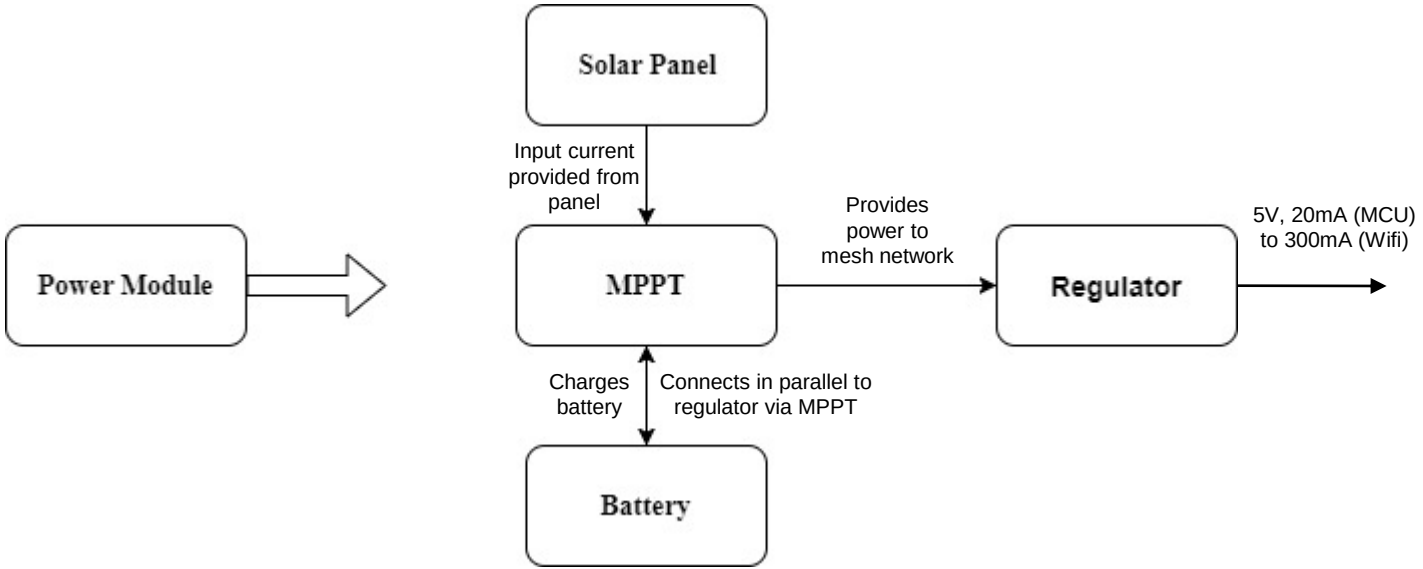
*The WiFi module has a built-in MCU that would be utilized instead of the ATMega.

Power Management Components

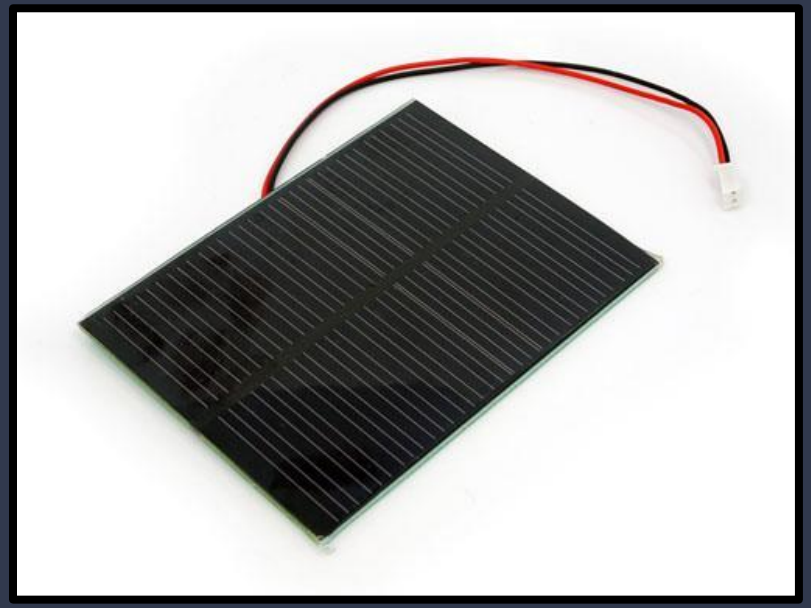


*The WiFi module has a built-in MCU that would be utilized instead of the ATMega.

Power Module Components



Solar Panel Selection



Monocrystalline 1W Solar Panel
Mtr. Seeed Studio

FEATURES

Dimension: 100x80x2.5(±0.2) mm

Efficiency: 15.5%

Typical peak power: 0.935W

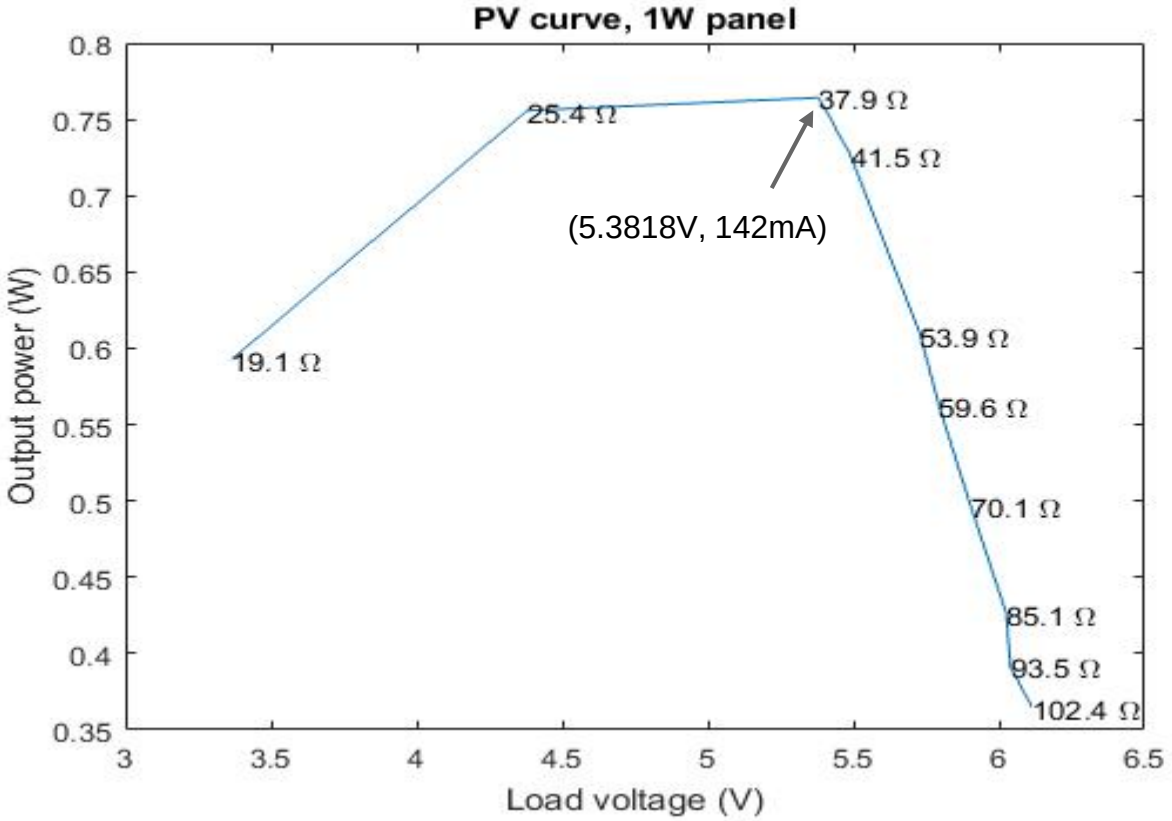
Typical voltage: 5.5V

Typical current: 170mA

Open-circuit voltage: 8.2V

Maximum load voltage: 6.4V

Weight: 33g



This plot illustrates the PV curve testing the 1W panel with a range of resistor loads from 19.1 ohms to 102.4 ohms.

