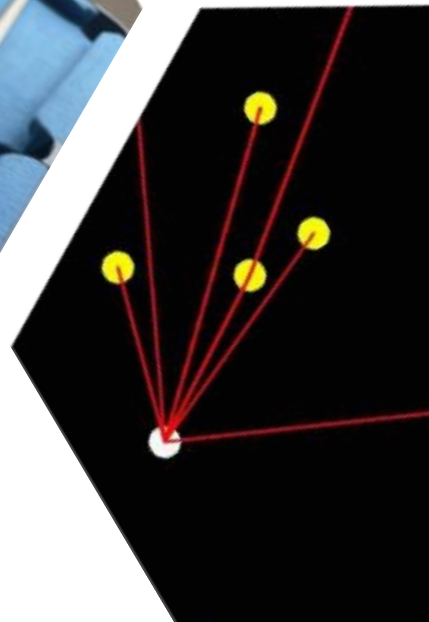


C7: 8-Ball Lifeguard

Devank Agarwal, Jimmy Ray, Justin Rager

Use-Case Requirements

#1 Given a random game state find the easiest shot to make for the player within 3 seconds.

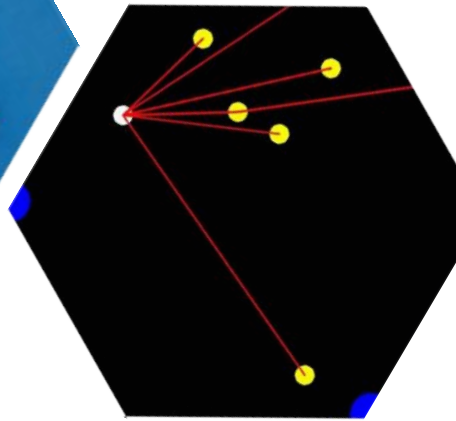
#2 Project an shot accurate to a 2 degree margin of error back onto the table

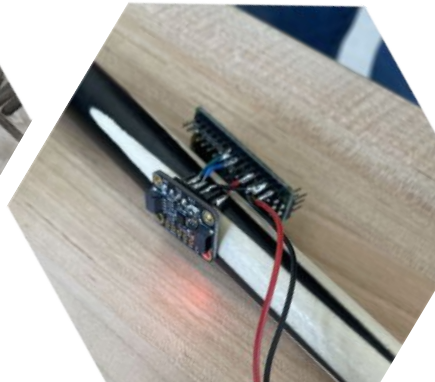
#3 Give the user post-shot feedback to improve player performance

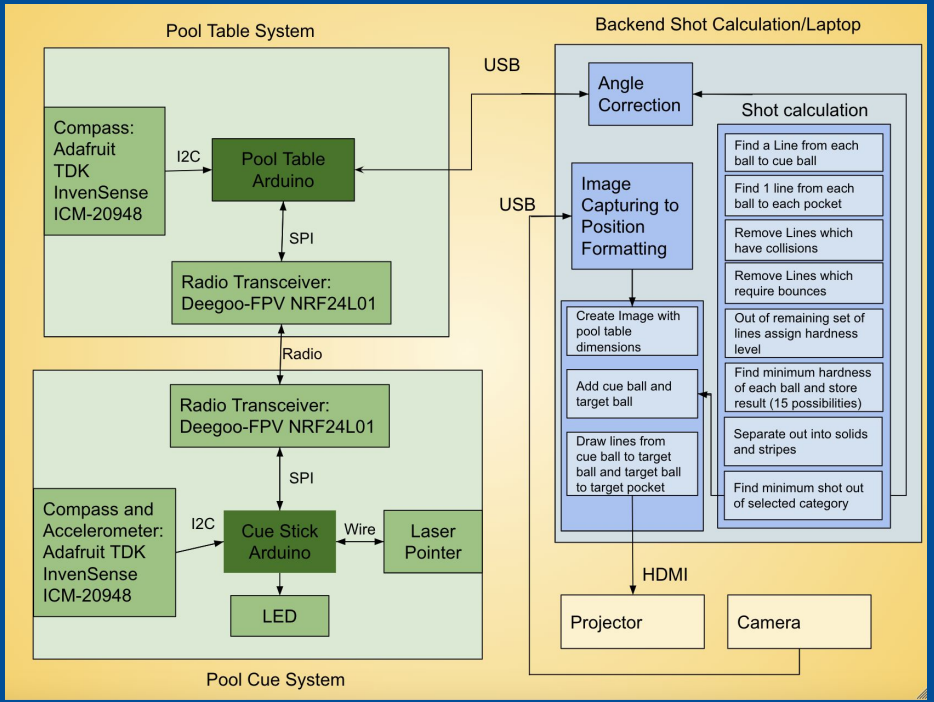
Solution Approach #1

Four Main Systems:

