BAGS: Bags Automated Game System

Team 23
Annabelle Epplin, Owen Schaufelberger, Sania Huq
TA: Zicheng Ma
Professor: Olga Mironenko

Introduction

Problem

America’s favorite pastime: Cornhole/Bags

How do we stop losing track of score?

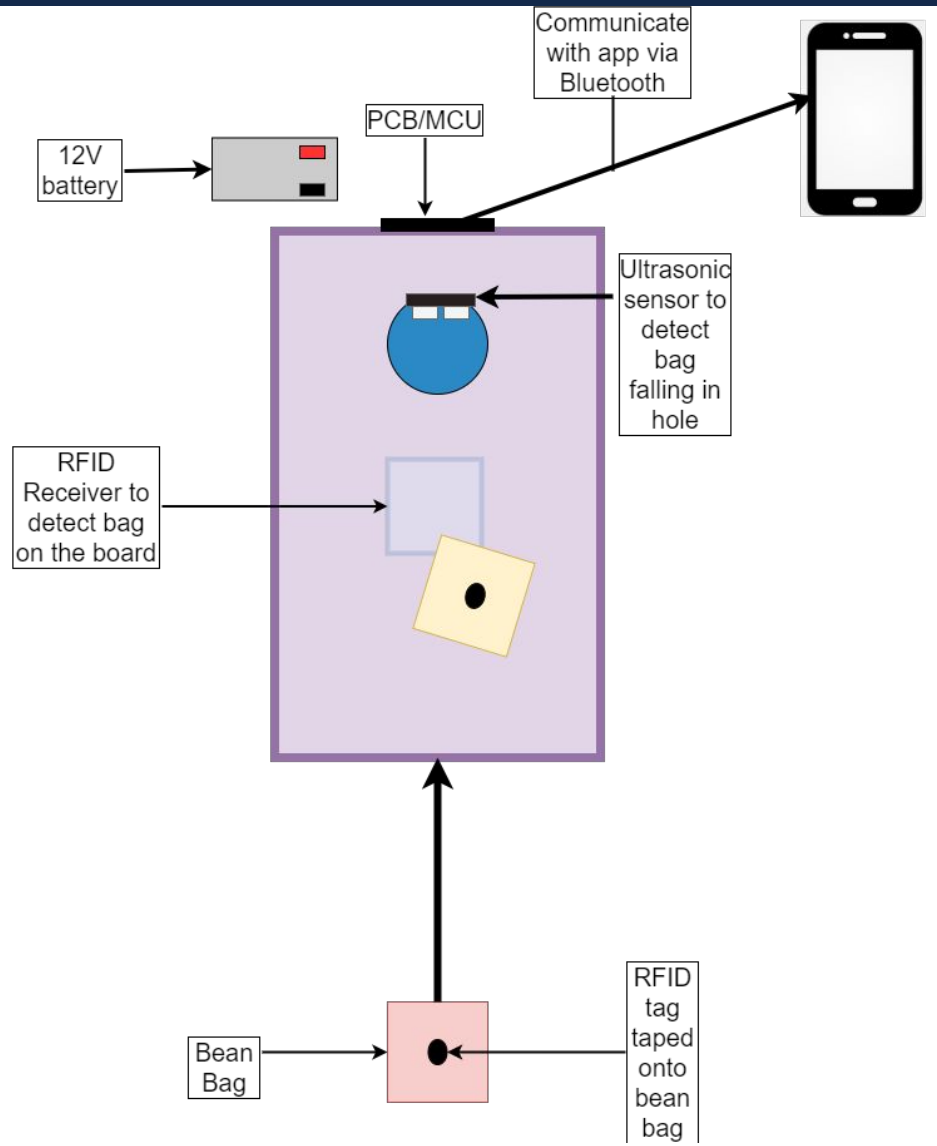
Game Rules

- 2 opposing teams of 2 with different colored bags
- Players take turns throwing each bag
- Bag on board, +1
- Bag in hole, +3 points

