

ECE 445 Proposal:

BAGS: Bags Automated Game System

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1 Introduction

1.1 Background

Cornhole, or bags, is one of the most beloved sports in the Midwest. The game is played with two teams of two, 8 total bags, 4 for each team, with two angled, opposing boards spaces around 15 feet away from each other. Players take turns throwing bean bags at the opposing boards in an attempt to either land their bag on the board or into the hole cut out on the board. Each bag on the board awards that player's team with one point while making it into the hole is three points. The game ends when either team reaches 21 points.

1.2 Problem

Due to its fairly simplistic nature, cornhole is a staple at events such as barbeques, tailgates, and other outdoor get together. Some other staples at these type of events are adults drinking, energetic children, and engaging conversations. While these are great and part of what makes these events fun, they are distractions that can affect one's ability to keep track of the score. This can lead to heated arguments that are heightened due to alcohol consumption or take away the competitive edge as it can devolve into just throwing bags back and forth no clear objective.

1.3 Solution

To combat participants losing track of score, we will be removing the need for them to score the game entirely. This will be accomplished by creating a set of bags, a board, and an app that will automatically score the game for them.

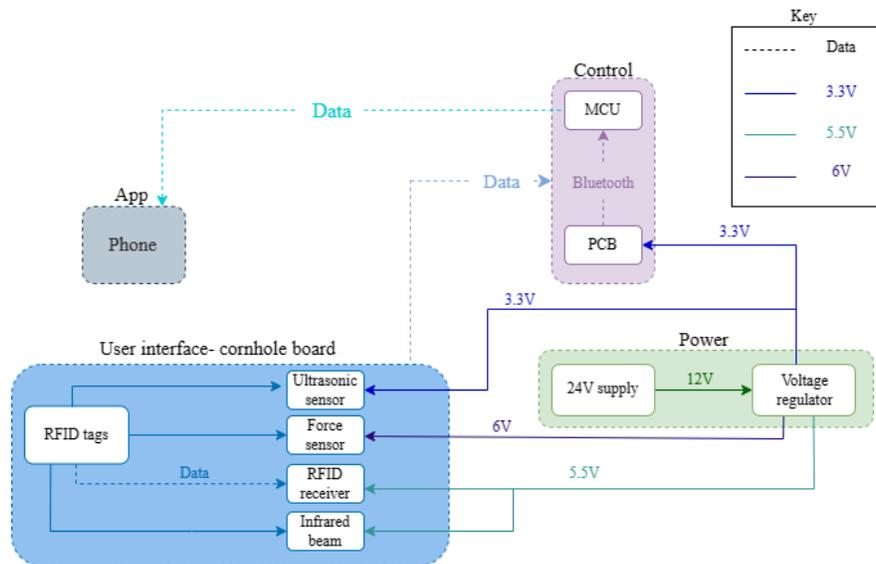
The bags will contain RFID tags that communicate with receivers embedded into the board to recognize when a bag has landed on the board. This will work in conjunction with the force sensors to determine if the bag has stuck on the board. This change to the board-state will be sent to the micro-controller which will then interface with our app via Bluetooth to update the game score appropriately.

To detect a bag falling into the hole, we will be placing IR emitter and receiver in the hole, which when momentarily broken, will determine that a bag has completely fallen into the hole. As before, this will be sent to the micro-controller and interfaced with the app via Bluetooth.

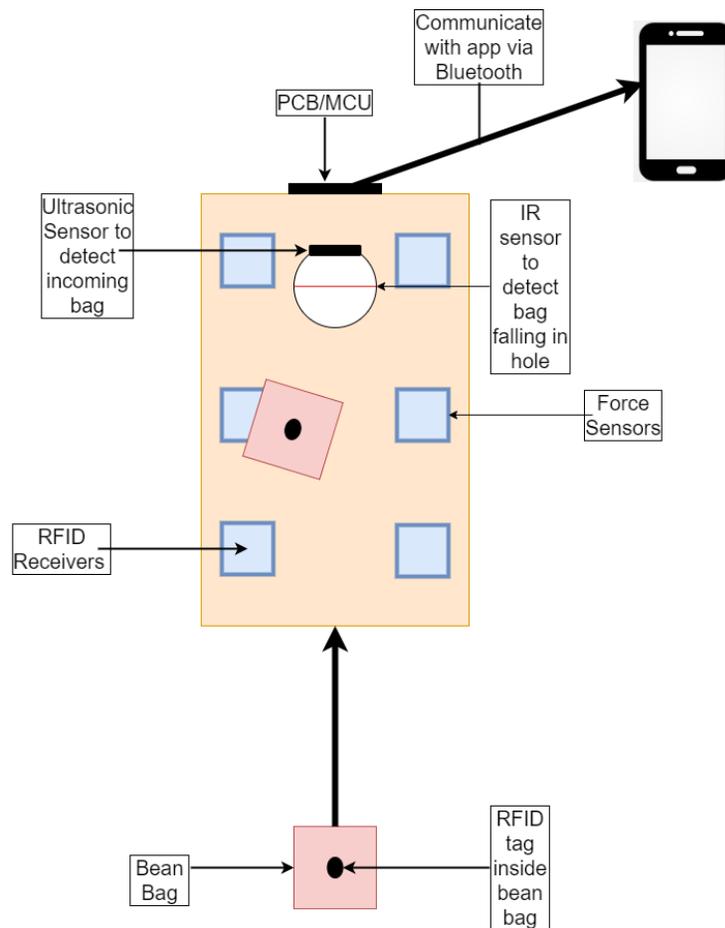
An ultrasonic sensor will also be placed in the board to detect an incoming bag. This will be used to determine if a player has missed the board completely. If an incoming bag is detected by the sensor but there was no change in board-state, the throw is determined to be a complete miss. This will allow the app to alternate which team is throwing after each through with no issues.