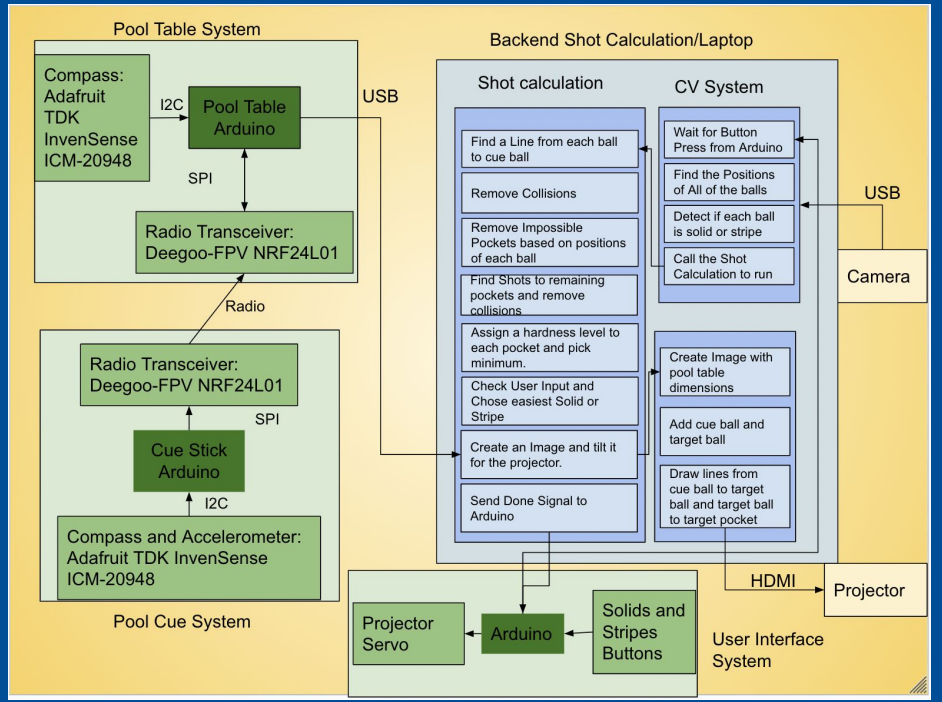
- CV System
  - Detects positions of balls on pool table
- Shot Calculation
  - Calculates best shot given the position
- Smart Cue System
  - Provides feedback to user on the previous shot
- Frame
  - Gives user Choice of Shot and handles control flow







