8 Ball Lifeguard

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Use Case

- This will be a learning device for people to improve at 8-ball
  - We use CV to detect where the pool balls are on the table, then find the simplest shot for the user to make
- Our design is different from previous designs as it incorporates sensors into the cue itself to help the user improve
  - Previous designs only projected information onto the table, while our design lets us give feedback to the user after they make a shot

Use-Case Requirements

1. Making sure the detection for the balls is accurate within 0.1in of their actual position on the table
2. The calculation for the shot should take less than 3 seconds and be less than 2 degrees off
3. The time it takes the position of the cue to update should be less than 10ms

Solution Approach - Smart Cue System

- Angle/Direction - compasses on the table and cue stick give directional vectors, the difference between them gives the cue stick's direction relative to the table
- Acceleration - accelerometers measure the acceleration of the stick, has an interrupt pin to tell us when there is a sudden drop
- LED/Laser - controlled by the computer, turns on when instructed

Solution Approach - CV System

Components:

- Camera: Logitech C922X to capture game state
- Use 4 barcodes on the pool table to detect camera angle and adjust CV computation based on said angle
- Program using OpenCV to find the pool balls on the table from pictures from the camera

Solution Approach - Projector

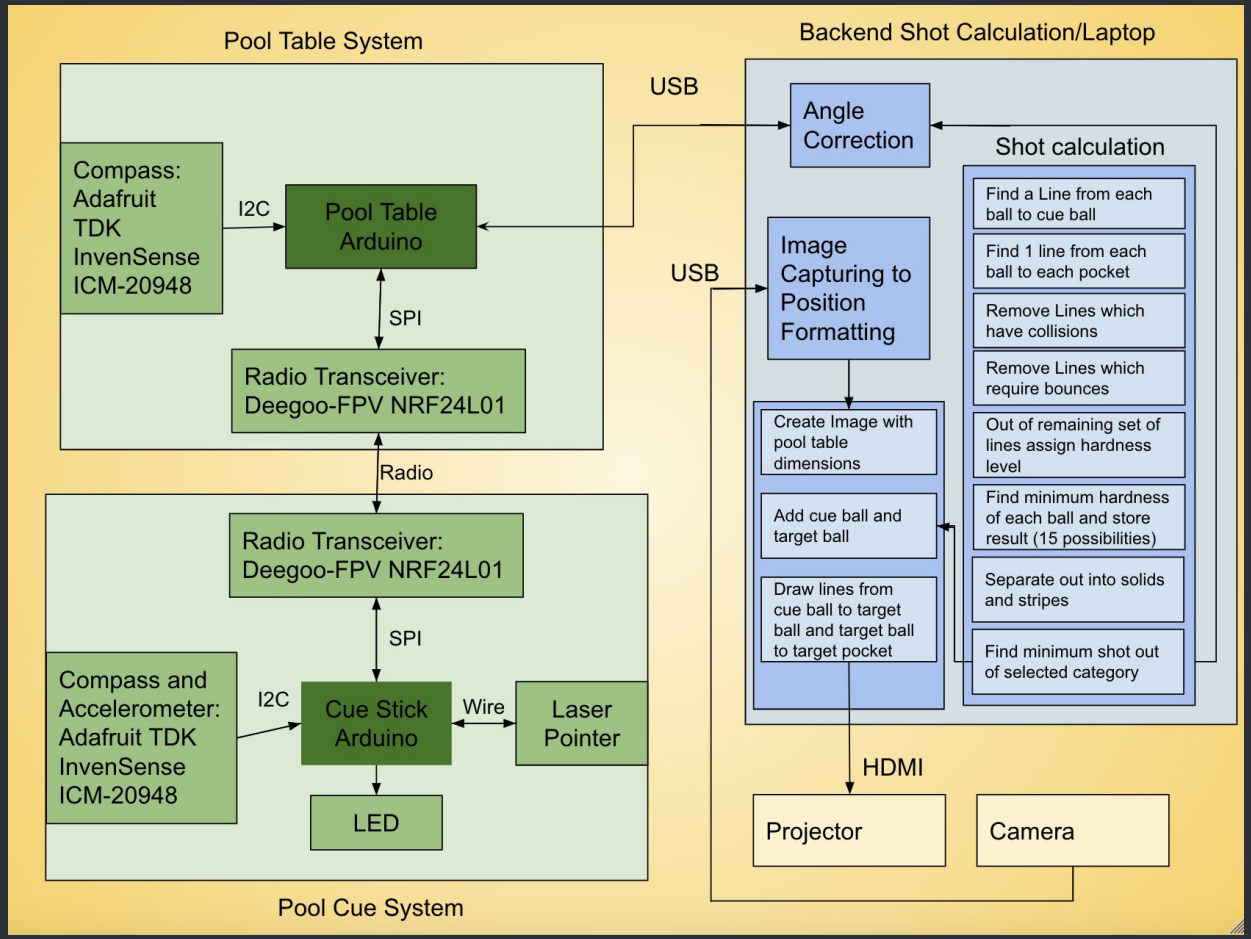
Components:

- Projector: Epson VS330
- 4 feet above the surface of the pool table.
- Create an Image on the Backend (the Laptop) with table dimensions intact, adding the cue ball and the target ball shortly after. Create 2 lines (one from cue to target ball, one from target ball to target pocket)
- Display Image on the a secondary screen (this is what the projector is hooked up to)

Solution Approach - Backend Shot Calculation

- After getting location of all objects in table, create lines from cue ball to each ball. (2 points using the line equation)
- Find the angle to hit the ball on for each pocket (using the tangent between the intersection of a line and a circle). Done for all pockets
- Remove sets of lines which require bounces/collisions from working set.
- Find the minimum angle deviation required for each ball after removing and call it “easiest shot”. Do this for all balls.
- Find minimum easiest shot and create an image based on the same.

Block Diagram



Implementation Plan

- Off the Shelf Purchases
  - Sensors on the Cue Stick, Camera and Projector
- Our design and development
  - Shot Calculation, Arduino Programs
- Assembling:
  - Communication between the sensors and the shot calculation
- Programs we are using
  - OpenCV to detect where the pool balls are

Testing and Verification

- Users take 9 shots with and without the system
  - We compare the results and see how much improvement was made when using the system
- What to measure?
  - Number of shots made
  - Angle off from the desired pocket
- Test after each new component is integrated

Validation

- A successful improvement would be if the user can make every shot when using the system
  - If they still miss, we hope for an improvement of at least five degrees
- If an element does not improve performance relative to the previous test, then we will analyze the possible reasons for why the performance did not improve

Work Distribution

- Jimmy does image capturing, image recognition, and communicating the ball positions with the shot calculation.
- Devank leads calculating the best shot, the angle of where the ball should aim and generating the projected image.
- Justin works on installing the sensors on the pool cue and communicating the angles of the pool cue to the back end.

Project Management

Name	Duration	Start	Finish
Pool Cue System	61 days?	**2/13/23 8:00 AM**	**5/8/23 5:00 PM**
Order/Receive Resources	5 days?	2/13/23 8:00 AM	2/17/23 5:00 PM
Setup Arduinos	10 days?	2/20/23 8:00 AM	3/3/23 5:00 PM
Compasses	8 days?	3/6/23 8:00 AM	3/15/23 5:00 PM
Accelerometer	5 days?	3/16/23 8:00 AM	3/22/23 5:00 PM
Laser	5 days?	3/23/23 8:00 AM	3/29/23 5:00 PM
Haptic Motor	5 days?	3/30/23 8:00 AM	4/5/23 5:00 PM
Verification	3 days?	4/6/23 8:00 AM	4/10/23 5:00 PM
Integration with Backend	10 days?	4/11/23 8:00 AM	4/24/23 5:00 PM
Testing	5 days?	4/25/23 8:00 AM	5/1/23 5:00 PM
Final Report/Buffer Time	5 days?	5/2/23 8:00 AM	5/8/23 5:00 PM
CV + Backend System	61 days?	**2/13/23 8:00 AM**	**5/8/23 5:00 PM**
Order/Receive Resources	3 days?	2/13/23 8:00 AM	2/15/23 5:00 PM
Frame Construction	6 days?	2/16/23 8:00 AM	2/23/23 5:00 PM
Image Capturing	1 day?	2/24/23 8:00 AM	2/24/23 5:00 PM
Align Camera to Frame	3 days?	2/27/23 8:00 AM	3/1/23 5:00 PM
Live Image to Board Positi	6 days?	3/2/23 8:00 AM	3/9/23 5:00 PM
Optimal Shot Calculation(P	4 days?	3/10/23 8:00 AM	3/15/23 5:00 PM
Spring Break	5 days?	3/16/23 8:00 AM	3/22/23 5:00 PM
Finish Optimal Shot	5 days?	3/23/23 8:00 AM	3/29/23 5:00 PM
Align Projector to Frame	3 days?	3/30/23 8:00 AM	4/3/23 5:00 PM
Project Optimal shot	5 days?	4/4/23 8:00 AM	4/10/23 5:00 PM
Integrate Pool Cue Angle C	10 days?	4/11/23 8:00 AM	4/24/23 5:00 PM
Testing	5 days?	4/25/23 8:00 AM	5/1/23 5:00 PM
Final Report/Buffer Time	5 days?	5/2/23 8:00 AM	5/8/23 5:00 PM