BAGS: Bags Automated Game System

Team 23
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Introduction
Problem

America’s favorite pastime: Cornhole/Bags

How do we stop losing track of score?
- 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

- 12V battery
- PCB/MCU
- Ultrasonic sensor to detect bag falling in hole
- RFID Receiver to detect bag on the board
- RFID tag taped onto bean bag
- Communicate with app via Bluetooth
- Bean Bag
Design Process
Original Design: Block Diagram
New Block Diagram

- 12V supply
- Voltage regulators
- ESP32 Wroom
- Arduino UNO
- External Antenna
- RFID Receiver
- RFID tags
- Ultrasonic Sensor
- Phone
- App

Key:
- Data
- Bluetooth
- 5V
- 12V
- 3.3V
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

<table>
<thead>
<tr>
<th></th>
<th>ESP32 WiFi-BT-BLE MCU Module</th>
<th>Simultaneous RFID Reader</th>
<th>Arduino UNO</th>
<th>HC-SR04 Ultrasonic Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Draw</td>
<td>Min: 500mA Max: 630mA</td>
<td>170mA</td>
<td>50mA</td>
<td>15mA</td>
</tr>
<tr>
<td>Voltage Draw</td>
<td>3.3V</td>
<td>5V</td>
<td>5V</td>
<td>5V</td>
</tr>
</tbody>
</table>
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
Begin Serial/Start Bluetooth

Pinging for ultrasonic /reading RFID data

RFID found

Does the id found match to a bag not yet found?

No

Set bag found flag high

Is something blocking the ultrasonic sensor?

Score of team +1

No

Yes

Score of team +3

Write new score to ESP_BT to send to app
Design Process: Assembling the Pieces
Results
Results- RFID System

Sparkfun M6ENano Serial Monitor Results

<table>
<thead>
<tr>
<th>RSSI</th>
<th>Bag Frequency</th>
<th>Timestamp</th>
<th>EPC name</th>
</tr>
</thead>
<tbody>
<tr>
<td>-47</td>
<td>921400</td>
<td>10</td>
<td>epc[22 2F]</td>
</tr>
<tr>
<td>-46</td>
<td>923400</td>
<td>43</td>
<td>epc[22 2F]</td>
</tr>
</tbody>
</table>

ESP32 Serial Monitor Results

<table>
<thead>
<tr>
<th>EPC name</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 2F</td>
</tr>
<tr>
<td>bag 5 front found</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 1F</td>
</tr>
<tr>
<td>bag 1 front found</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>11</td>
</tr>
</tbody>
</table>
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
#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

<table>
<thead>
<tr>
<th>High Level Requirements</th>
<th>Was it Met?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successfully keeping track of bag locations with regards to the board and hole</td>
<td>Yes- able to detect if a bag was on the board or in the hole</td>
</tr>
<tr>
<td></td>
<td>- Ultrasonic sensor issues during demo</td>
</tr>
<tr>
<td>App able to keep track of score and time played with the game</td>
<td>Yes- point system and timer on app</td>
</tr>
<tr>
<td></td>
<td>- Demo sensor issues</td>
</tr>
<tr>
<td>System is able to distinguish between two different teams playing</td>
<td>Yes- two different scores were managed for game duration</td>
</tr>
</tbody>
</table>
- 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
- Minimal ethics concerns
  - Exposed wires for outside play
  - Personal injuries

IEEE CODE OF ETHICS
Thank you!