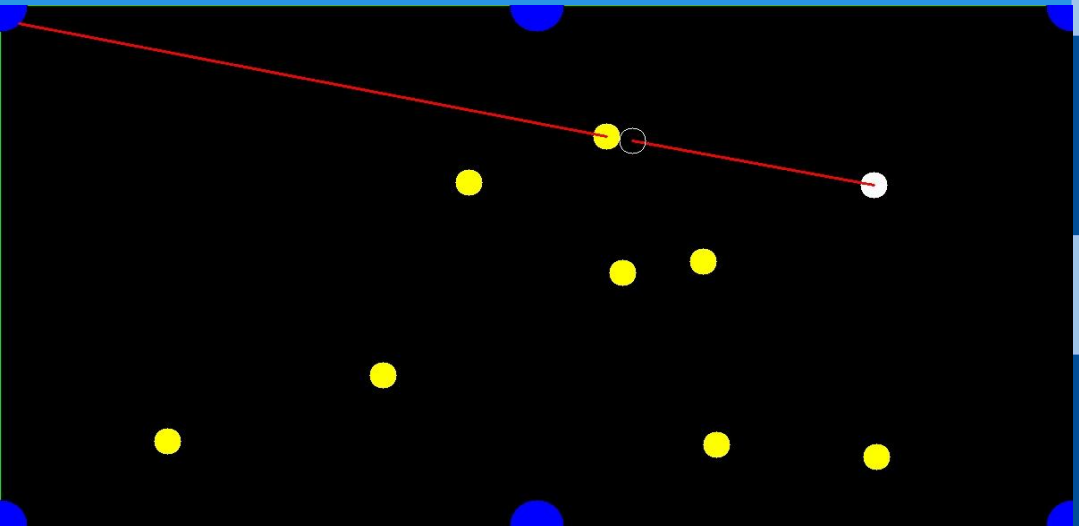
Old Block Diagram



New Block Diagram

Solution Approach #2

Complete Solution #1



#1

CV System:

- Detects Position of most of the Pool Balls
- Needs Ideal Lighting
- Trouble detecting balls when they are clumped together

#2

Shot Calculation:

- Finds and Selects Easiest Shot
- Only direct Shots
- Finds Exact Point of Contact
- Image Creation

#3

Projection System:

- Projects the Best Shot onto the Table
- Adjusts Image by 2˚ to have the projection aligned correctly

Complete Solution #2

```
OK
Gyro range set to: 2000 degrees/s
Accelerometer data rate divisor set to: 20
Accelerometer data rate (Hz) is approximately: 53.57
Gyro data rate divisor set to: 10
Gyro data rate (Hz) is approximately: 100.00
Magnetometer data rate set to: 100 Hz

diff = 0.00
calX = -5.11 calY = -5.26 calZ = 8.69
heading = 360.00
magX = 0.00 magY = 0.00 magZ = 0.00

diff = 1.48
X = 0.97 Y = 1.07 Z = 0.35
heading = 259.44
magX = -3.30 magY = -17.70 magZ = -13.35

diff = 3.44
X = 3.95 Y = -2.06 Z = -2.10
heading = 241.23
magX = -14.25 magY = -25.95 magZ = -18.75

diff = -1.42
X = 1.49 Y = 3.04 Z = 0.93
heading = 262.79
magX = -1.65 magY = -13.05 magZ = -4.20
```

#4

Feedback System:

- Sensors on the pool cue track its angle and acceleration
- Data is then sent to the laptop, which then is displayed using the projector

#5

Wooden Frame:

- Holds the camera and Projector at the correct height
- Provides Stability so the projection isn't moving around

#6

Electronic Frame:

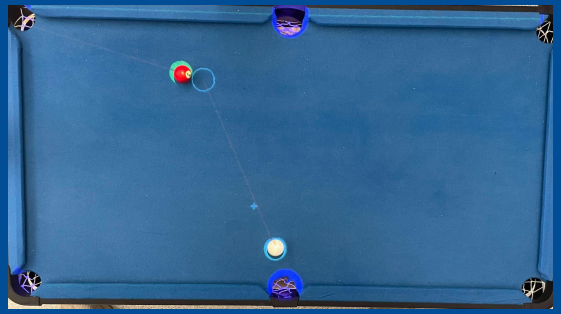
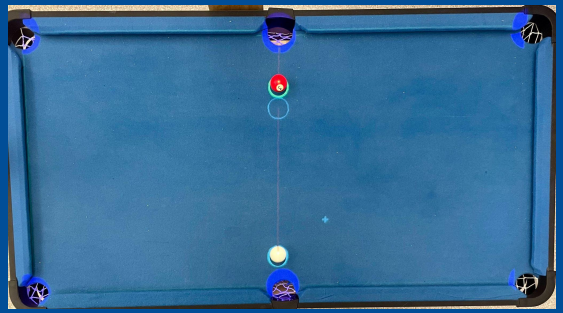
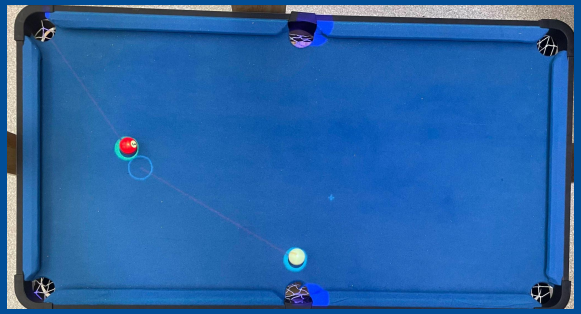
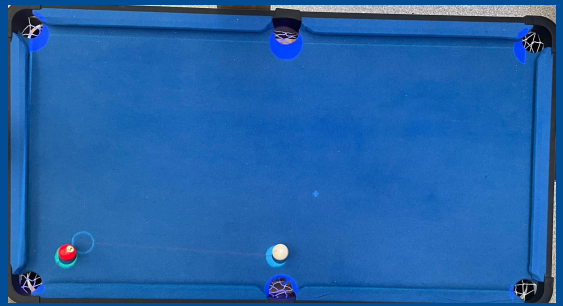
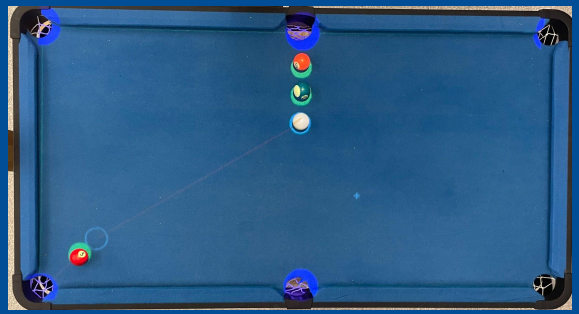
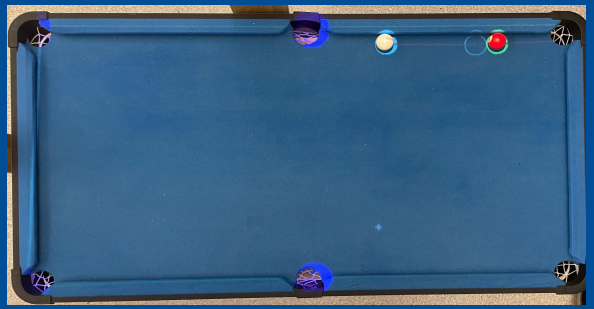
- Servo blocks Projection while CV is detecting
- Buttons inform system on if user is shooting solids or stripes