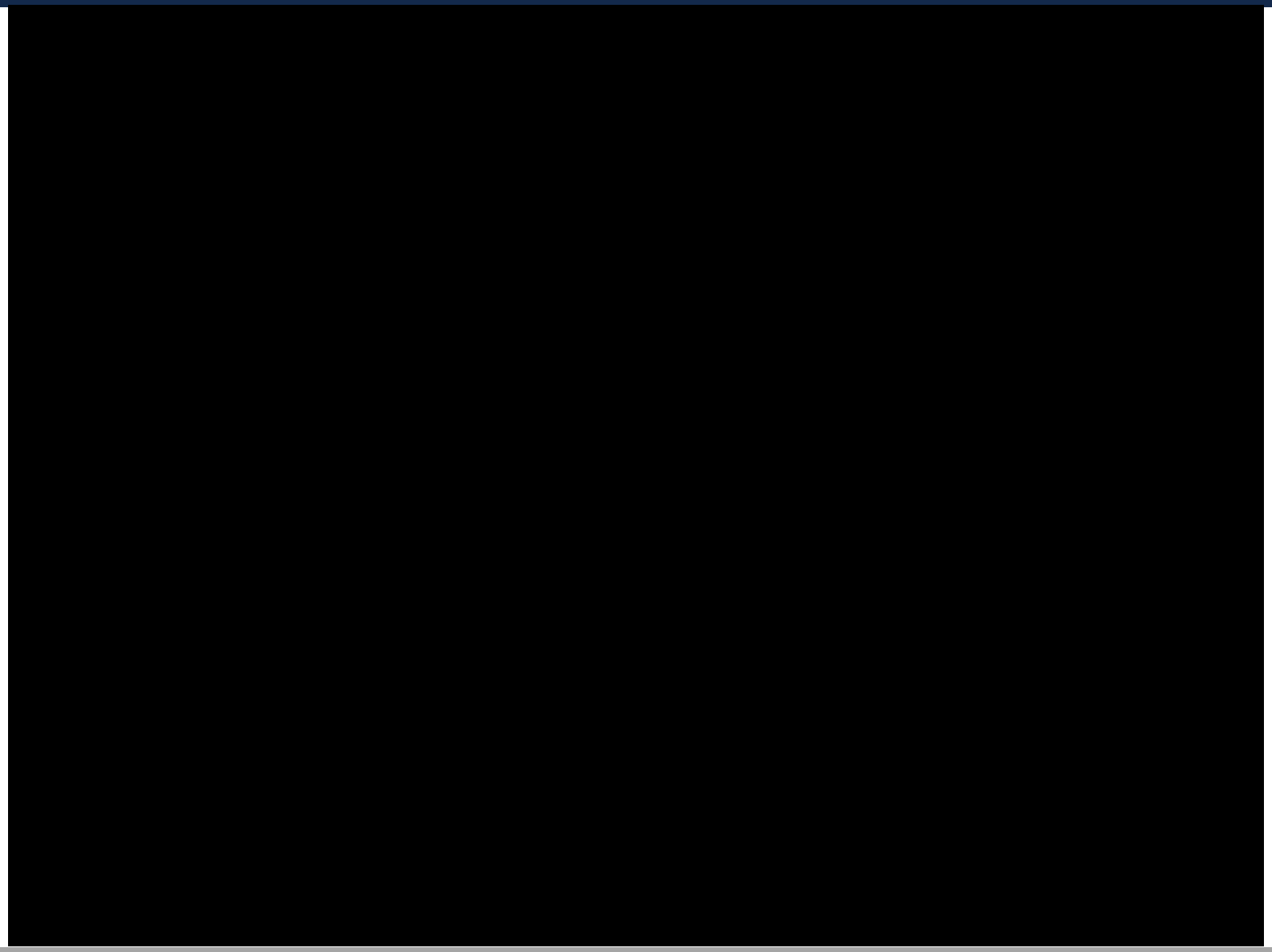
High Level Requirements

1. Keep track of the bag's location with regards to the board and hole
2. Keeping track of score and time played with the game
3. Ability to distinguish between the two different teams playing