We found the maximum power point around (5.3818V, 142mA) using a 37.9 ohm, 2W load resistor.

PV Curve, 1W Panel Testing

Battery Selection

EBL 840 9V Li-ion

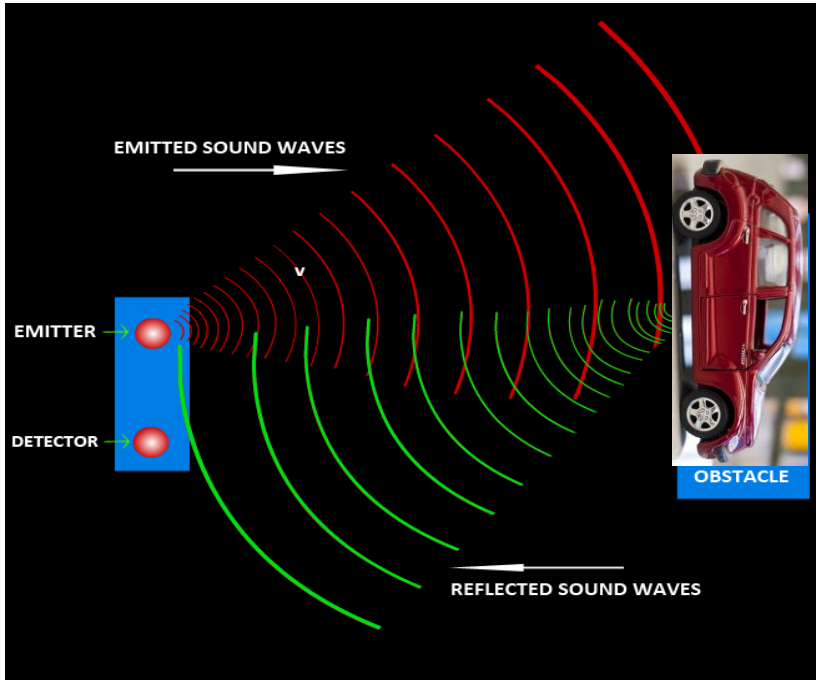
- Rated capacity: 600 mAh
- Estimated battery life: ~5 hours
- Protection provided
- Cost: ~$4.75 each

Ipower IP 9V Lithium Polymer (LiCoO2)

- Rated capacity: 700 mAh
- Estimated battery life: ~5.5 hours
- Protection provided
- Cost: ~$19.95 each

HC-SR04 Ultrasonic Module

Features	Specifications
Operating Voltage	5VDC
Operating Current	15mA
Effectual Angle	<15°
Measuring Angle	30°
Min-Max Range	2cm-4m
Dimension	45mm x 20mm x 15mm



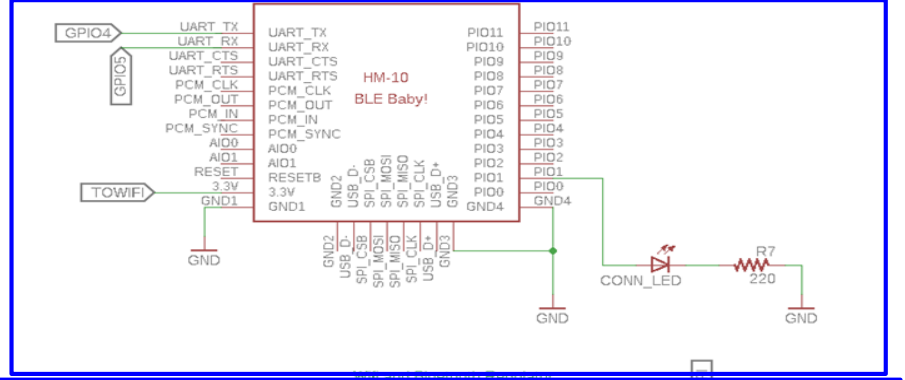
MPPT Selection

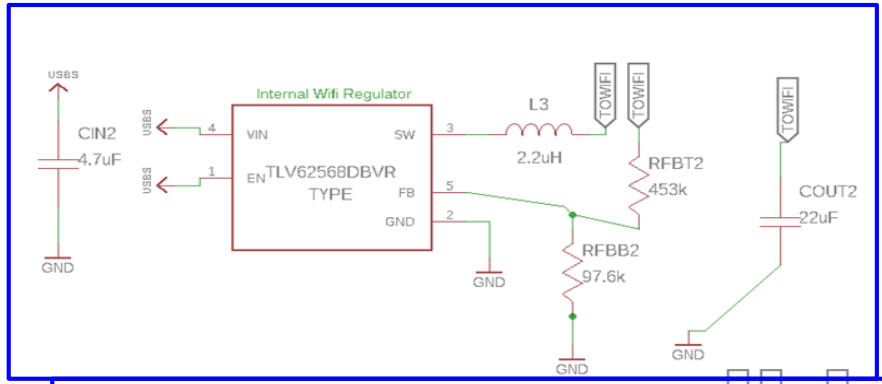
LT 3652-Solar Buddy

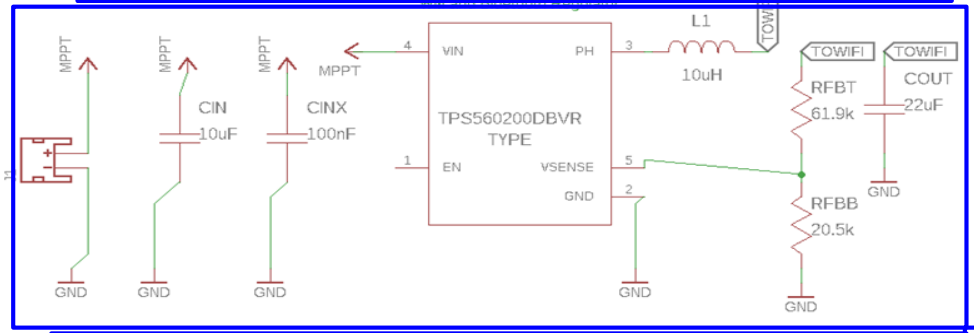
- Input Solar Panel Voltage: 6V - 20V
- Battery Potential Charge Rate: 2A
- Power Efficiency: 80%
- Battery Charge Range: 4.95V - 32V

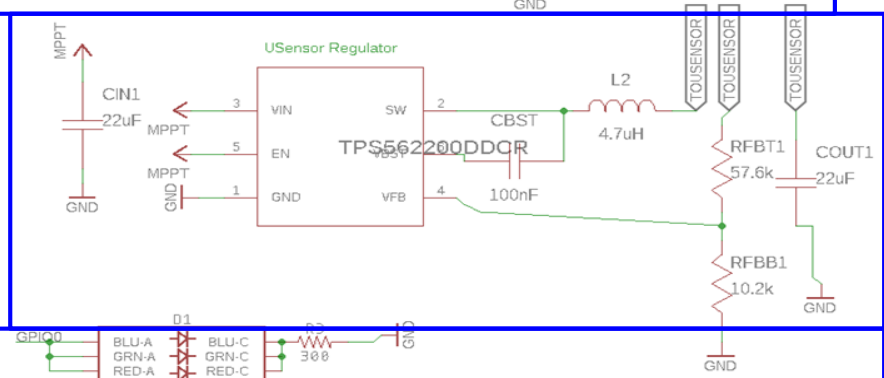
Main PCB with Wifi

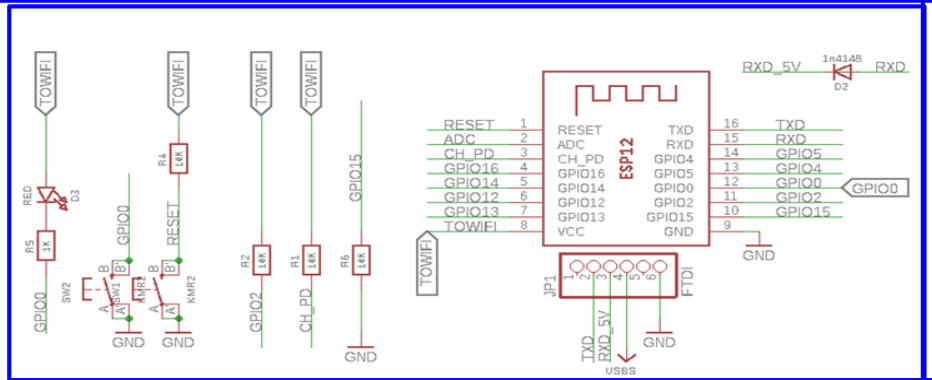
(Schematic & PCB Layout)


HM-10
BLE Baby!
UART_TX
UART_RX
UART_CTS
UART_RTS
PCM_CLK
PCM_OUT
PCM_IN
PCM_SYNC
AIO0
AIO1
RESETB
3.3V
GND1
GND2
USB_D-
SPI_CSB
SPI_MOSI
SPI_MISO
SPI_CLK
USB_D+
GND3
PIO11
PIO10
PIO9
PIO8
PIO7
PIO6
PIO5
PIO4
PIO3
PIO2
PIO1
PIO0
GND4
GPIO4
GPIO5
TOWIFI
GND
CONN_LED
R7
220

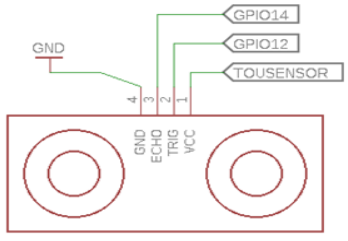

Internal Wifi Regulator
TLV62568DBVR
TYPE
VIN
SW
EN
FB
GND
USBS
CIN2
4.7uF
L3
2.2uH
RFBT2
453k
RFBB2
97.6k
COUT2
22uF
TOWIFI
GND

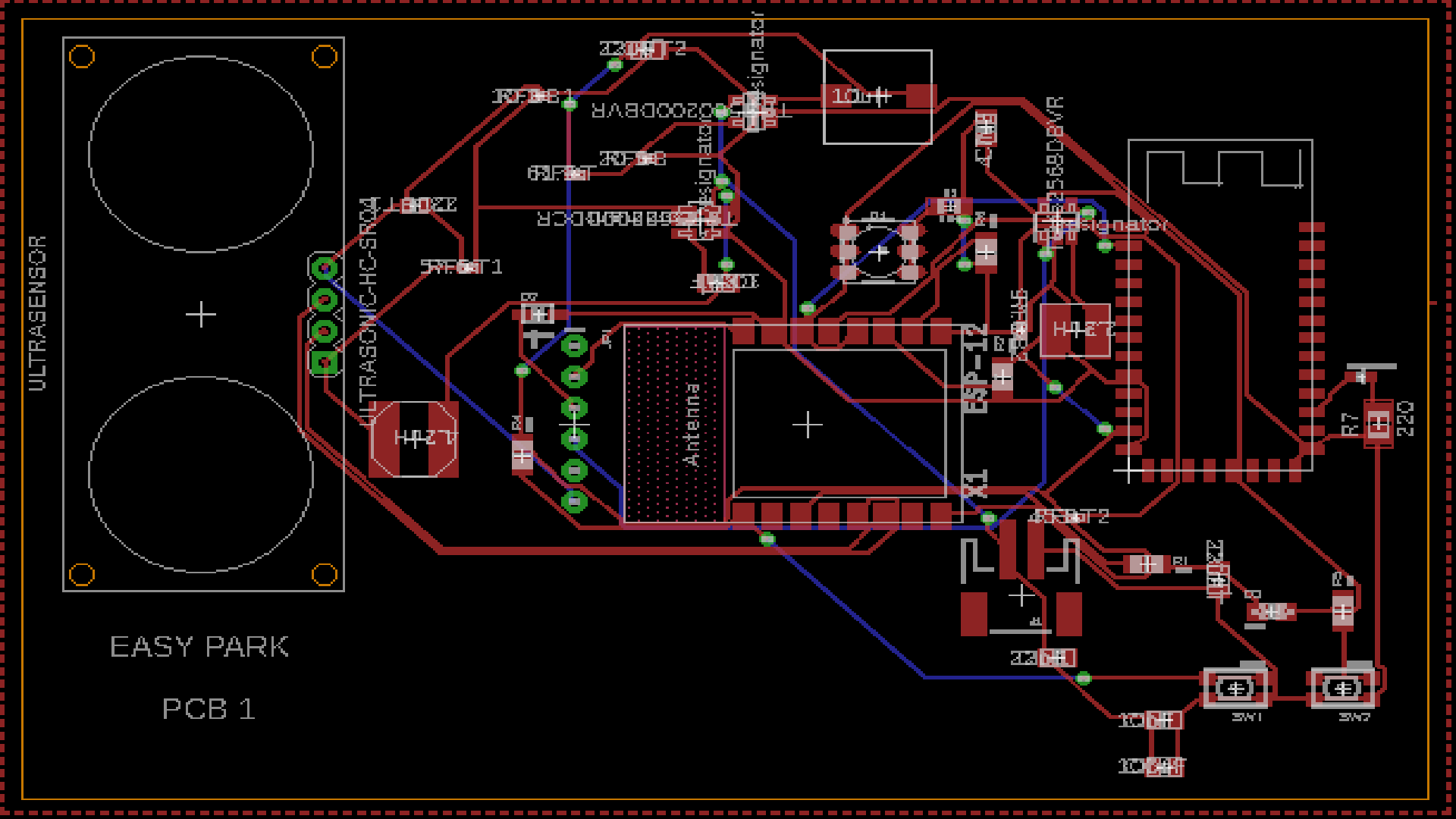

MPPT
CIN
10uF
CINX
100nF
TPS560200DBVR
TYPE
VIN
PH
EN
VSENSE
GND
L1
10uH
RFBT
61.9k
RFBB
20.5k
COUT
22uF
TOWIFI
GND


USensor Regulator
TPS562200DDCR
VIN
SW
EN
VBST
GND
VFB
MPPT
CIN1
22uF
CBST
100nF
L2
4.7uH
RFBT1
57.6k
RFBB1
10.2k
COUT1
22uF
TOUSENSOR
GND


ESP12
RESET
ADC
CH_PD
GPIO16
GPIO14
GPIO12
GPIO13
VCC
TXD
RXD
GPIO4
GPIO5
GPIO0
GPIO2
GPIO15
GND
TOWIFI
RXD_5V
1n4148
D2
RXD
GPIO0
GPIO15
GPIO2
CH_PD
RESET
GPIO0
JP1
FTDI
USBS
GND

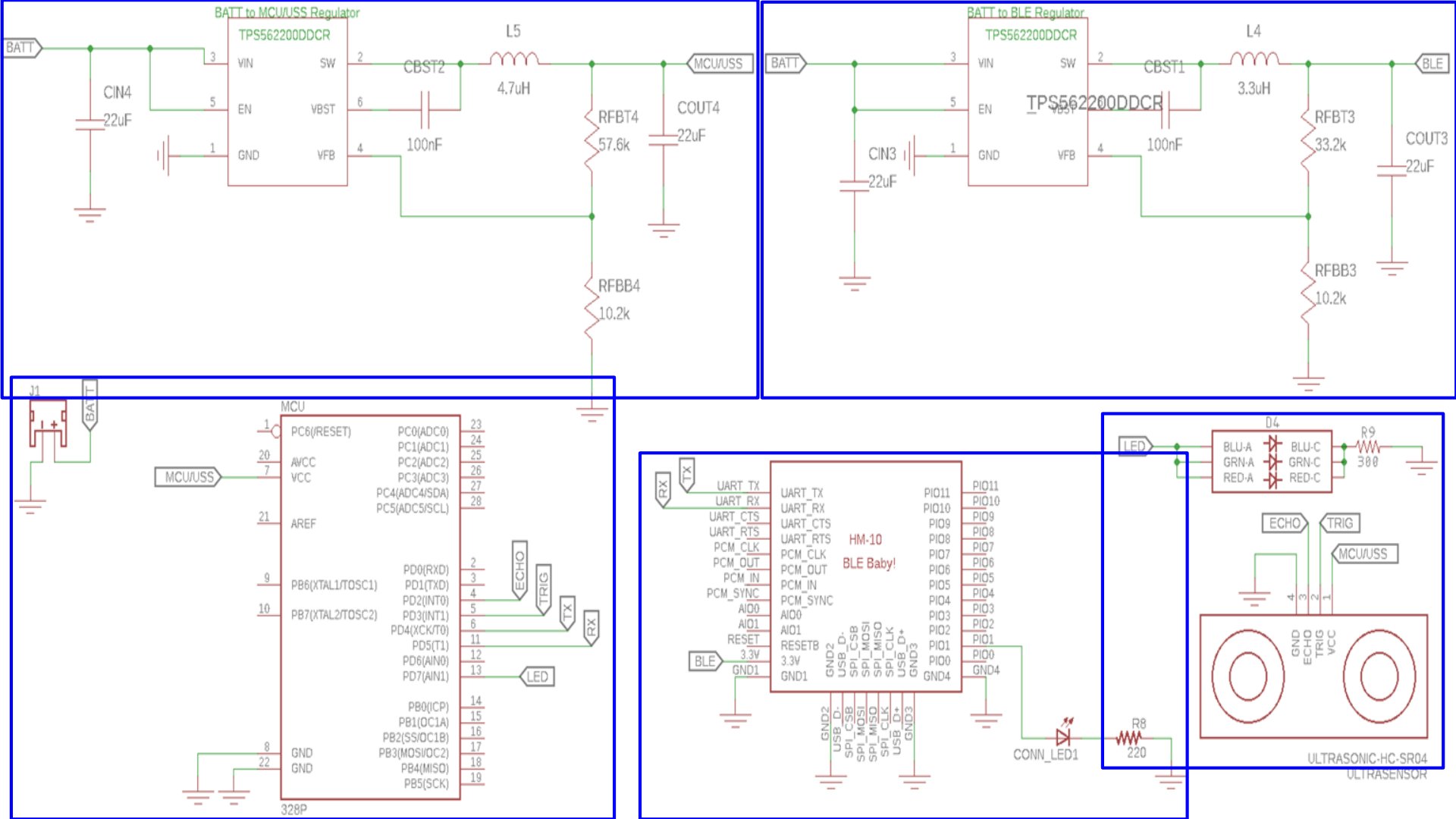
GPIO0
BLU-A
GRN-A
RED-A
BLU-C
GRN-C
RED-C
D1
300
GND

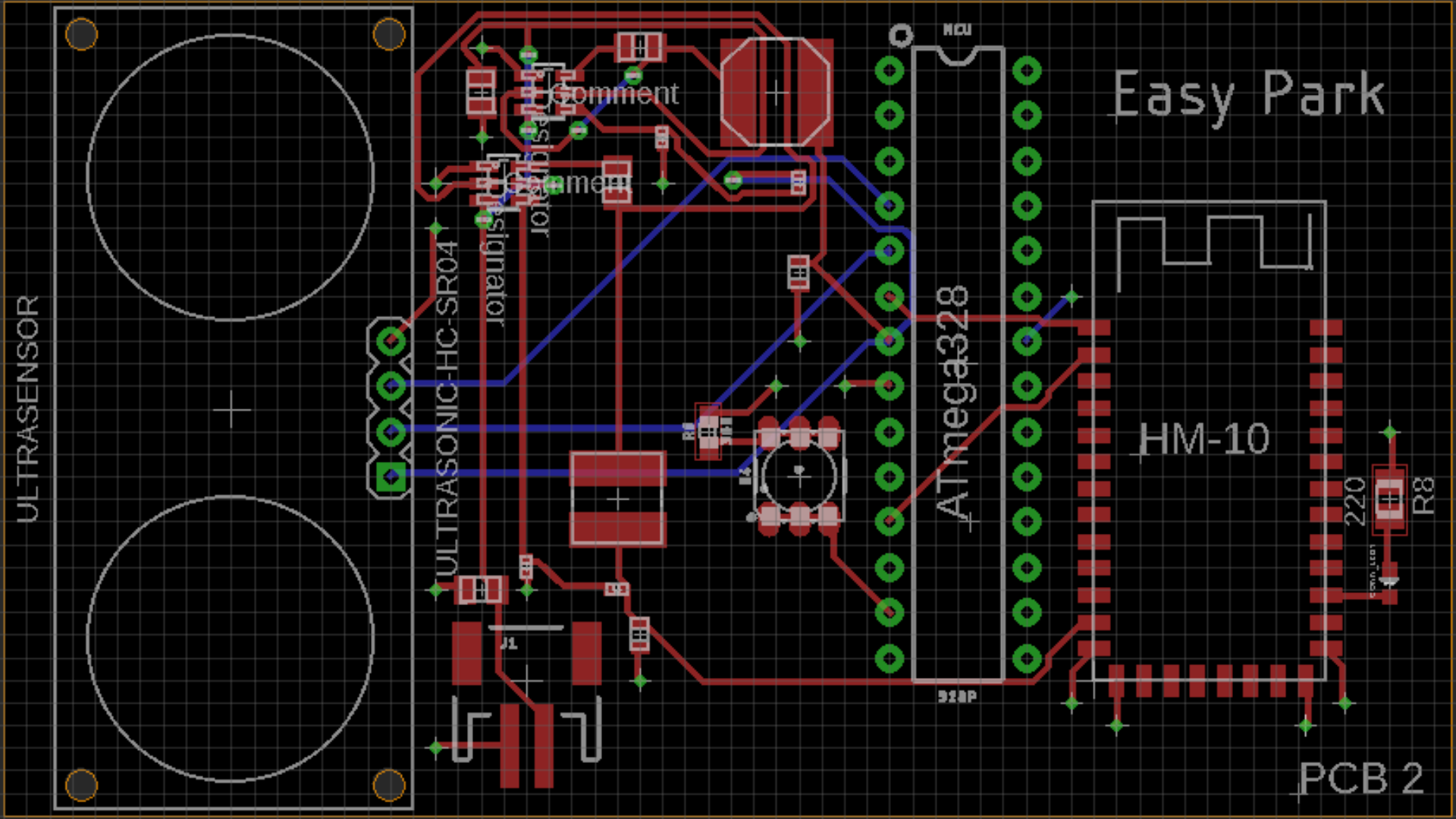

GPIO14
GPIO12
TOUSENSOR
GND
GND
ECHO
TRIG
VCC
ULTRASONIC-HC-SR04
ULTRASENSOR


ULTRASENSOR
ULTRASONIC-HC-SR04
ESP-12
Antenna
EASY PARK
PCB 1

Mesh Network PCBs

(Schematic & PCB Layout)


BATT to MCU/USS Regulator
TPS562200DDCR
BATT
CIN4
22uF
VIN
SW
EN
VBST
GND
VFB
CBST2
100nF
L5
4.7uH
MCU/USS
RFBT4
57.6k
COUT4
22uF
RFBB4
10.2k
BATT to BLE Regulator
TPS562200DDCR
BATT
CIN3
22uF
CBST1
100nF
L4
3.3uH
BLE
RFBT3
33.2k
COUT3
22uF
RFBB3
10.2k
J1
BATT
MCU
MCU/USS
PC6(/RESET)
AVCC
VCC
AREF
PB6(XTAL1/TOSC1)
PB7(XTAL2/TOSC2)
GND
GND
PC0(ADC0)
PC1(ADC1)
PC2(ADC2)
PC3(ADC3)
PC4(ADC4/SDA)
PC5(ADC5/SCL)
PD0(RXD)
PD1(TXD)
PD2(INT0)
PD3(INT1)
PD4(XCK/T0)
PD5(T1)
PD6(AIN0)
PD7(AIN1)
PB0(ICP)
PB1(OC1A)
PB2(SS/OC1B)
PB3(MOSI/OC2)
PB4(MISO)
PB5(SCK)
ECHO
TRIG
TX
RX
LED
328P
RX
TX
BLE
UART_TX
UART_RX
UART_CTS
UART_RTS
PCM_CLK
PCM_OUT
PCM_IN
PCM_SYNC
AIO0
AIO1
RESET
3.3V
GND1
RESETB
GND2
USB_D-
SPI_CSB
SPI_MOSI
SPI_MISO
SPI_CLK
USB_D+
GND3
HM-10
BLE Baby!
PIO11
PIO10
PIO9
PIO8
PIO7
PIO6
PIO5
PIO4
PIO3
PIO2
PIO1
PIO0
GND4
CONN_LED1
R8
220
LED
D4
BLU-A
GRN-A
RED-A
BLU-C
GRN-C
RED-C
R9
300
ECHO
TRIG
MCU/USS
GND
ECHO
TRIG
VCC
ULTRASONIC-HC-SR04
ULTRASENSOR


ULTRASENSOR
ULTRASONIC-HC-SR04
Comment
Designator
Comment
Designator
ATmega328
Easy Park
HM-10
220
R8
PCB 2

LED

5050-G3500 SMD LED

- Input Forward Voltage: 3.2V - 3.4V
- Viewing Angle: 120 Degrees
- Input Current: 20 mA
- Lumens: 11
- Visible Frequency: 45 Hz

Regulator Chips

TLV62568DBVR

- Input Voltage: 2.5V - 5.5V
- Output Voltage: 0.6 to Input
- Efficiency: Up to 95%
- Overcurrent Protection
- Soft Start Current

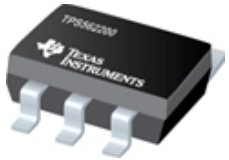
TPS560200DBVR

- Input Voltage: 4.5V - 17V
- Output Voltage: 0.8V to 6.5V

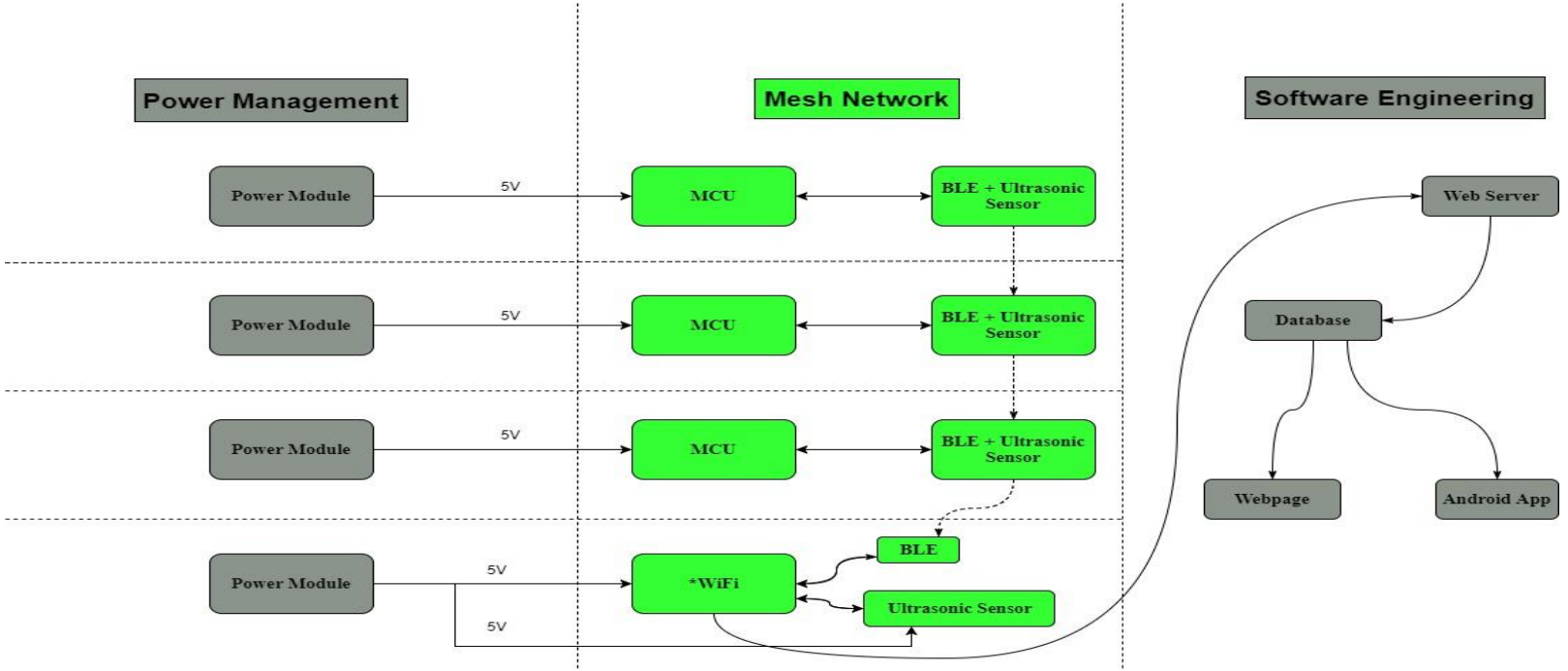
- Efficiency: Up to 90%
- 500mA Current
- Soft Start Time: 2ms

TPS562200DDCR

- Input Voltage: 4.5V - 17V
- Output Voltage: 0.76V to 7V
- Efficiency: Up to 95%
- Advanced Eco at low loads
- Soft Start time: 1ms



Mesh Network Components



*The WiFi module has a built-in MCU that would be utilized instead of the ATMega.

Mesh Network Components Comparison

	Zigbee	**Bluetooth LE**
Current Consumption	~200mA	8.5mA
Range	291m	77m
Transmit Power	100mW	10mW
Network Type	LAN	PAN

ZigBee

Advantages
- Easy to setup mesh network
- Longer Range

Disadvantages
- Higher cost
- High latency

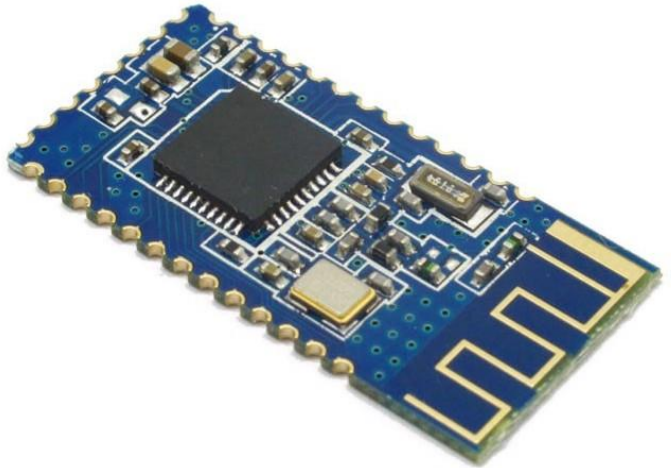
Bluetooth LE

Advantages
- Lower Cost
- More control/ flexibility

Disadvantages
- Shorter Range

HM-10 BLE (Bluetooth Module)

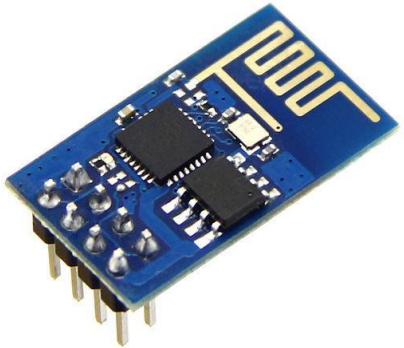
Features	Specifications
Range	100m (open space)
Working Temperature	-5 ~ 65 C
Power (Active Mode)	8.5mA
Input Voltage/Power	+3.3VDC/ 50mA
Power (Sleep Mode)	400uA~1.5mA
Chipset	TI CC2541



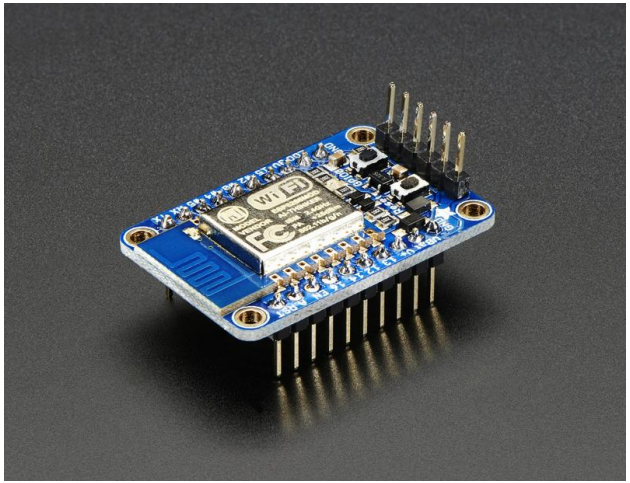
ESP8266 WiFi Module

- Good arduino and community support.
- Somewhat easy to program
- Powerful built-in MCU
- Has quite a few digital pins

ESP - 01

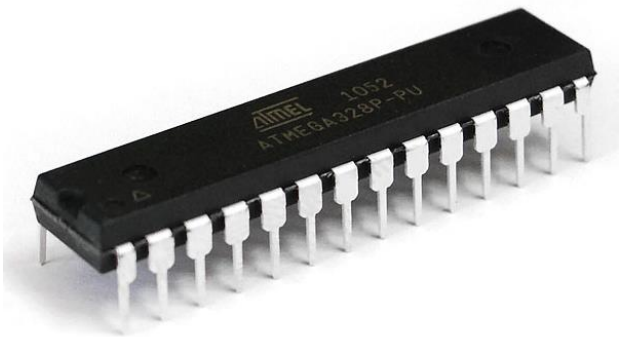


Huzzah ESP - 12F



MCU: ATMega328P

- Multiple digital I/O pins.
- Low power module (especially in deep sleep mode).
- Great arduino library support and sketches.
- Easy to program with other modules.



How we programmed the mesh network?

Hardware Serial

- Programmed through AT commands at the serial input stream.
- Usually to test each ultrasonic or bluetooth module.
- Command is executed directly with the module.

Software Serial

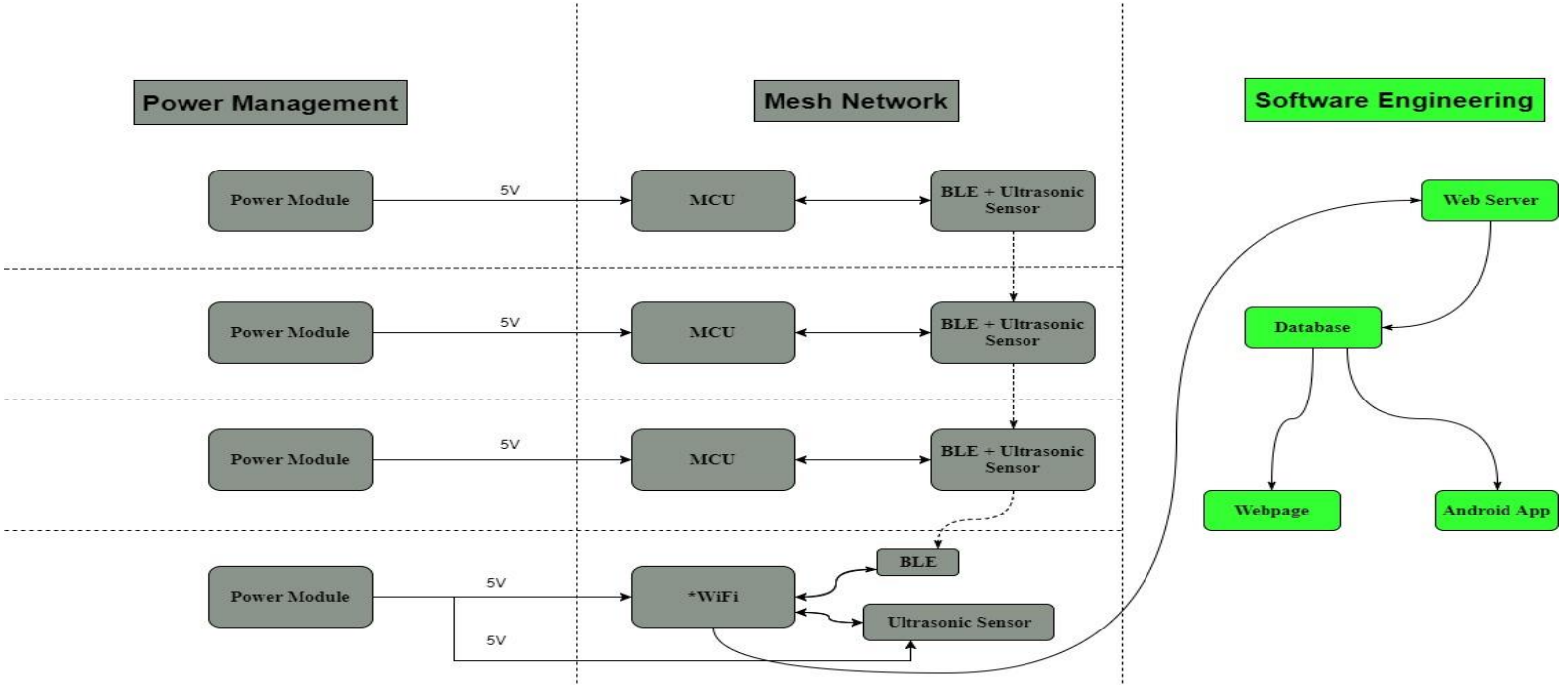
- Programmed through AT commands, but written in code.
- To make the mesh network possible after hardware serial testing is a success.
- Code is stored and flashed at the MCU.

```
void setup(){
  Serial.begin(9600);
  BTSerial.begin(9600); // default baud rate
  while(!Serial);
  Serial.println("AT commands: ");
  delay(1000);
  BTSerial.write("AT");
  delay(500);
  BTSerial.write("AT+IMME1");
  delay(500);
  BTSerial.write("AT+ROLE1");
  delay(1500);
  BTSerial.write("AT+CON3CA308966811");
  delay(5000);
  BTSerial.write("AT");
```

How we programmed the mesh network?

- Ultrasonic sensors detect the difference in distance through sound waves.
- That event then triggers BLE communication.
- BLE modules talk one another by connecting to each others MAC addresses.
- Data is relayed in a series connection, i.e. A→ B, B→ C, C→ D, etc.
- If ‘A’ is sending to ‘B’, then ‘A’ has to be Master to send, and ‘B’ has to be slave to receive the data.

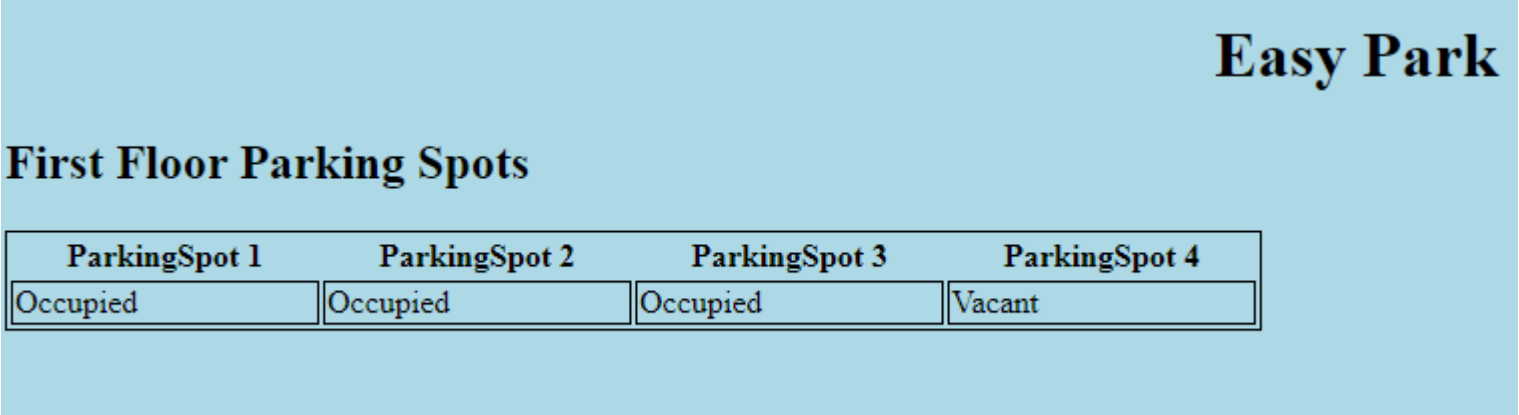
Software Engineering Components



*The WiFi module has a built-in MCU that would be utilized instead of the ATMega.

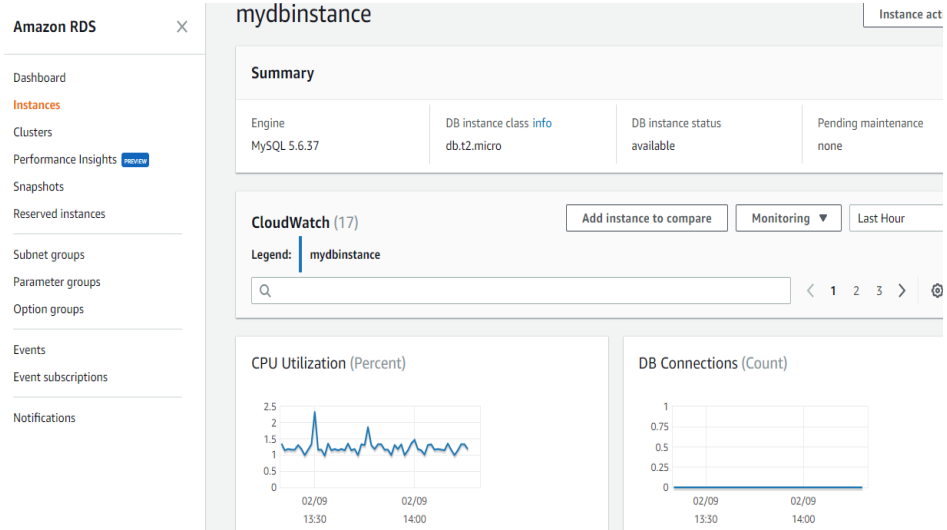
Web Server

- Using a free web hosting domain.
- Specifics are ***www.000webhost.com***
- Web Page shown below (to view the database, written in PHP).
- Arduino communicates with the web server.



Database

- Amazon relational database
- Storage capacity ~ 20GB
- Enough to cover all parking garages at UCF.
- Web server communicates with the database, written in PHP code.



Mobile App

Android Studio

Advantages
- Strong Platform
- More powerful

Disadvantages
- Android only

JQueryMobile

Advantages
- Cross Platform
- Better for mobile applications
- Easy to use/develop