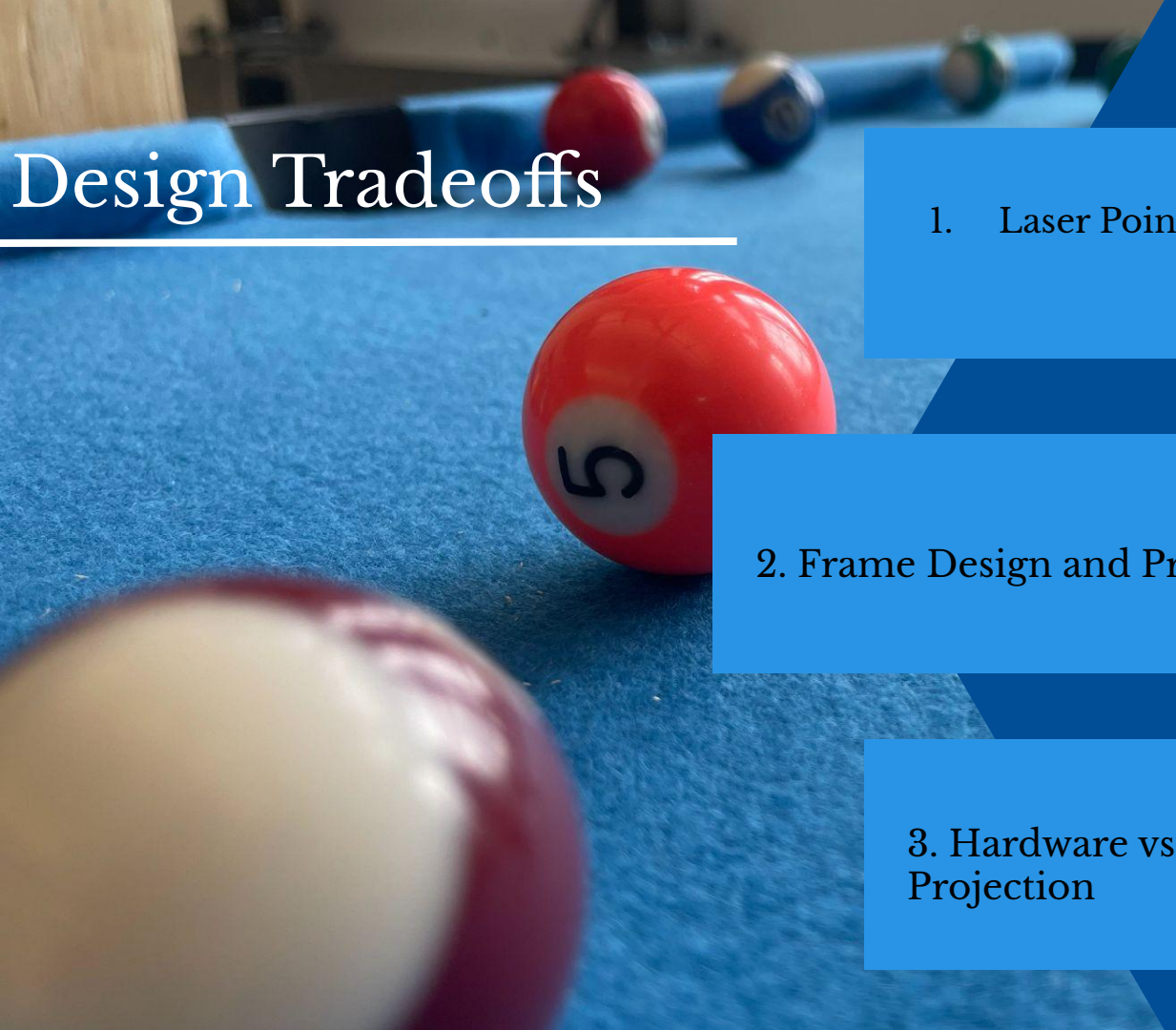
Video Demos

Testing and Verification #1

End to End Latency: Time from Button Press to Projection Pass = <3 seconds	**Angle Deviation:** Angle Deviation of Actual Shot vs Projected Shot Pass = <2 degrees	**Feedback Correctness:** Feedback Cue Stick Provides vs Actual fixes that is necessary Pass = <2 degrees and < 1/2m/s
Camera Capturing: (ideal lighting) Percentage of Pool table captured and amount of balls correctly captured Pass = 100%	**Camera Capturing: (non ideal lighting)** Percentage of Pool table captured and amount of balls correctly captured Pass = 100%	**Feedback Latency:** Time from shot to feedback onto the table. Pass = <1 second