Design Process: Initial Steps

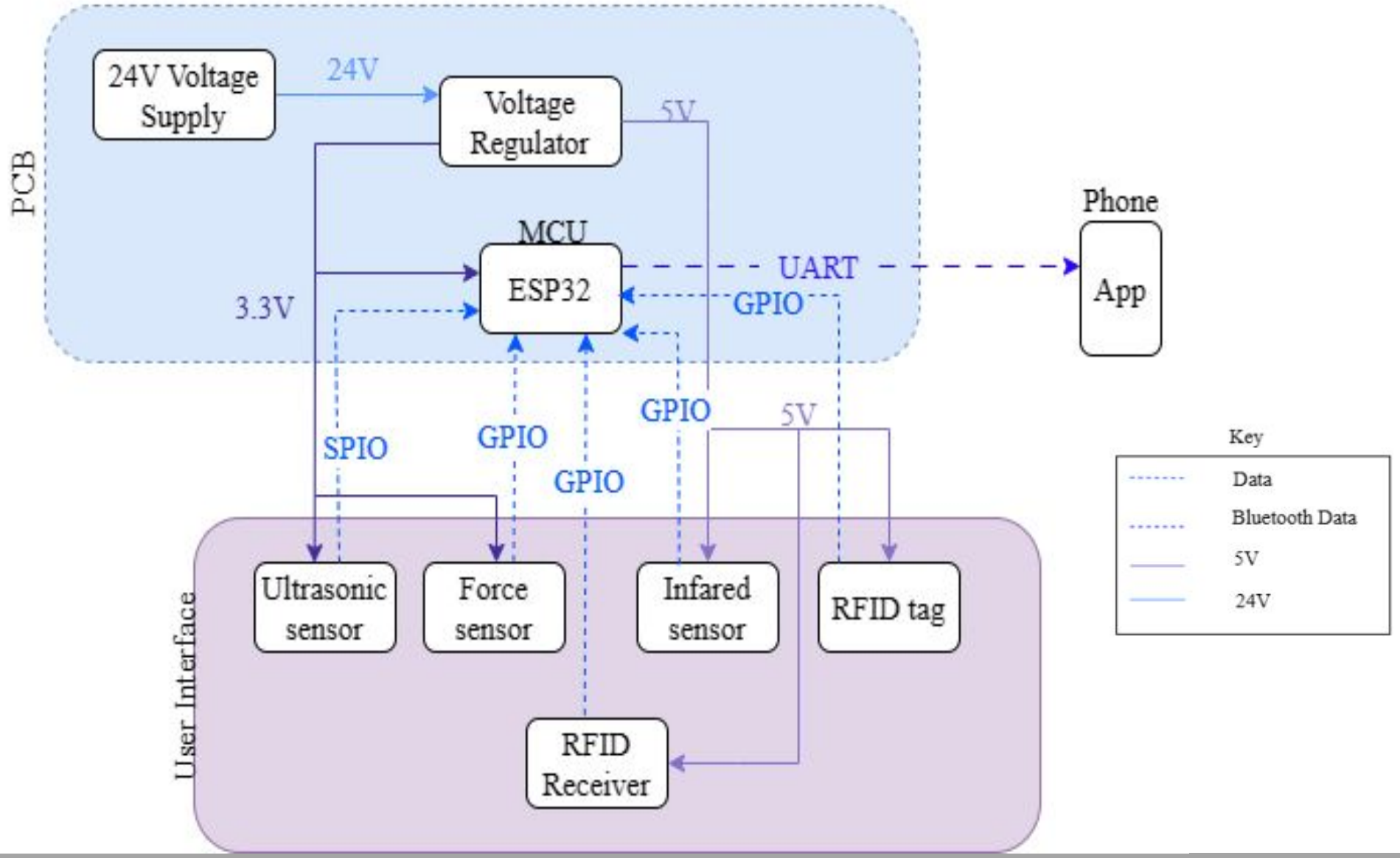


Demonstration Video

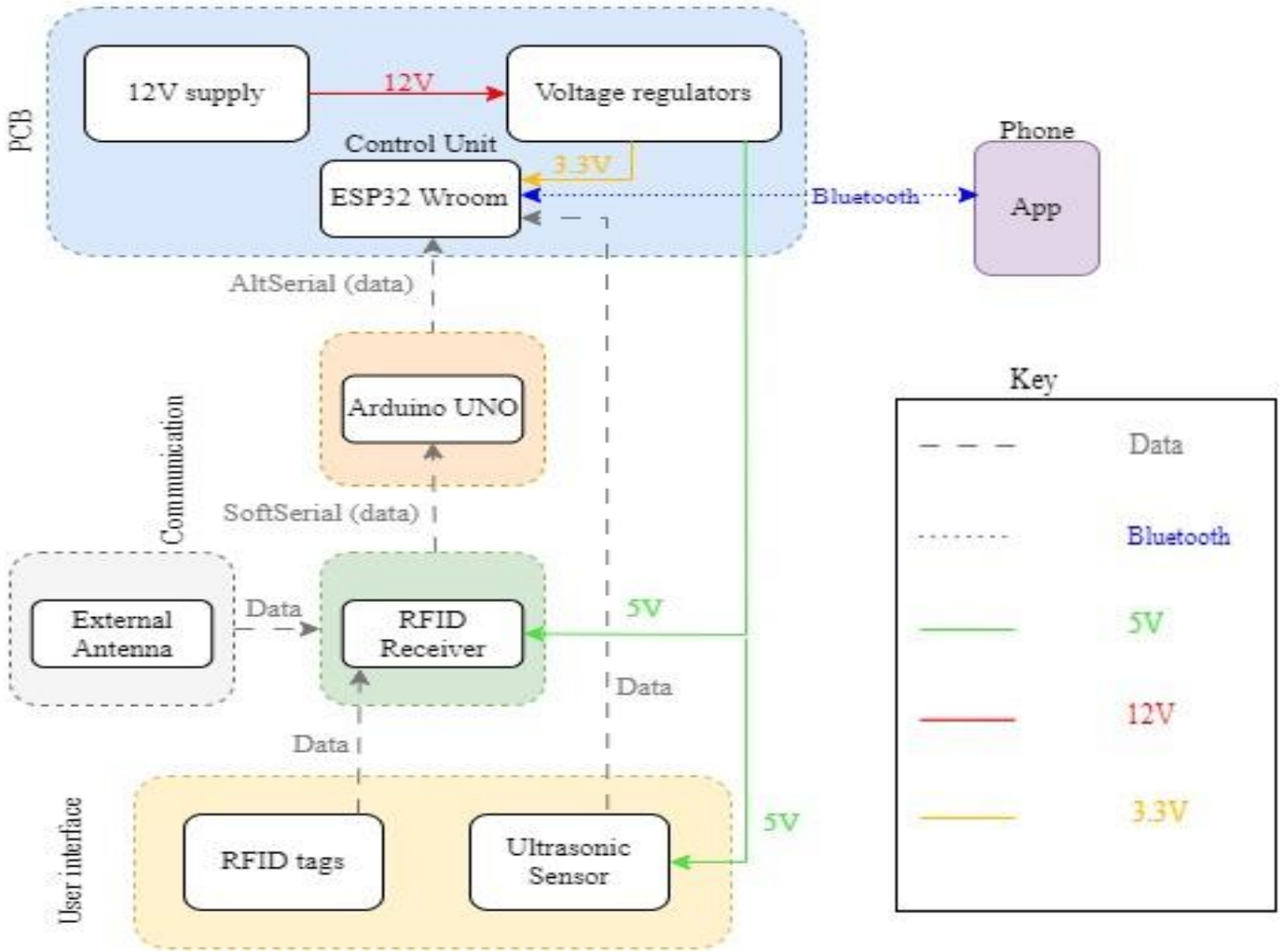


Design Process

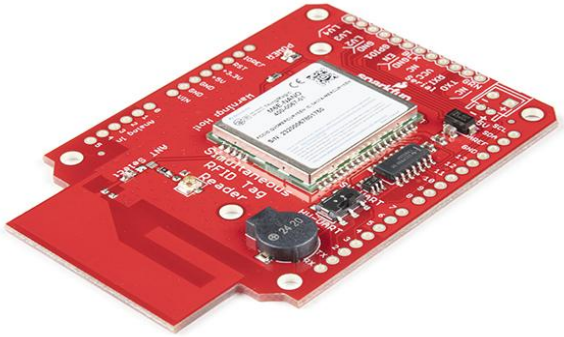
Original Design: Block Diagram

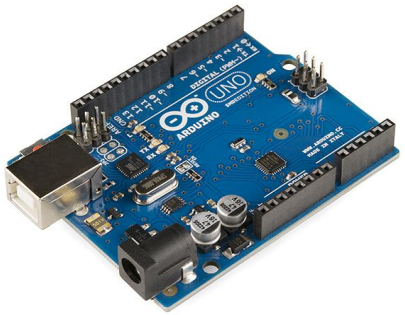


New Block Diagram



Design Process: Hardware





- ESP32 Wroom (microcontroller)
- Portable plastic cornhole board
- SparkFun Simultaneous RFID Reader - M6E Nano
- Arduino UNO*
- HC-SR04 (ultrasonic sensor)*
- External antenna*

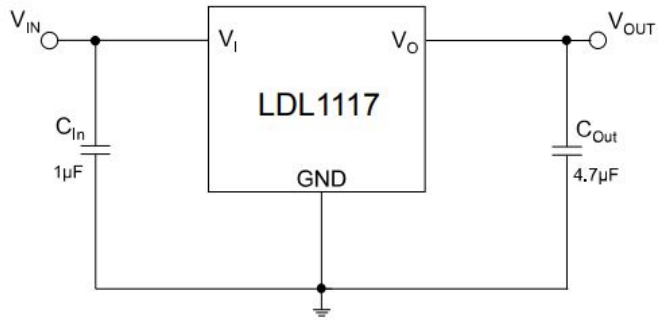
Design Process: Hardware, Power

Design:

- 12V: main supply
- 3.3V: ESP32
- 5V: RFID, Arduino, and ultrasonic sensor

Issues:

- 3.3V regulator circuit damaged ESP32 on PCB and dev board
  - had to use dev kit on breadboard as MCU
- needed wall adaptor for RFID and Arduino for demo



	ESP32 WiFi-BT-BLE MCU Module	Simultaneous RFID Reader	Arduino UNO	HC-SR04 Ultrasonic Sensor
Current Draw	Min: 500mA Max: 630mA	170mA	50mA	15mA
Voltage Draw	3.3V	5V	5V	5V

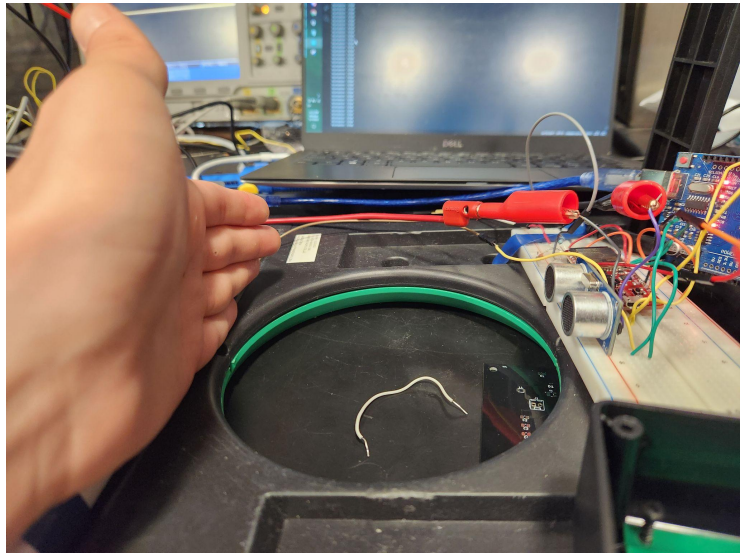
Design Process: Hardware

IR receiver and emitter:

- initial design to detect bags in the hole
- interference from RFID tags
- bags always registered as in the hole
- tried PIR sensor

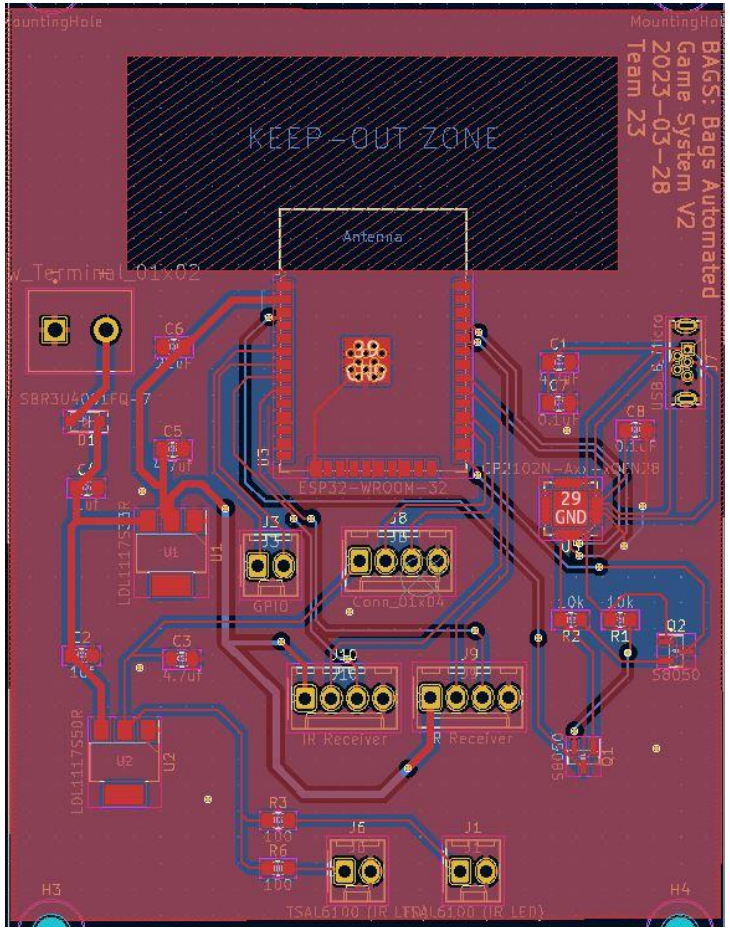
Ultrasonic Sensor:

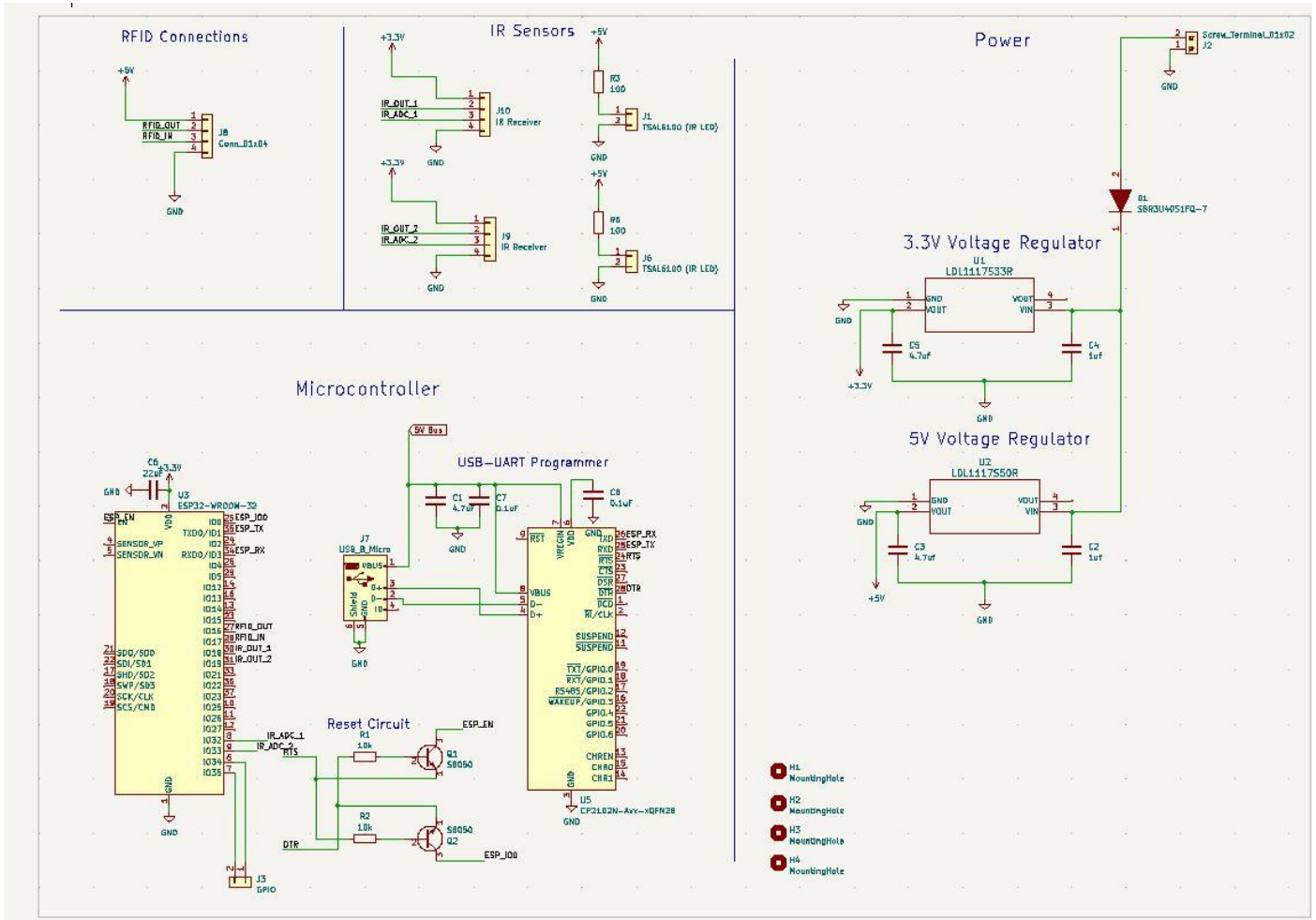
- replaced IR receiver and emitter
- tuned in software to only detect items within diameter of hole



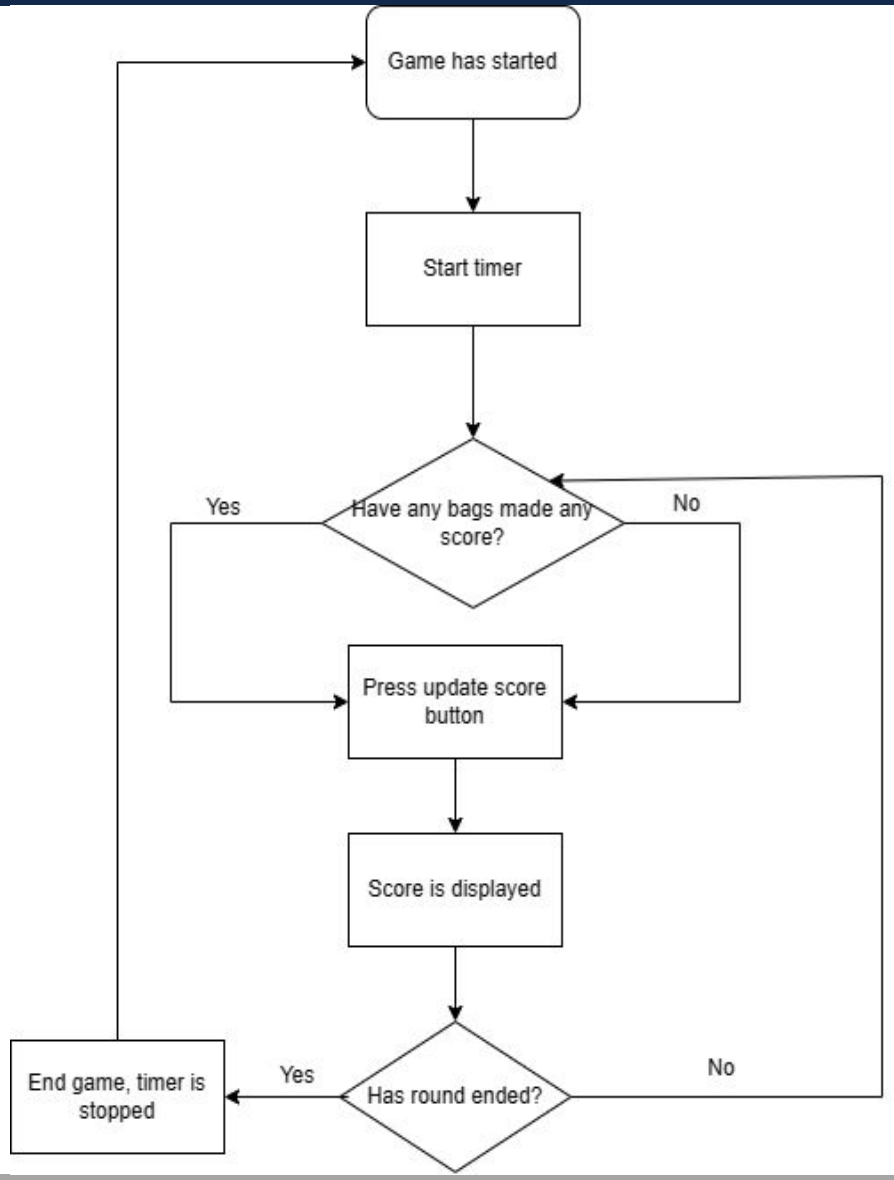
```
Distance: 13cm
Distance: 13cm
Distance: 13cm
Distance: 13cm
Distance: 13cm
Distance: 13cm
Distance: 13cm
Distance: 13cm
Distance: 13cm
Distance: 13cm
```