2 Design

2.1 Block Diagram



2.2 Visual Aid



2.3 High-Level Requirements List

To consider our project successful, we want to accomplish several objectives:

1. System must be able to accurately determine bags on the board and in the hole and deliver that information to the app
2. System must be able to determine misses and correct switch turns between teams
3. System must be able to communicate between app and cornhole board sensor array using Bluetooth

2.4 Subsystems

2.4.1 Power Subsystem

Battery

- 24 Volt replaceable battery used to power sensor array and MCU
- Supply sufficient 24V power for all components

2.4.2 User Interface Subsystem

Cornhole Board

- Physical wooden board used to play cornhole game
 - 2'x4' surface with the hole being 6" in diameter, 6" away from the back of the board.
 - Inclined at an angle of 10°
- Embedded electronics must have minimal effect on physical game play in comparison to a standard board

Ultrasonic Sensors

- Used to help determine whether a bag has completely missed the board or gone into the hole
 - It senses when there is an incoming bag and sends this information to the MCU which then compares this to any change in the board state
 - If an incoming bag was sensed and there was no registered change on the board then the bag is marked as completely missing the board
- Must be able to sense if a bag within 2 feet of the board is heading in the direction of the board
- Must be able to communicate information of incoming bag to MCU

Force Sensors

- Used to determine the impact of the bags on the cornhole board to ensure that the throw was not a miss
 - A way to ensure the hit did happen and was not a result of location inaccuracy from the other sensors
- Must be able to determine impact of bags on board and communicate that information to MCU

IR Emitter and Sensor

- IR emitter and sensor are connected and placed inside the hole. When a bag interrupts the connection
 - Determines if bag has fallen into hole, then rewards three points to designated team
- Must be able to detect that a bag has fallen in the hole and send that information to the MCU

RFID Receiver

- Several receivers will be embedded into to the board and will serve as points that will detect bags making contact and sticking onto the board
- Must be able to communicate with RFID tags through board and bags material
- Must be able to determine location of RFID tags

RFID Tags

- RFID tags communicate with the RFID receivers when in close contact with each other
 - This serves to register that a bag has landed on the board
 - When a bag is registered, data is sent to the MCU which then sends data to the app via Bluetooth to tell it that the score has changed
- Must not drastically the weight and feel of the cornhole bags
- Must be able to communicate with RFID receiver through the material of the bag

User Interface Subsystem Requirements

- Sensors accurately determine board impact and can communicate that information to app
- Sensors can determine which bags are on the board and/or within the hole

2.4.3 App Subsystem

- To display the game score, an app will be created that will provide an updated scoring and game statistics to users
 - Game statistics include percent of bags landing on the board and a player ranking to see who has scored the most points
- App is able to provide correct game statistics to users, including game score and percent of bags landing on the board
- App is able to receive information from MCU using Bluetooth

2.4.4 Control Subsystem

PCB

- Holds the microcontroller and provides power to the MCU

Microcontroller

- Utilizing an ESP32 microcontroller due to its Bluetooth capability

2.5 Tolerances

The focal point of the entire cornhole board system is the sensor array on the board used to determine where the bags are thrown. The primary set of sensors consist of an RFID receiver located on the board and that will interface with RFID tags in the bags to determine when the bags are located on the board. However, this leaves room for error, whether it be the bags moving or receiver inaccuracy. To ensure further accuracy, additional force sensors will be placed throughout the board to determine the location of impacts of the bags. The end goal is to ensure that each hit is accurate and has been through a series of checkpoints using various sensors that prove the bag is on the board.

The other potential issue is determining misses during the game. We want to be able to determine misses that were thrown within 2 feet of the board. By forcing a series of checks before determining a hit, we will also be able to determine when the bag hasn't hit the board. The location accuracy of an active RFID receiver is typically within 3 meters, so the RFID receiver will then be able to determine the bag location in relation to the board using the RFID tag placed inside the board.

3 Ethics and Safety

For a successful senior design project, it is imperative that safety and ethics policies are followed throughout the entire process.

For a successful project, any potential safety concerns with the project must be addressed (IEEE Code of Ethics I.1) [1]. Because our project is an auto-scoring corn-hole game, there are not many immediate safety risks to users. However, there is the potential of electrical shock or fire due to faulty wiring or degradation of the board in inclement weather. This can be remedied by ensuring the wiring in our design is done with proper wires and that the board is built with weather-withstanding materials to protect the electronics. Although there is always going to be some risk, every care will be taken to minimize the little risk our project poses.

Ethical concerns must also be addressed to ensure that our senior design project is compliant with IEEE standards. Due to the nature of our project, the main ethical concern would most likely be plagiarism. In this project, designers will be researching several different components and methods and looking at other products in the automated game industry, such as auto-scoring dart boards. It is vital to make every effort to ensure each source is correctly cited and referenced in the senior design process.

4 Citations and References

[1] "IEEE code of Ethics," IEEE. [Online]. Available: <https://www.ieee.org/about/corporate/governance/p7-8.html>. [Accessed: 12-Sep2022].