User Test Suite



Design Tradeoffs

1. Laser Pointer vs Cue Stick Integrity

2. Frame Design and Projector Choice

3. Hardware vs Software Controlled for Projection

Performance Metrics

Projector feedback: Projected feedback reports angle within 2 degrees

End To End Latency: 1.5 seconds

User Improvement: Improvement on 7/9 user test case shots

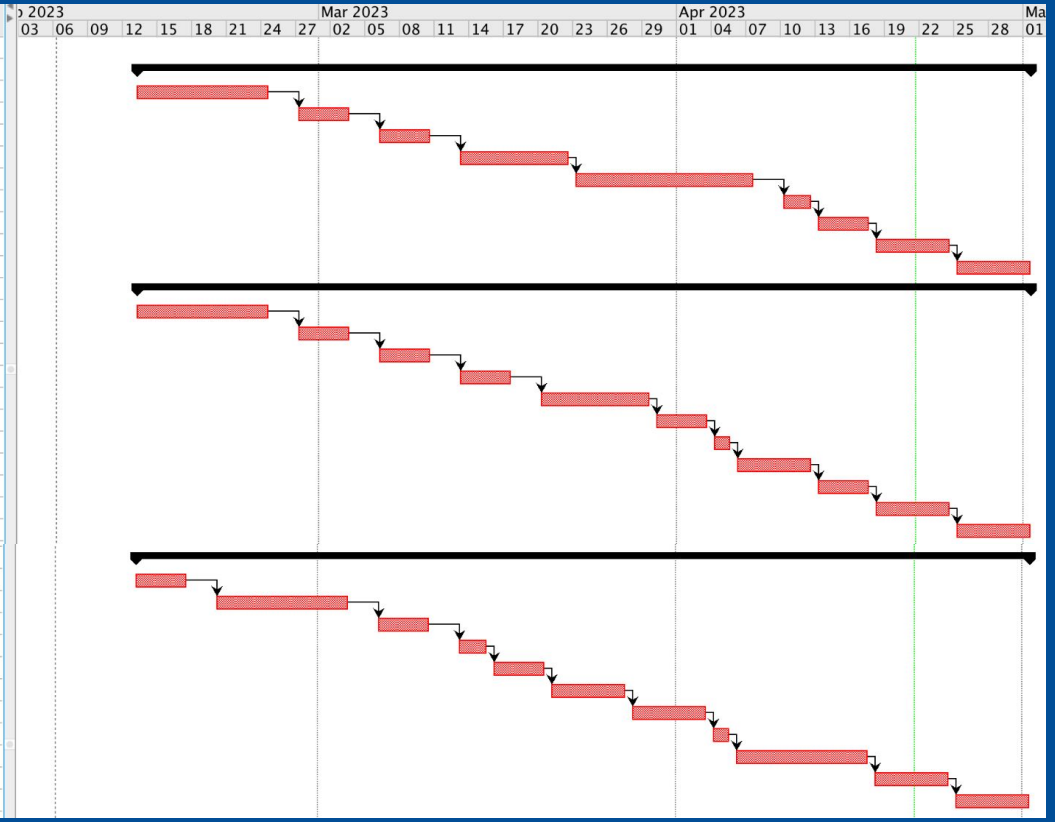
Camera Capturing: Ideal Lighting = 100%
Non-Ideal = 65%

Arduino Communication: Arduinos communicate to each in <0.5 seconds

Angle Deviation: Our angle deviation by 1 degree once aligned up

Project Management

Name	Duration	Start
Justin	56 days?	**2/13/23 8:00 AM**
Order/Receive Resources	10 days?	2/13/23 8:00 AM
Setup Arduinos	5 days?	2/27/23 8:00 AM
Spring Break	5 days?	3/6/23 8:00 AM
Accelerometer	8 days?	3/13/23 8:00 AM
Compasses	12 days?	3/23/23 8:00 AM
Verification	3 days?	4/10/23 8:00 AM
Integration with Backend	3 days?	4/13/23 8:00 AM
Testing	5 days?	4/18/23 8:00 AM
Final Report/Buffer Time	5 days?	4/25/23 8:00 AM
Devank	56 days?	**2/13/23 8:00 AM**
Order/Receive Resources	10 days?	2/13/23 8:00 AM
Frame Construction Pt 1	5 days?	2/27/23 8:00 AM
Optimal Shot Calculation P	5 days?	3/6/23 8:00 AM
Spring Break	5 days?	3/13/23 8:00 AM
Finish Optimal Shot	8 days?	3/20/23 8:00 AM
Frame Construction Pt 2	3 days?	3/30/23 8:00 AM
Integration with CV System	2 days?	4/4/23 8:00 AM
Optimal Shot Calculation P	5 days?	4/6/23 8:00 AM
Integrate Pool Cue Angle C	3 days?	4/13/23 8:00 AM
Testing	5 days?	4/18/23 8:00 AM
Final Report/Buffer Time	5 days?	4/25/23 8:00 AM
Jimmy	56 days?	**2/13/23 8:00 AM**
Order/Receive Resources	5 days?	2/13/23 8:00 AM
Research CV	10 days?	2/20/23 8:00 AM
Spring Break	5 days?	3/6/23 8:00 AM
Find Pool Balls In Image	3 days?	3/13/23 8:00 AM
Find Pool Balls in Live Video	3 days?	3/16/23 8:00 AM
Find Color of Balls in Image	5 days?	3/21/23 8:00 AM
Find Color of Balls in Video	5 days?	3/28/23 8:00 AM
Integrate with Shot Calculati	2 days?	4/4/23 8:00 AM
Improve Ball Detection in Liv	8 days?	4/6/23 8:00 AM
Testing	5 days?	4/18/23 8:00 AM
Final Report/Buffer Time	5 days?	4/25/23 8:00 AM



Conclusions

- Computer Vision with real-time projection is hard
- Fine tuning and thresholding is a never ending problem
- Integration with hardware always takes more time than expected.
- Leave Time for on the fly adjustments.