8 Ball Lifeguard

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Use Case

- This will be a learning device for people to improve at 8-ball
- Our design is different from previous designs as it incorporates sensors into the cue itself to help the user improve
- This project will involve both hardware and software

Use Case Requirements

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

Technical Challenges

- Smart Cue Stick
  - How to determine where the cue is relative to the table
- AR/CV System
  - How to determine where the balls are on the table
- Software Computation
  - How to determine which shot the user should make

Solution - Smart Cue Stick

Sensors on the cue stick:

- A compass to know the cue stick's direction
  - A matching compass on the table for relative values
- Accelerometer to know the speed of the cue stick when a shot is made
- Shock detection to detect when the cue hits a ball
- Laser to line up the shot with the cue ball
- Small haptic motor to vibrate when the angle of the stick with the cue ball is correct

Solution - AR System

Camera and Projection Components:

- Camera: Logitech C920 to capture game state
- Use 4 barcodes on the pool table to detect camera angle and adjust CV computation based on said angle
- Going to Feed Data to the computation on a Macbook Pro
- Post Computation, Data will be fed back to a projector to display the line from the cue ball to the target ball.

Solution - Software Computation

Shot Making Decisions:

- Certain Heuristics to decide which shot to make:
  - Distance (pocket, cue, ball), Angle of deflection, direct or bounced.
  - Give each property a value and calculate “quantitative” difficulty of a shot
- Chose easiest shot to do, amongst all the possible shots.

Adjusting for CV Angle:

- Use barcode to determine relative camera table-angle
- Use angle for adjustments for ball positions

Testing

- Line up 9 shots
- Compare the performance of users with and without the system
- Analyze how many more shots were made on average for users
- Analyze how close the shots were to going in

Verification

- Our CV/Projection system should take less than 5 seconds to compute and display the recommended shot
- Pool Cue should update direction in all 360˚ and detect any impact with the cue ball

Metrics

- Angle Delta from pocket with and without system assistance should be significant (>5°) for a non-optimal player
- End to End Latency should be less than 3 seconds.

Division of Labor

Jimmy does CV - OpenCV

Devank makes the projection/camera system and frame and shot computation.

Justin works on installing the sensors on the pool cue

Schedule

⊟Pool Cue System	61 days?	**2/6/23 8:00 AM**	**5/1/23 5:00 PM**	
Order/Receive Resources	5 days?	2/6/23 8:00 AM	2/10/23 5:00 PM	
Setup Arduinos	10 days?	2/13/23 8:00 AM	2/24/23 5:00 PM	2
Compasses	8 days?	2/27/23 8:00 AM	3/8/23 5:00 PM	3
Accelerometer	5 days?	3/9/23 8:00 AM	3/15/23 5:00 PM	4
Laser	5 days?	3/16/23 8:00 AM	3/22/23 5:00 PM	5
Haptic Motor	5 days?	3/23/23 8:00 AM	3/29/23 5:00 PM	6
Verification	3 days?	3/30/23 8:00 AM	4/3/23 5:00 PM	7
Integration with Backend	10 days?	4/4/23 8:00 AM	4/17/23 5:00 PM	8
Testing	5 days?	4/18/23 8:00 AM	4/24/23 5:00 PM	9
Final Report/Buffer Time	5 days?	4/25/23 8:00 AM	5/1/23 5:00 PM	10
⊟CV + Backend System	61 days?	**2/6/23 8:00 AM**	**5/1/23 5:00 PM**	
Order/Receive Resources	3 days?	2/6/23 8:00 AM	2/8/23 5:00 PM	
Frame Construction	6 days?	2/9/23 8:00 AM	2/16/23 5:00 PM	13
Image Capturing	1 day?	2/17/23 8:00 AM	2/17/23 5:00 PM	14
Align Camera to Frame	3 days?	2/20/23 8:00 AM	2/22/23 5:00 PM	15
Live Image to Board Positi	6 days?	2/23/23 8:00 AM	3/2/23 5:00 PM	16
Optimal Shot Calculation(P	4 days?	3/3/23 8:00 AM	3/8/23 5:00 PM	17
Spring Break	5 days?	3/9/23 8:00 AM	3/15/23 5:00 PM	18
Finish Optimal Shot	5 days?	3/16/23 8:00 AM	3/22/23 5:00 PM	19
Align Projector to Frame	3 days?	3/23/23 8:00 AM	3/27/23 5:00 PM	20
Project Optimal shot	5 days?	3/28/23 8:00 AM	4/3/23 5:00 PM	21
Integrate Pool Cue Angle C	10 days?	4/4/23 8:00 AM	4/17/23 5:00 PM	22
Testing	5 days?	4/18/23 8:00 AM	4/24/23 5:00 PM	23
Final Report/Buffer Time	5 days?	4/25/23 8:00 AM	5/1/23 5:00 PM	24