PCB Design

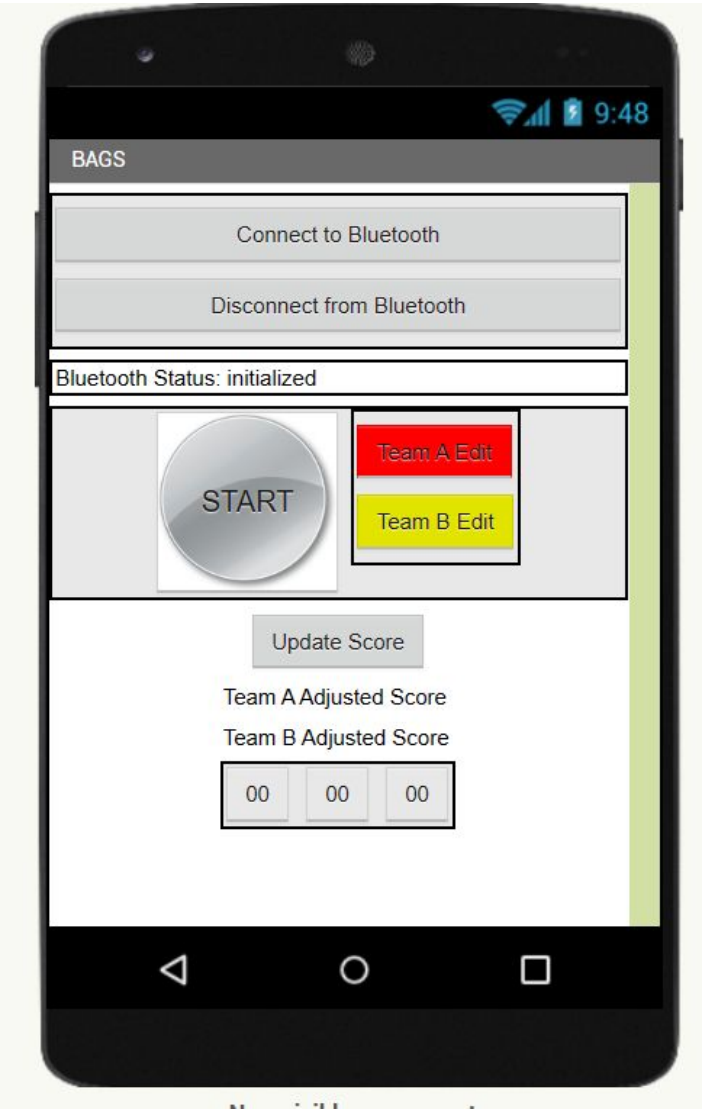

KEEP-OUT ZONE
Antenna
BAGS: Bags Automated Game System V2
2023-03-28
Team 23
ESP32-WROOM-32
CP2102N-Axx-xQFN28
IR Receiver
IR Receiver
GPIO
TSAL6100 (IR LED)
TSAL6100 (IR LED)


RFID Connections
IR Sensors
Power
Microcontroller
USB–UART Programmer
Reset Circuit
3.3V Voltage Regulator
5V Voltage Regulator
ESP32-WROOM-32
CP2102N-Axx-xQFN28
LDL1117S33R
LDL1117S50R
IR Receiver
IR Receiver
TSAL6100 (IR LED)
TSAL6100 (IR LED)
Screw_Terminal_01x02
Conn_01x04
USB_B_Micro
S8050
SBR3U40S1FQ-7
MountingHole