Disadvantages
- Limited capabilities

Bootstrap

Advantages
- Better for web applications
- Easy to use/develop

Disadvantages
- Not good for Mobile applications

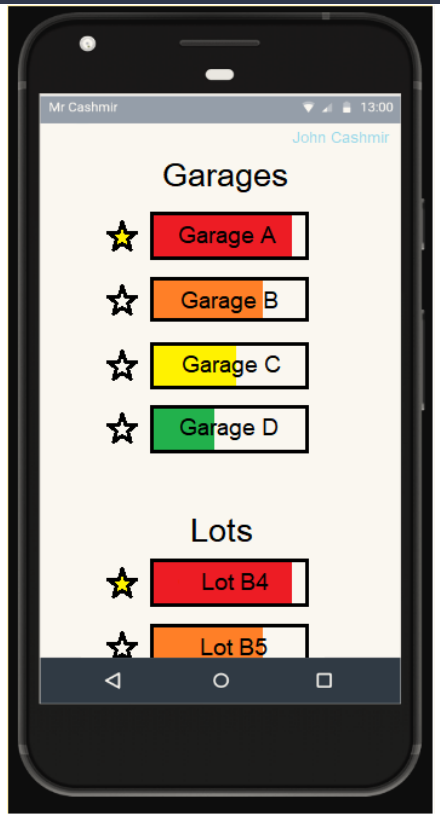
Mobile App

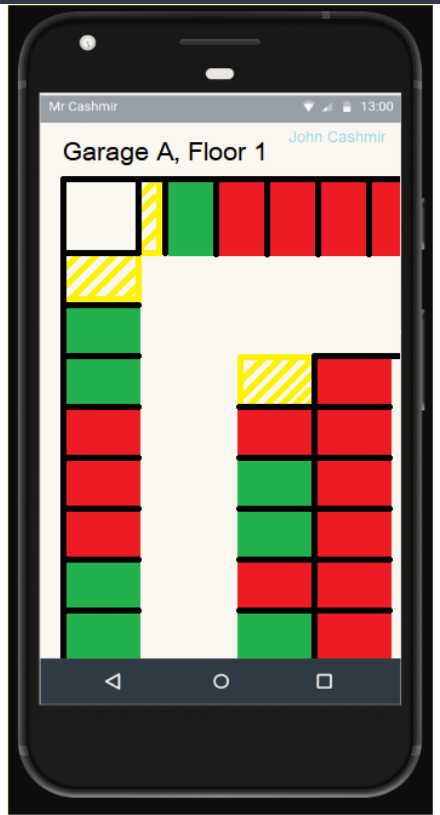
Design Goals

- Keeps eye off app as much as possible
- Easy to use
- Quick to use

Key Features

- Colored progress bar
- Bookmark
- Map



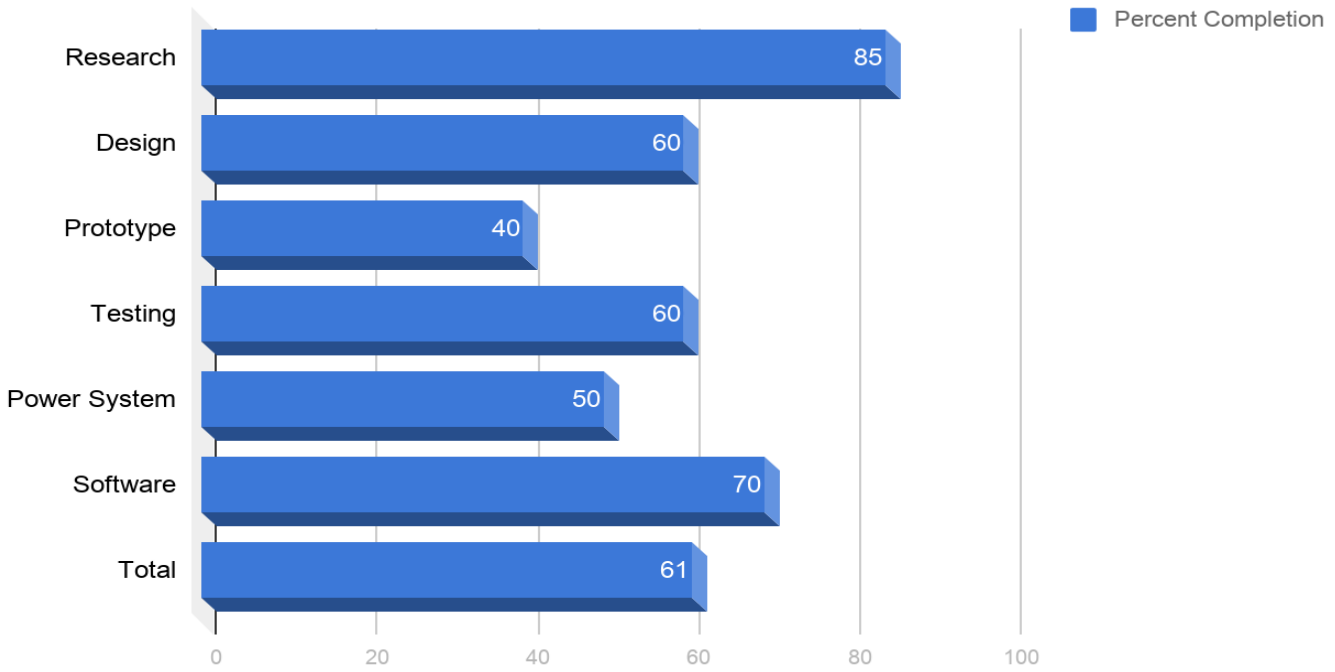


Administration

Task Breakdown

	Jayson	Lorenzo	Muhammad	Peter
Wireless Communication			x	x
Power Systems	x	x		
PCB Design	x	x		
Mobile App			x	x
Server/Database			x	

Percent Completion



Budget

	Quantity	Unit Price	Cost
AMS117-5 Voltage Regulator	10	0.81	8.10
AMS117-3.3 Voltage Regulator	5	1.80	9.00
Arduino Nano	8	3.88	31.04
ATMega823p	10	3.00	30.00
Barrel Jacks Adapters and connectors	10	0.67	6.70
Breadboard	6	3.33	19.98
ESP8266	3	4.10	12.30
Green LEDs	12	0.49	5.88
HC-SR04	10	1.70	17.00
HM-10	4	10.00	40.00
Jumper Cables	120	0.05	6.00
Solar Buddy (MPPT)	1	24.95	24.95
Solar Panels (.5W)	3	1.95	5.85
Solar Panels (1W)	5	3.95	19.75
Total Cost			236.55
Cost to Manufacture			~40.00

Successes and Difficulties

Successes:

- Able to program the new WiFi and use its MCU.
- Built an in-house working Bluetooth Mesh Network.
- All schematic designs finished.

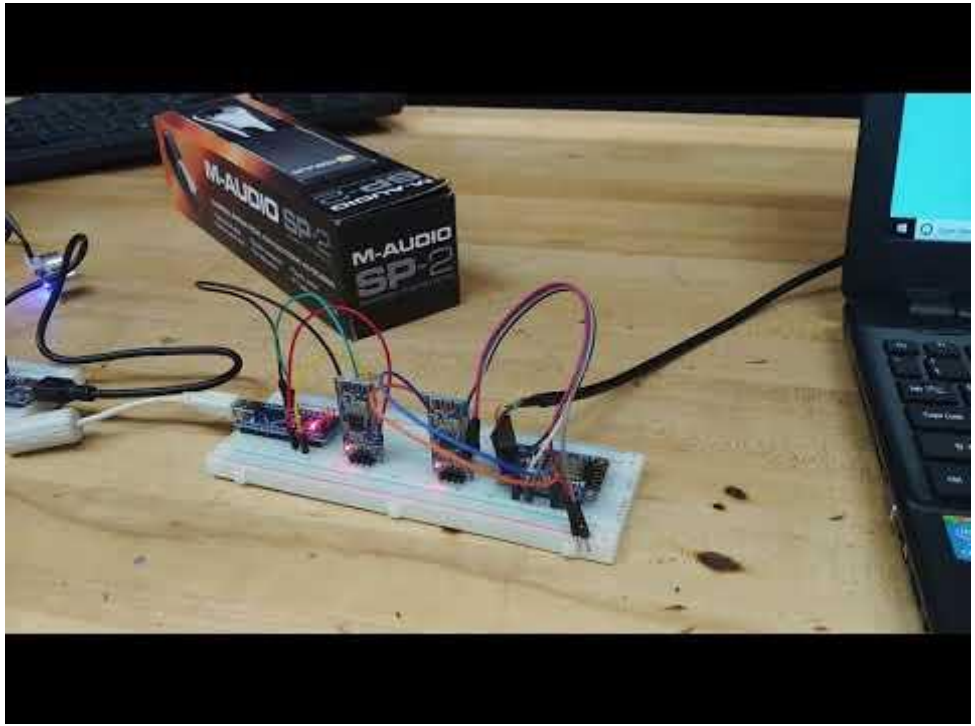
Difficulties:

- Implementation and finding parts (EE).
- Learning curve for programming an Android app.
- Uploading sketches to ATMega328P-PU without an UNO.

And so forth...

- Build Android app
- Redo MPPT design
- Fix PCB errors
- Perform additional testing on PCB in an ideal testing environment

Demo



Questions?