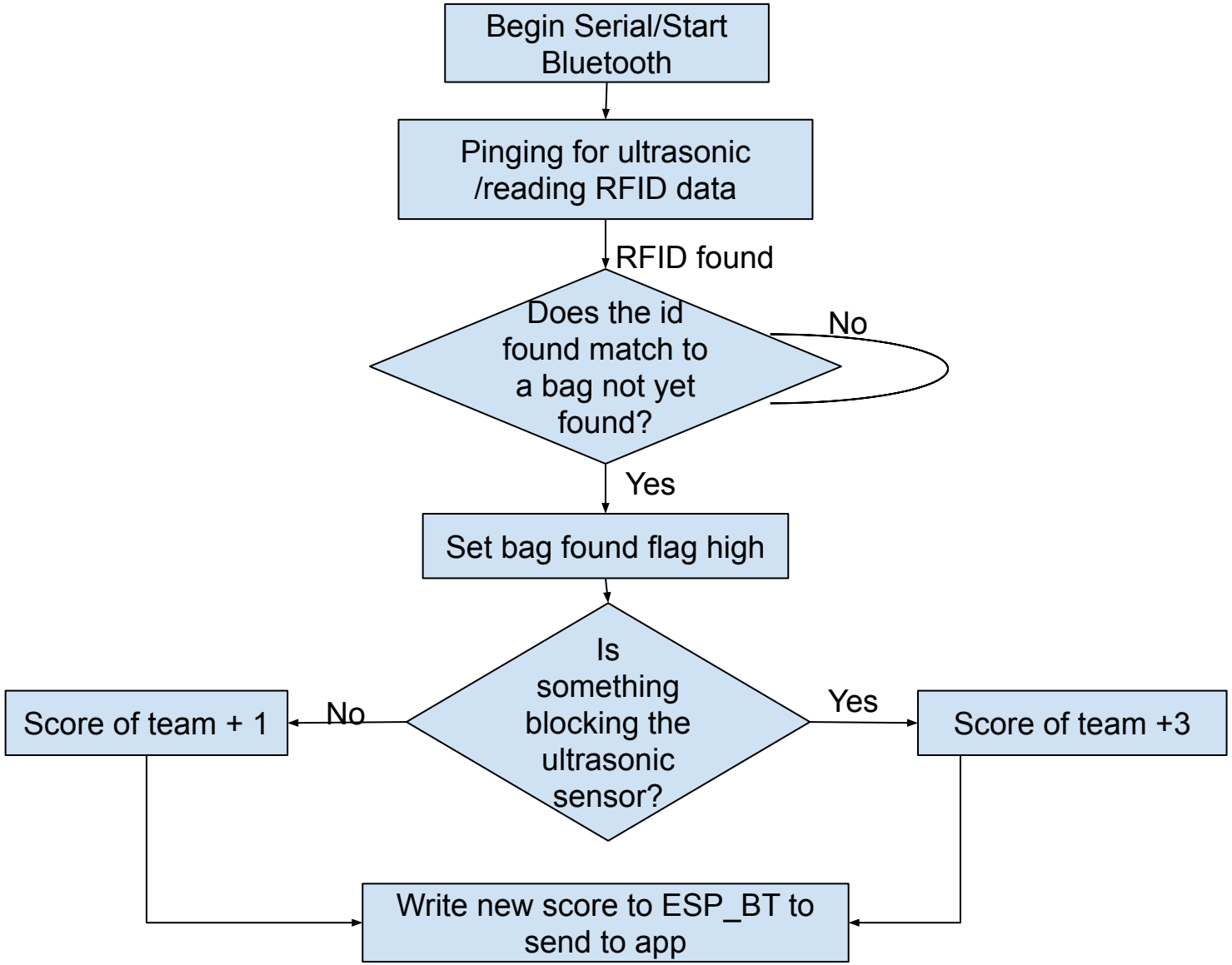
Design Process: Software



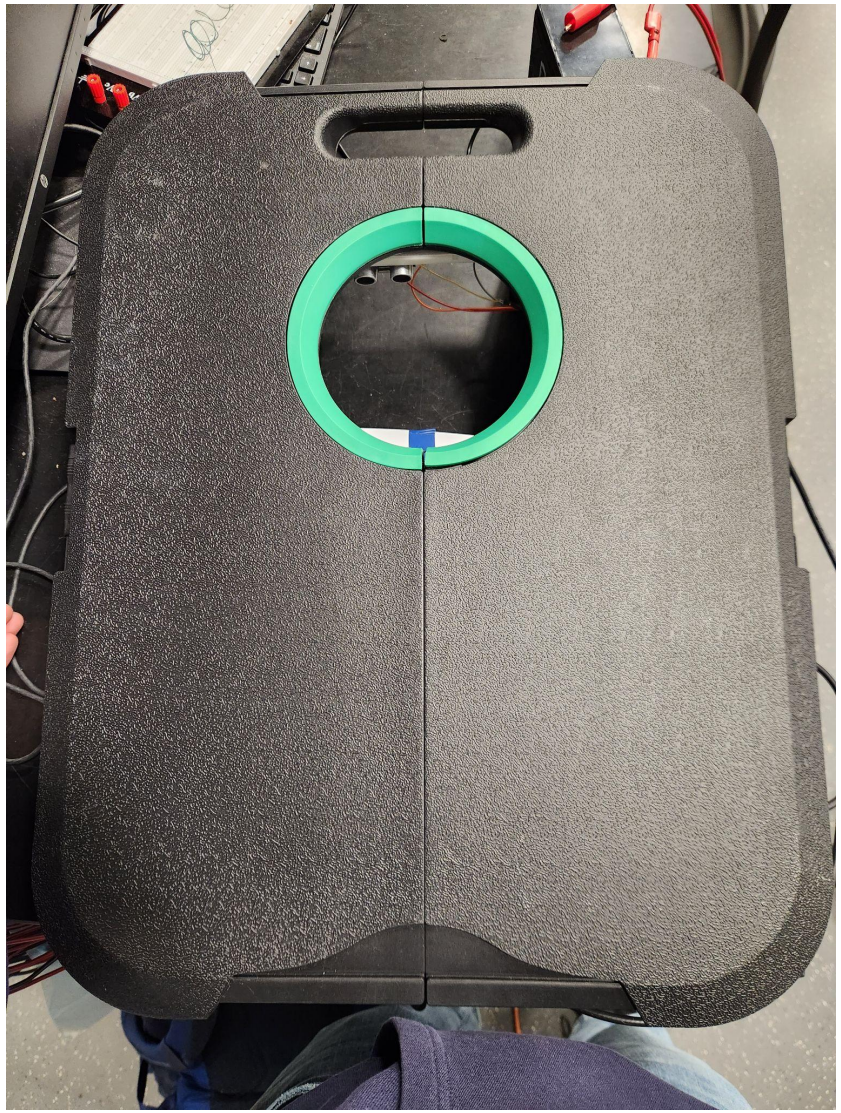
Design Process: Software

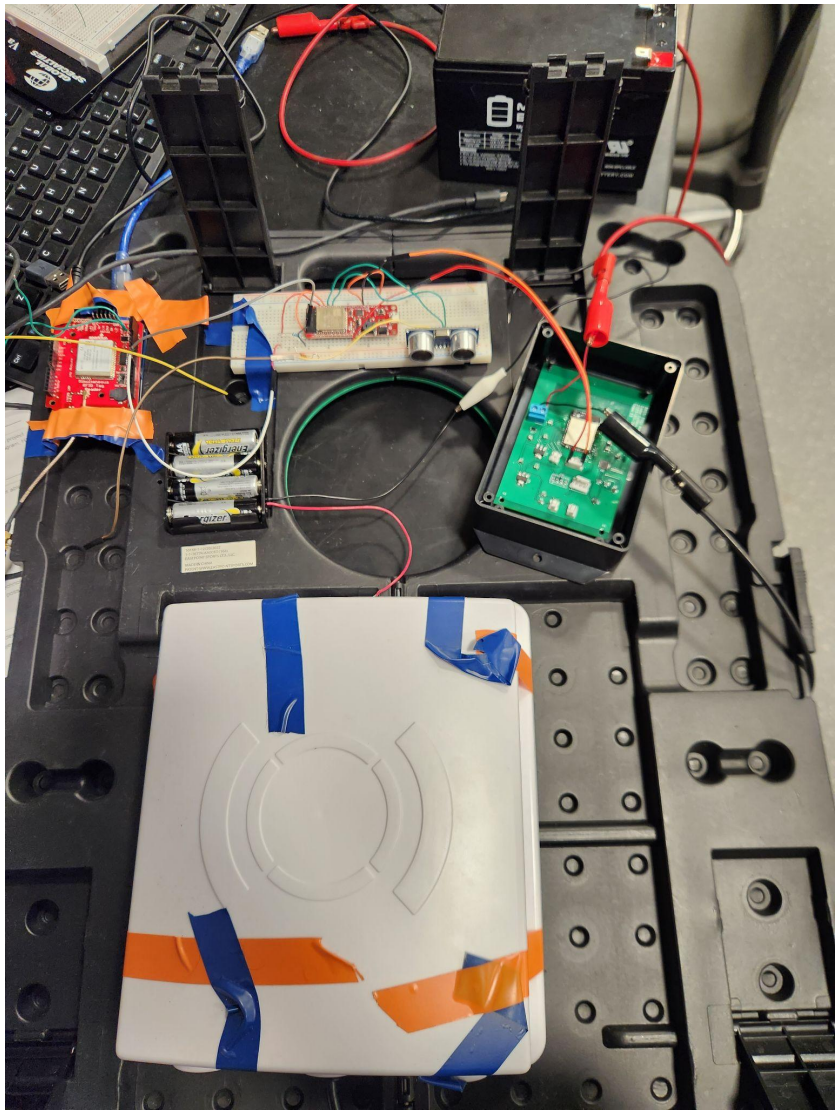


Design Process: Firmware Development



Design Process: Assembling the Pieces





Results

Results- RFID System

Sparkfun M6ENano Serial Monitor Results

```
 rssi[-47] freq[921400] time[10] epc[22 2F ]
 rssi[-46] freq[923400] time[43] epc[22 2F ]
Scanning
Scanning
 rssi[-45] freq[924200] time[502] epc[11 1F ]
 rssi[-45] freq[918000] time[536] epc[11 1F ]
 rssi[-42] freq[927200] time[570] epc[11 1F ]
 rssi[-45] freq[920000] time[602] epc[11 1F ]
```

RSSI

Bag Frequency

Timestamp

EPC name

ESP32 Serial Monitor Results

EPC name

```
22 2F
bag 5 front found
0
1
1
```

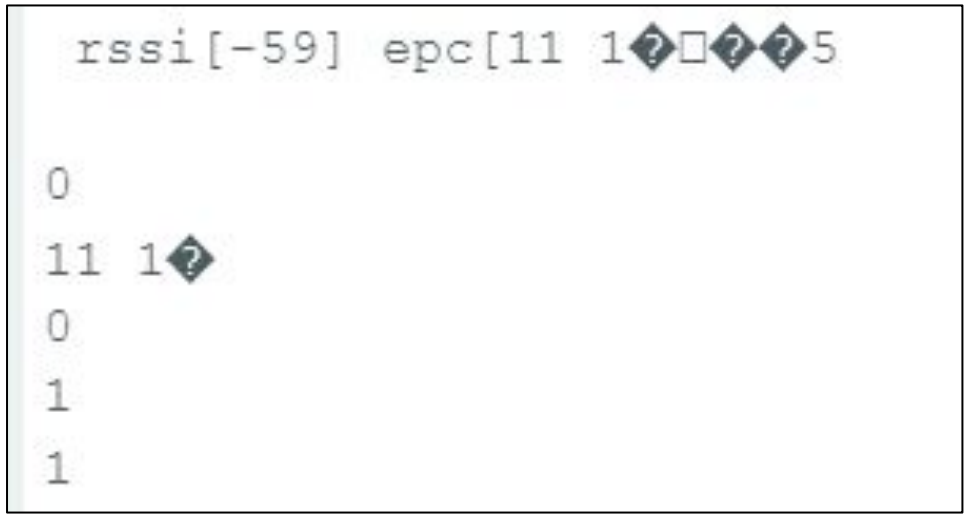
```
11 1F
bag 1 front found
1
1
11
```

Score

Quantitative Results

- Data received by app within 30 seconds
- RFID reader able to detect 8 tags simultaneously
- Ultrasonic sensor detects items within 6 inches (size of hole)
- 3.3V voltage regulator steps down 12V supply to 3.135V
- 5V voltage regulator steps down 12V supply to 4.8V

ESP32 Serial Monitor Noise



#1 Issue: Electromagnetic Noise

- IR emitter electromagnetic interference at 38 kHz
- ESP32 picking up EM noise from antenna
- EMI noise issues during demonstration
- Bluetooth delay

#2 Issue: PCB Issues

- Unable to program ESP32 on PCB board
- 3.3 V voltage regulator current fluctuations

Key Takeaways/Successes

High Level Requirements	Was it Met?
Successfully keeping track of bag locations with regards to the board and hole	**Yes**- able to detect if a bag was on the board or in the hole - Ultrasonic sensor issues during demo
App able to keep track of score and time played with the game	**Yes**- point system and timer on app - Demo sensor issues
System is able to distinguish between two different teams playing	**Yes**- two different scores were managed for game duration

Things We Would've Changed in Redesign

- Demoing outside/less noisy place
- Ultrasonic sensor over IR sensor
- PCB voltage regulator fixes
- Hardware display on board over app
- Better equipment to read bags when completely missed on board

Further Work/ Improvements

- Score read continuously real time
- Larger scale board
- Entertainment factor
- LEDs on board
- Scoreboard on physical board

Ethics

- Minimal ethics concerns
  - Exposed wires for outside play
  - Personal injuries

Thank you!

The Grainger College of Engineering

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN