RevMetrix Milestone 2

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Presentation Overview

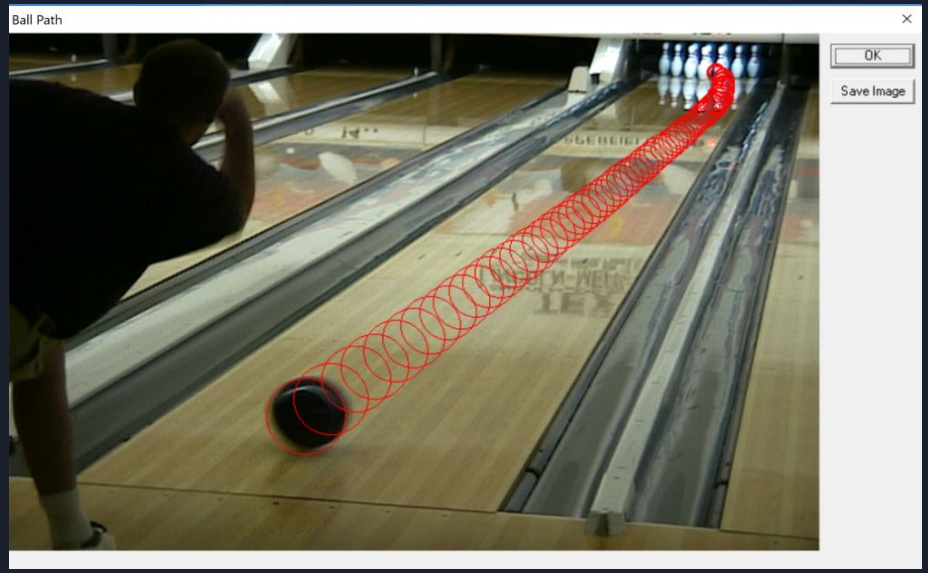
- Background
  - RevMetrix, SmartDot, Ciclopes, Ball Spinner
- Project Overview
- Tools & technologies
- Current Design
  - UMLs and schemas
- Current Implementations
- Demos
- Future implementations
- Conclusion

RevMetrix Background

- Brainchild of Professor Hake and Dr. Babcock
- Combination of Ciclopes and SmartDot Module
- Both compliment each other with supplemental data
- Application:
  - Bowlers
  - Researchers

What is Ciclopes

- Dr. Babcock's contribution
- External bowling analysis



Ciclopes - Bowler1

File Edit View Tools Camera Window Help

Bowler1

60'
45'
30'
15'

Personal Information

Name [ ]
Date [9/18/2023]
Center [ ]
Notes [ ]

Statistical Information

	Mean	Min	Max	Range
Initial Speed (mph)	16.78	16.62	17.03	0.42
Average Speed (mph)	15.66	15.37	15.90	0.54
Launch Angle (deg)	-2.15	-2.33	-2.03	0.30
Entry Angle (deg)	7.13	6.66	7.89	1.23
Loft Distance (ft)	2.44	1.03	4.43	3.40
Laydown Board	21.49	20.52	22.18	1.66
Arrow Board	15.71	15.05	16.19	1.14
Pindeck Board	17.26	16.88	17.56	0.69
Breakpoint Distance (ft)	42.34	41.91	42.82	0.91
Breakpoint Board	4.85	4.10	5.37	1.27
Shots	ALL			

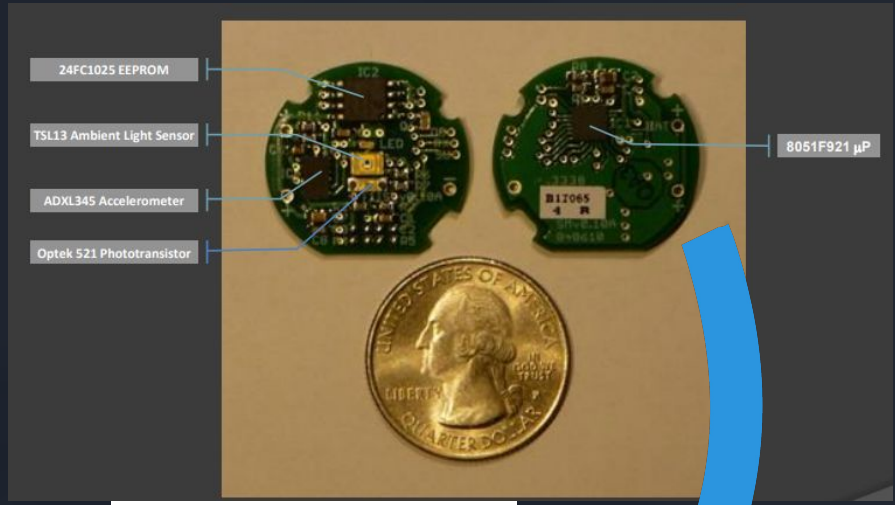
Shot Information

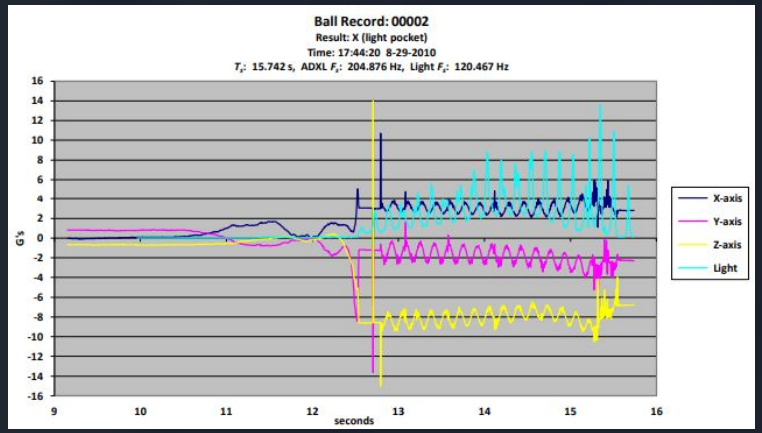
	Shot 1	Shot 2	Shot 3
Initial Speed (mph)	17.03	16.62	16.68
Average Speed (mph)	15.90	15.71	15.37
Launch Angle (deg)	-2.03	-2.09	-2.33
Entry Angle (deg)	6.66	6.83	7.89
Loft Distance (ft)	1.85	4.43	1.03
Laydown Board	21.79	20.52	22.18
Arrow Board	16.19	15.87	15.05
Pindeck Board	16.88	17.34	17.56
Breakpoint Distance (ft)	42.82	42.29	41.91
Breakpoint Board	5.37	5.10	4.10
Result	X	X	X

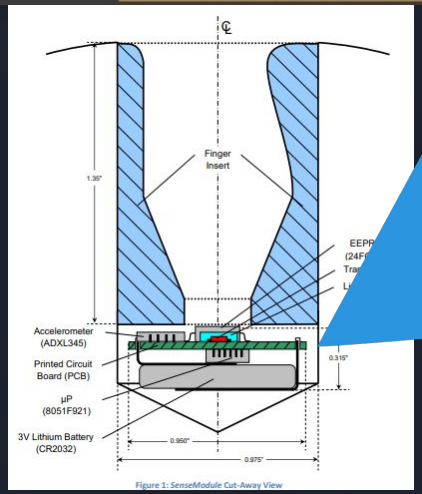
Ready

What is SmartDot

- Professor Hake's Brain-Child
- Light Sensor + Accelerometer

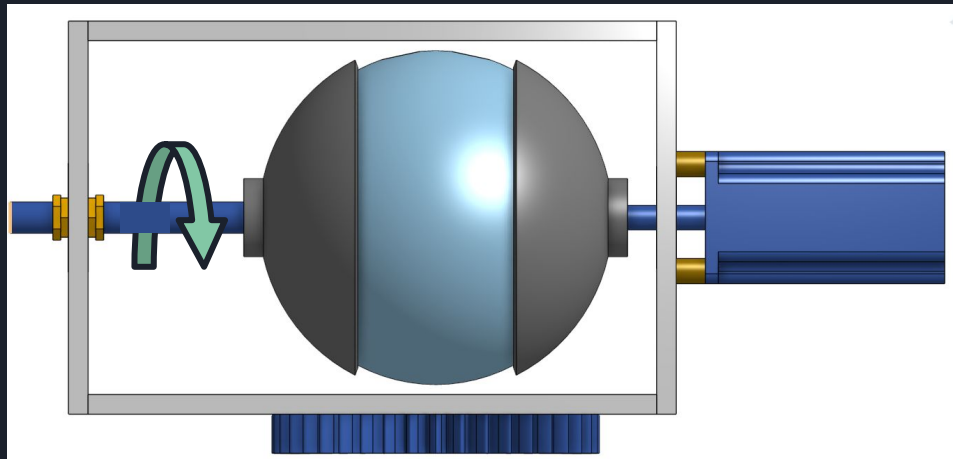






What is the Ball Spinner?

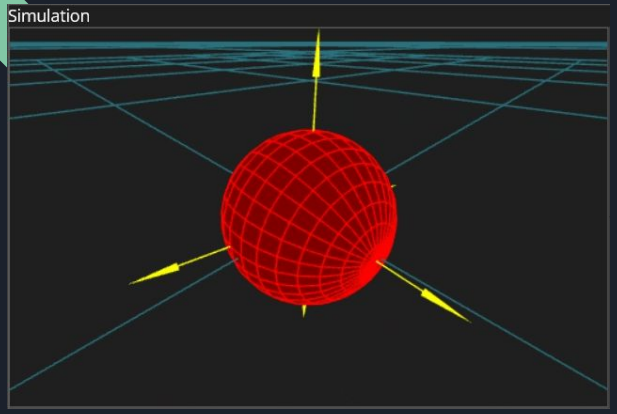
- Device that can emulate a throw down a lane
- Controls movement across 3 orthogonal axes of spin
- External sensors generate data

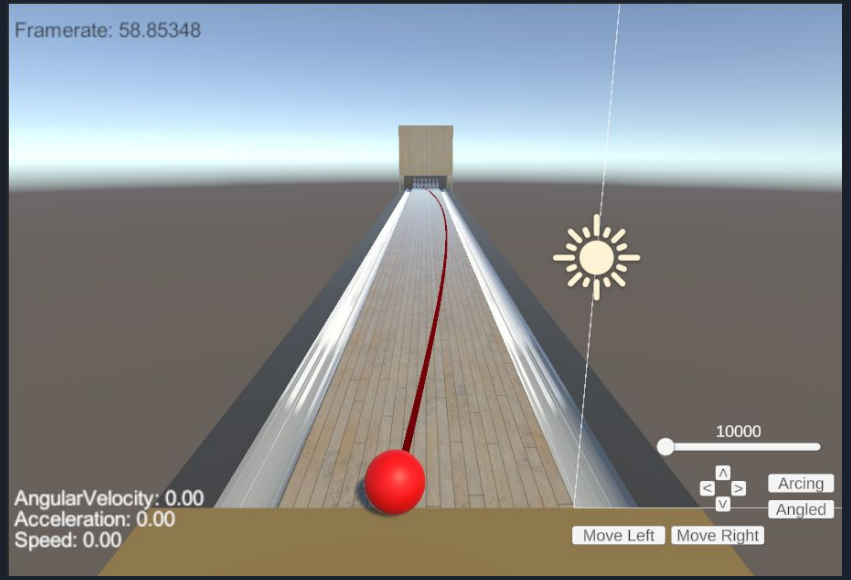


Questions?

Project Overview

Simulation

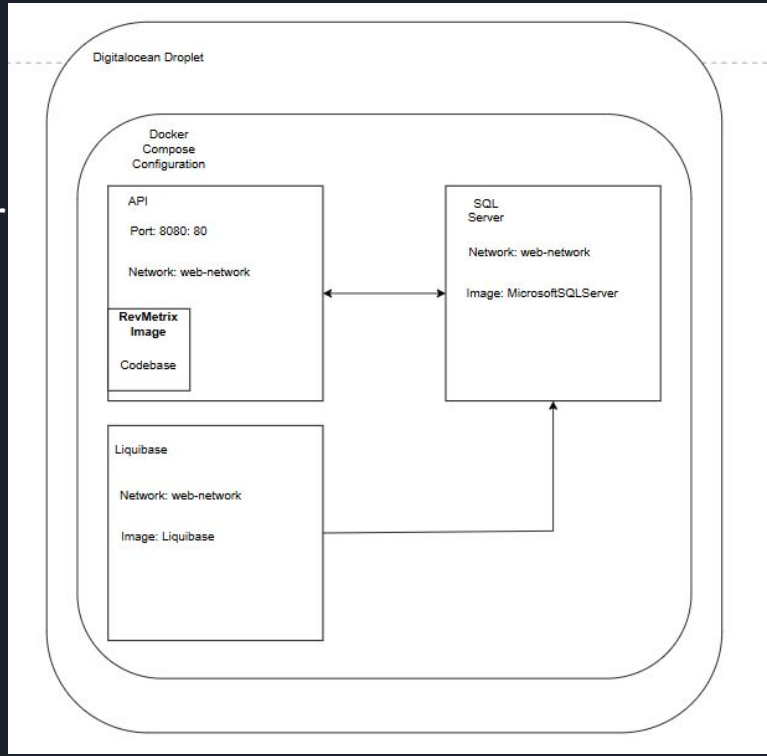




- Shows ball rotation
- Visualizes data through graphs
- Choice between real data from smartdot, and a simulated version of a possible shot
- Unity game with movable shot origin and a possible curve

BSA Backend/Cloud

- BSA:
  - Client-side API methods to interact with API server
  - Processing of incoming/outgoing data
- Cloud:
  - Server-side API methods
  - Administrative tasks for production server
    - CI/CD
    - Server infrastructure



BSA Frontend

- Interface between the User and further system
  - Cloud - save and load users, shots and arsenal
  - Controller - communicate data regarding the motors and handle SmartDot control
- Output of SmartDot sensor data

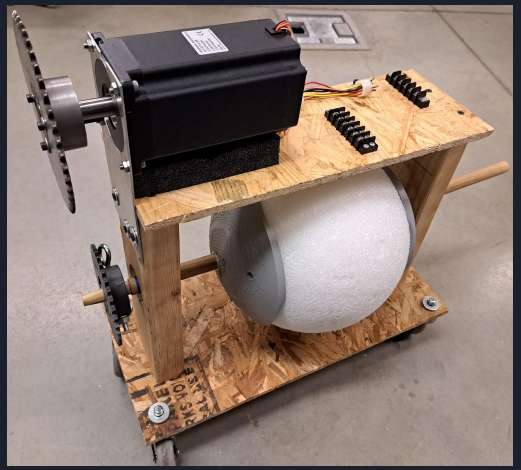
Ball Spinner Controller

- Connects to the BSA Frontend
- Receives commands from the BSA to control the motors at variable speed
- Connects to Metamotion module over Bluetooth Low Energy (BLE) and forwards data to the BSA
- Has a Human Machine Interface (HMI)
- Implements a TCP messaging protocol with the BSA

Include Raspberry Pi and python based device. Has GPIO to connect to multiple hardware devices.

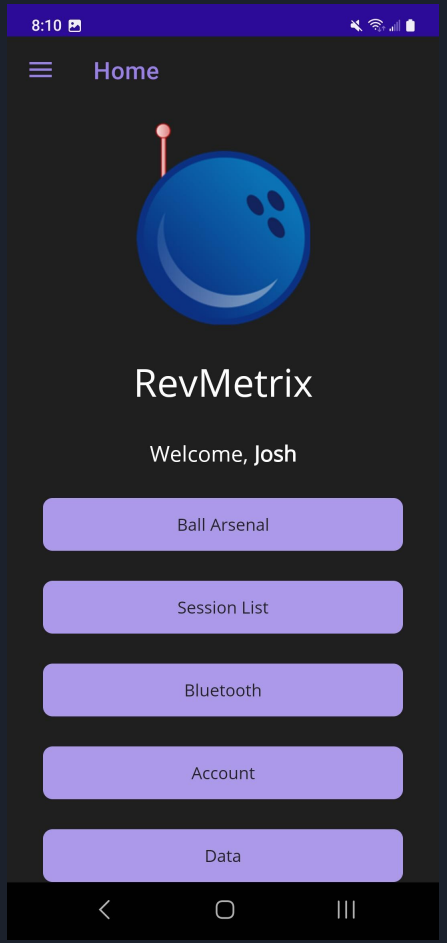
Ball Spinner Team

- Recreates the motion of a bowling ball rolling down a lane
- Motion will be split between 3 DoFs (Degrees of Freedom)
    - Each will be built on the system of the last.
- Will be used to test the accuracy of the SmartDot



Mobile Application Team

- Mobile app for the RevMetrix project
- Allows users to create an account
- Access personal ball arsenal
- View/Create events, sessions, and games



Questions?

Technologies Used

Application

- .NET, .NET MAUI
- OpenTK(Three.JS)
- Livecharts2(Chart.JS)
- xUnit

Cloud

- .NET
- xUnit
- Docker
- Digital Ocean
- Github Actions

Ball Spinner Controller

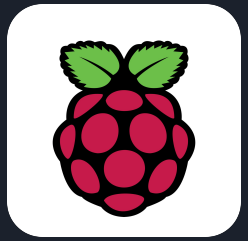
- Raspberry Pi
- KiCad
- Tkinter

Ball Spinner

- SolidWorks
- Onshape

Cellular

- .NET MAUI
- SQLite



Current Design

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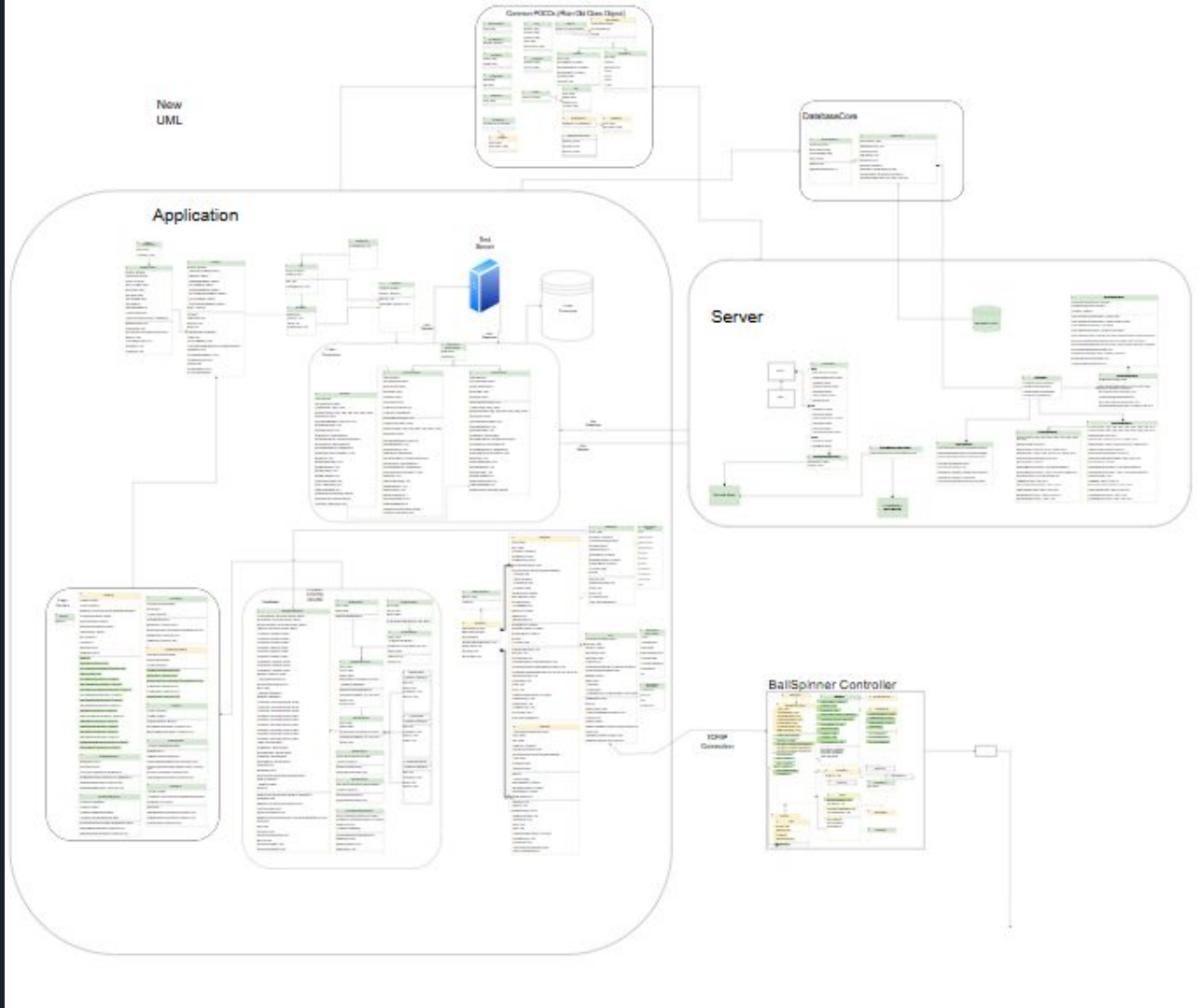
Not Yet Implemented



Current Database Schema BS

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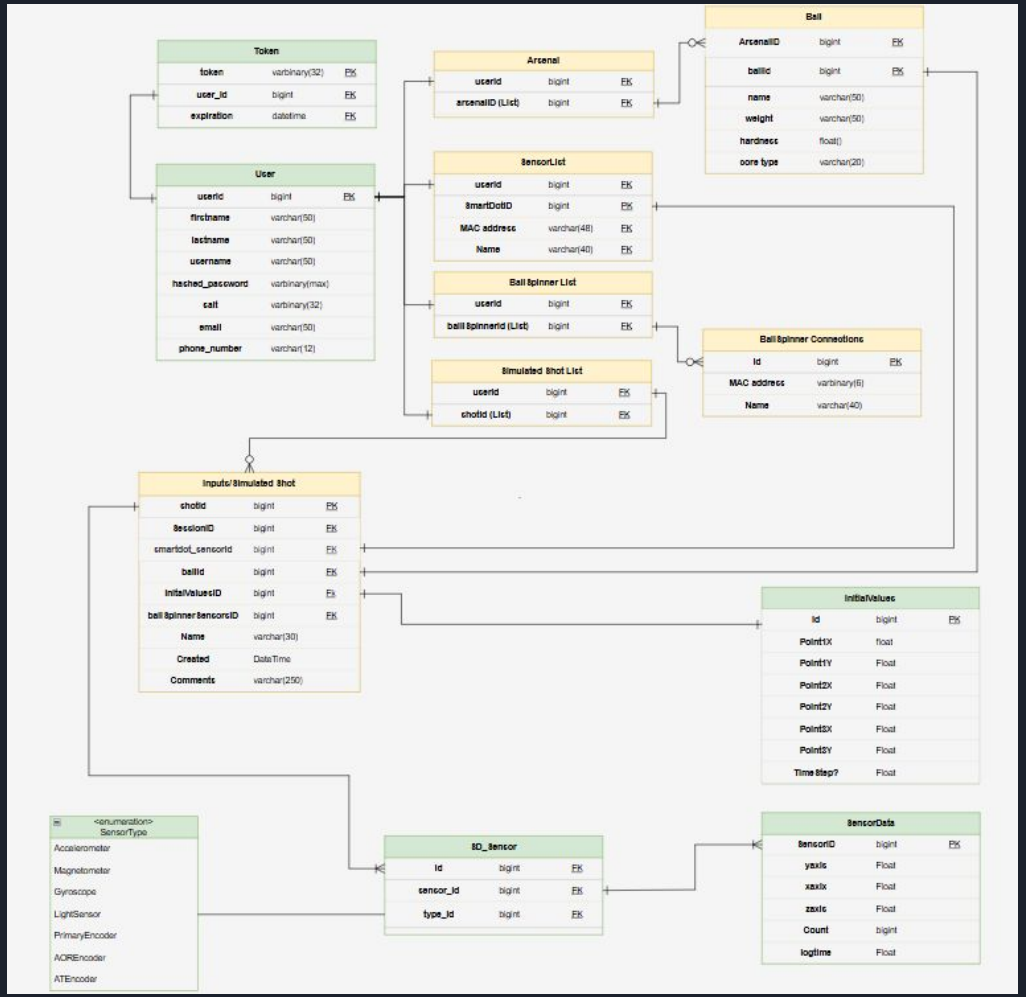
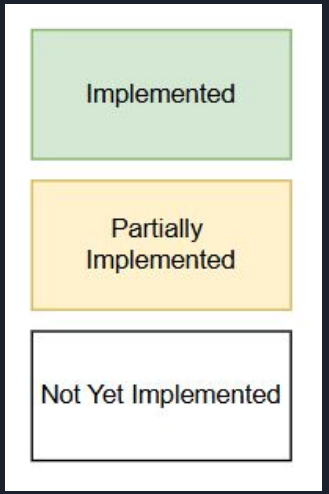
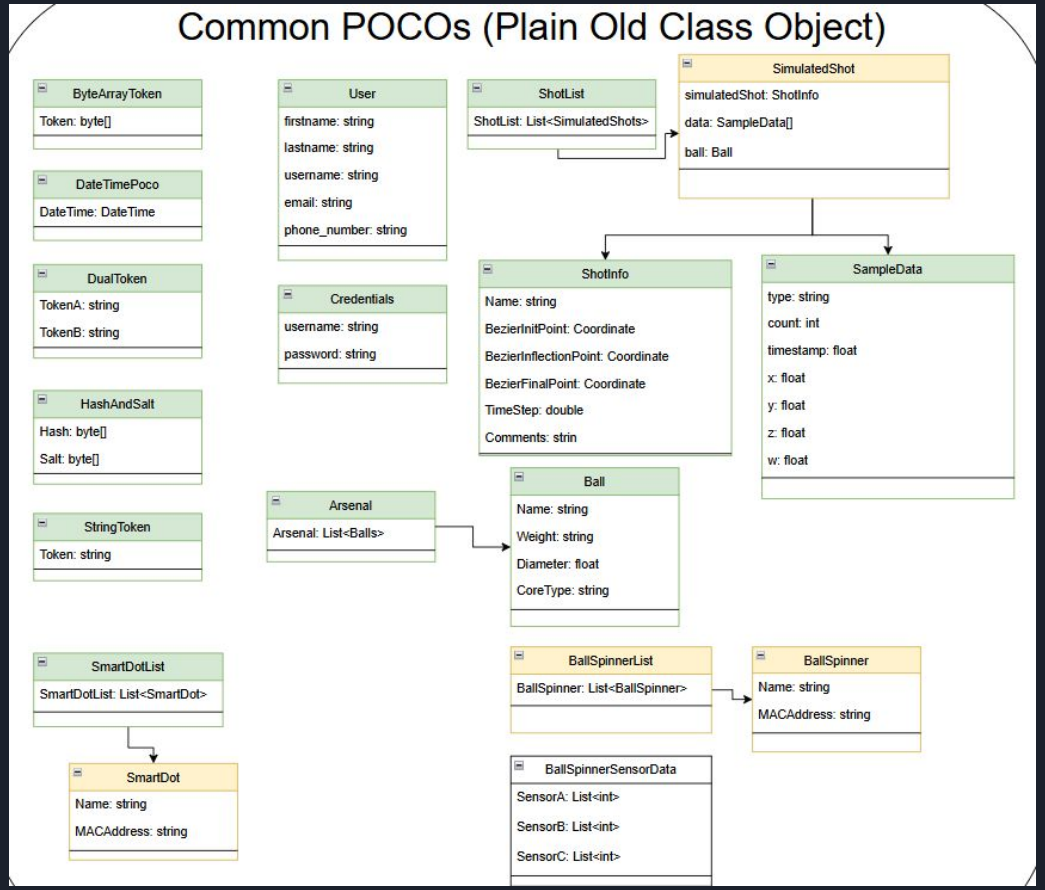


Current Design

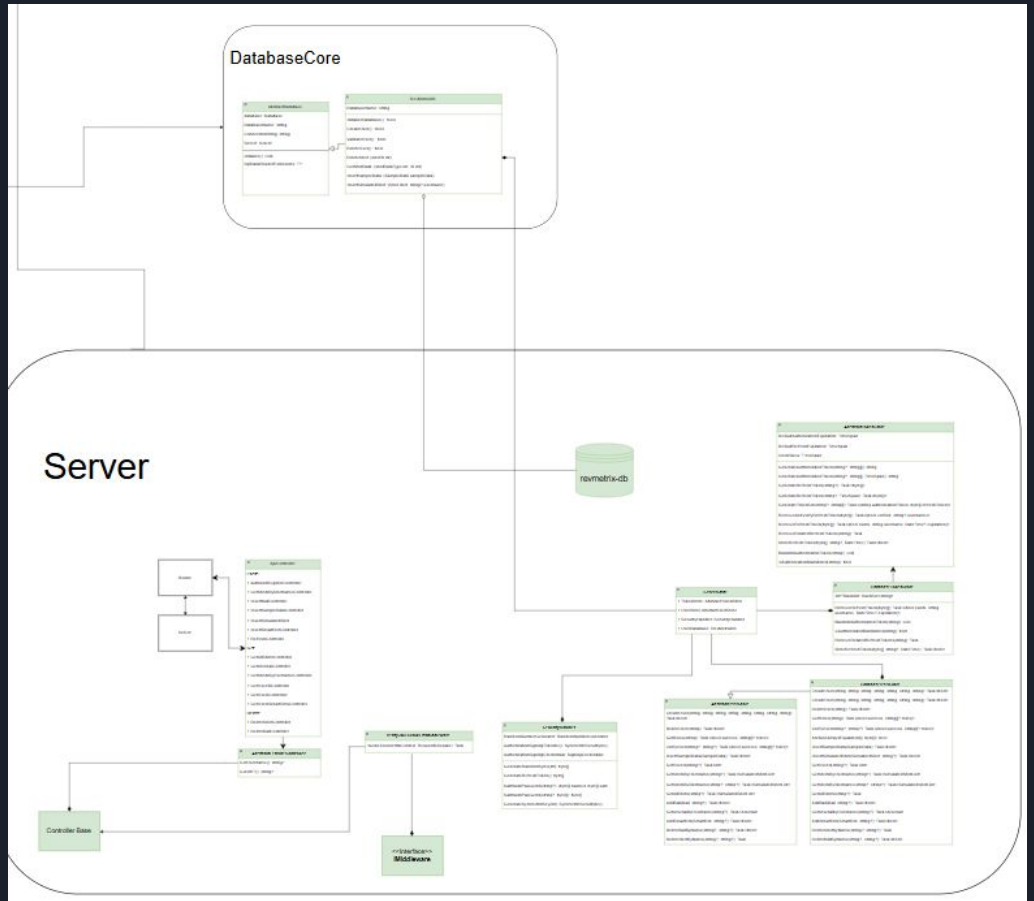
POCOs





Current Design

Cloud



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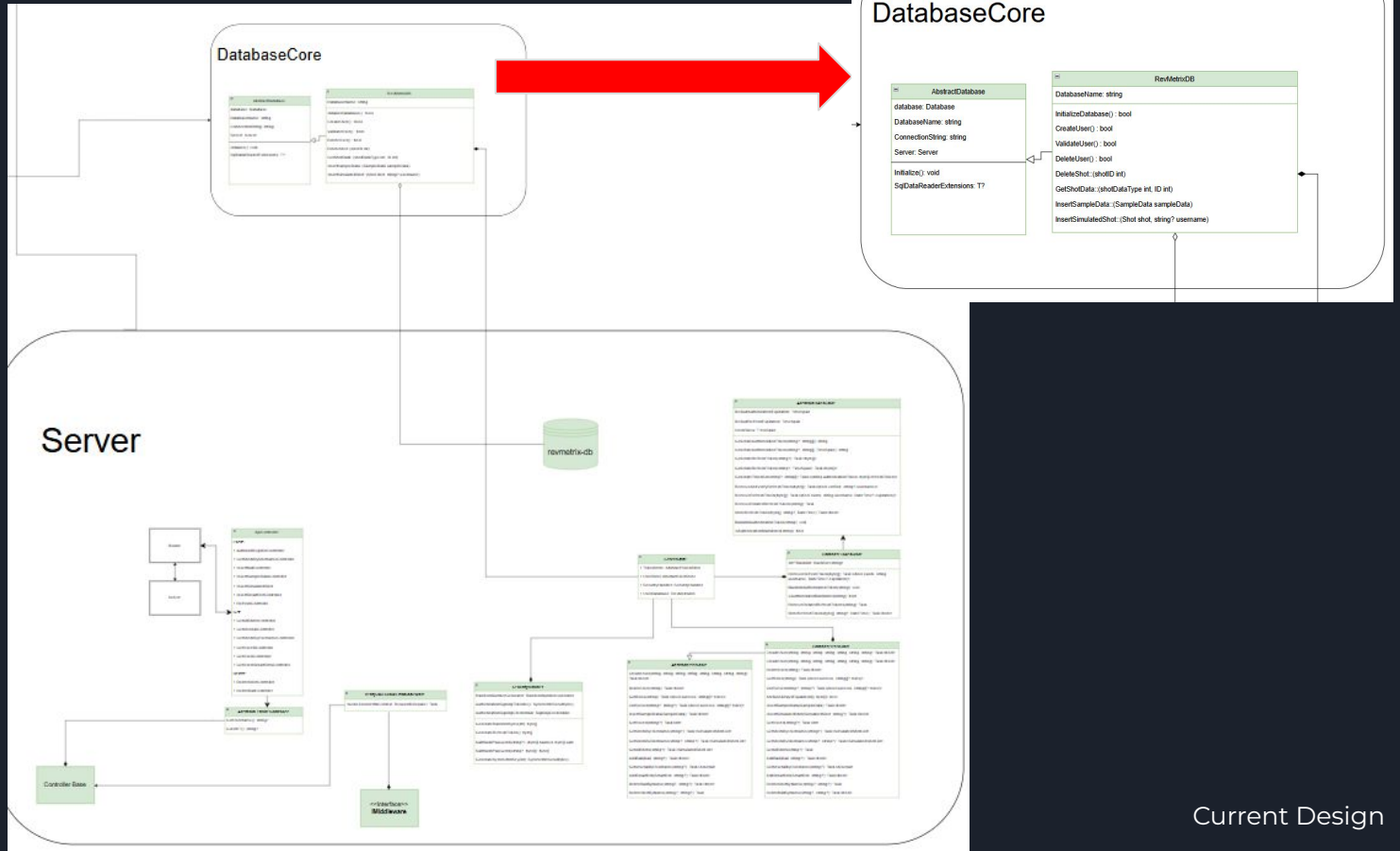
Current Design

Cloud



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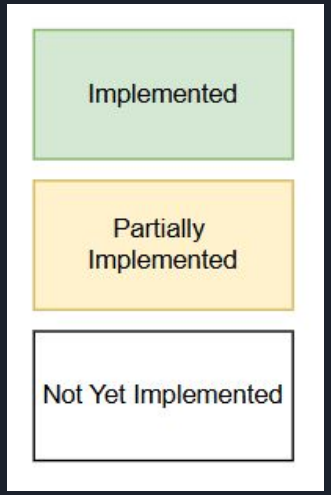
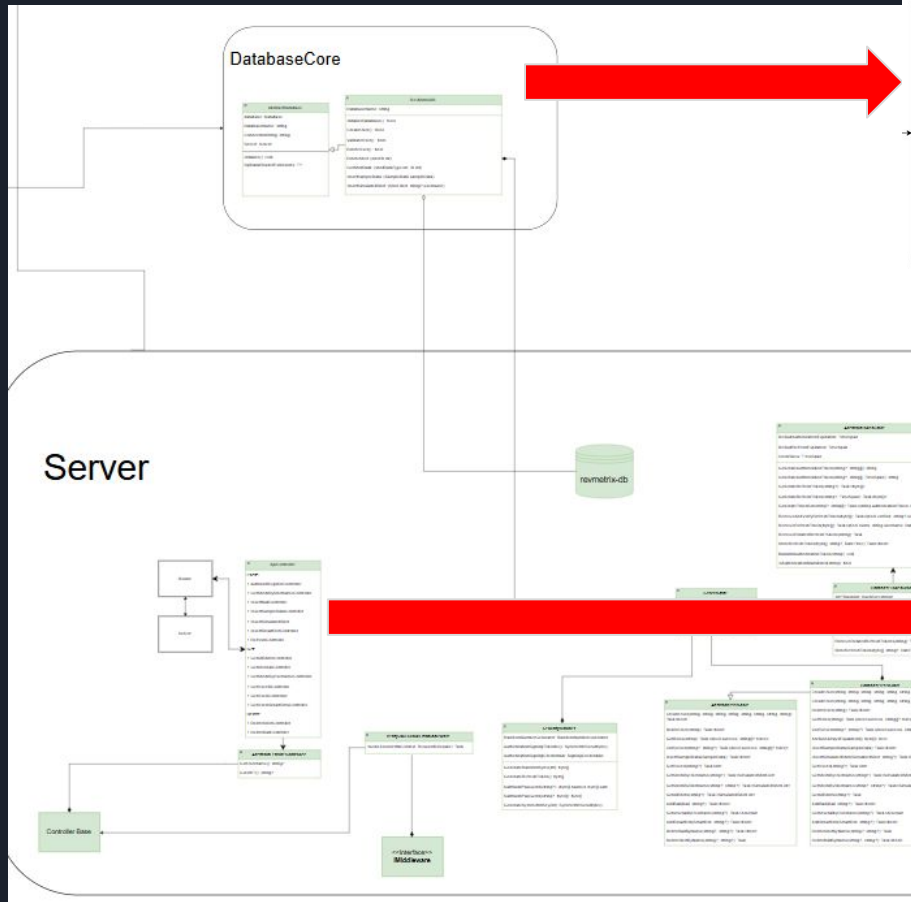
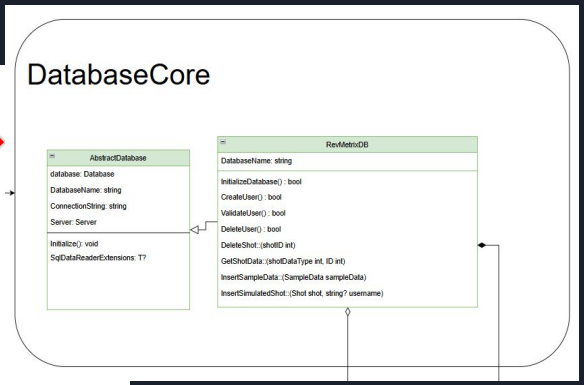
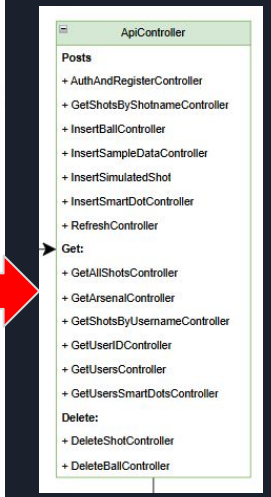
Current Design

Cloud



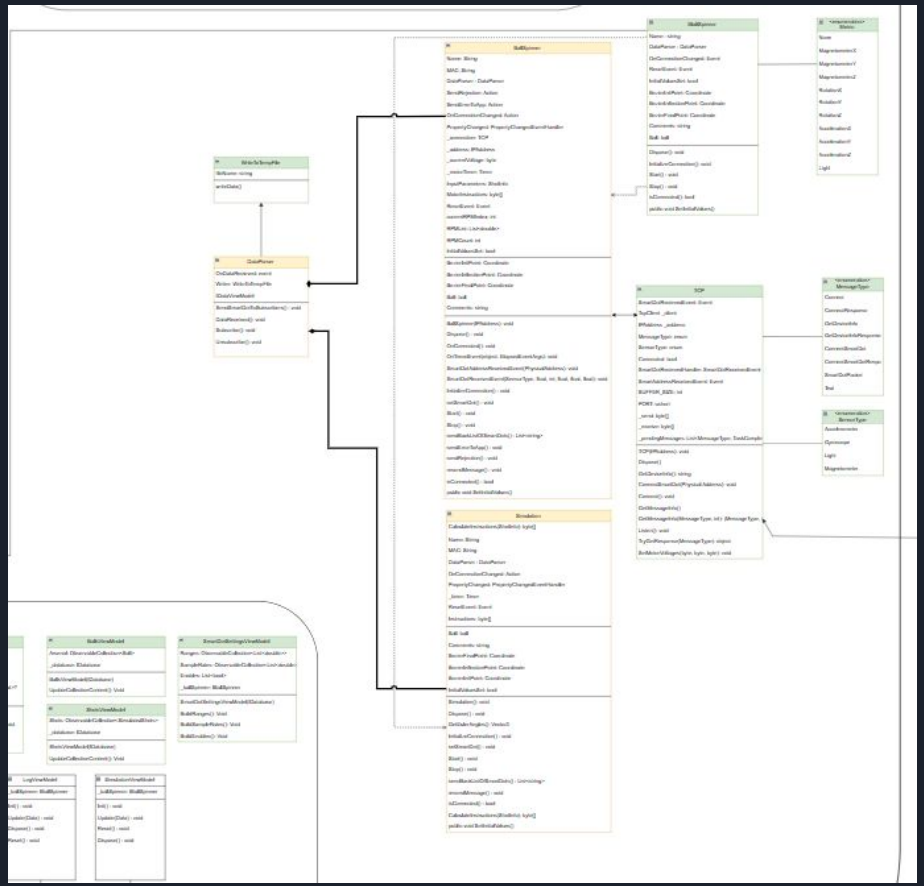






Current Design

BSA Backend



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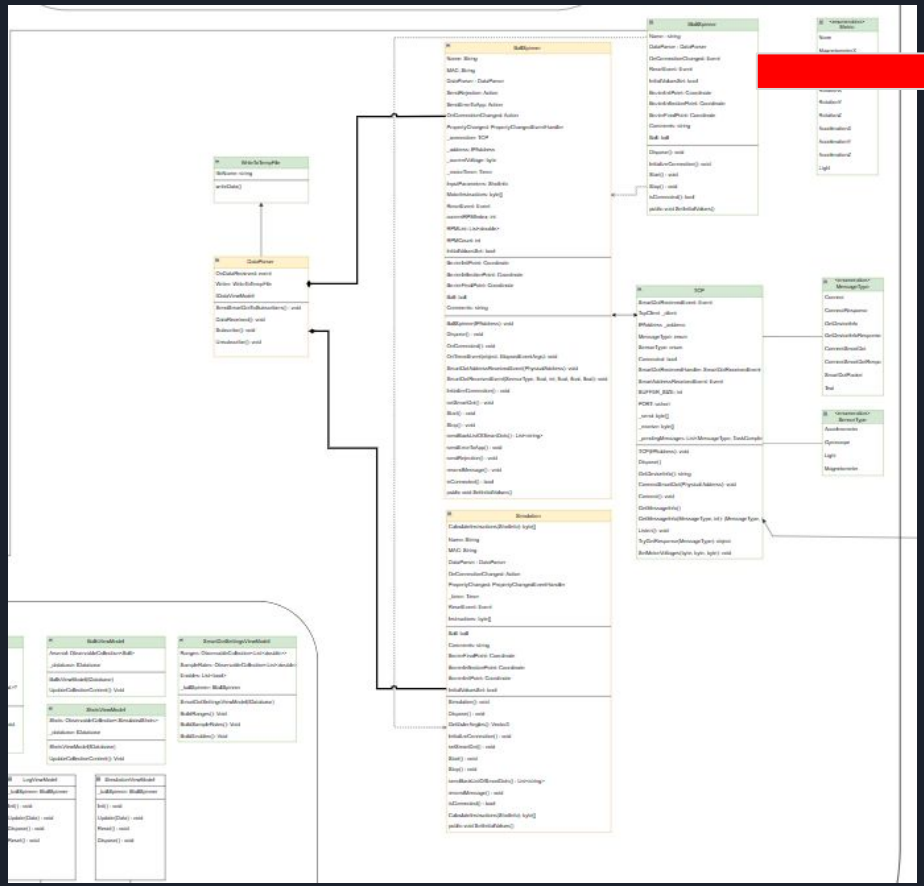

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IBallSpinner

Name : string

DataParser : DataParser

OnConnectionChanged: Event

ResetEvent: Event

InitialValuesSet: bool

BezierInitPoint: Coordinate

BezierInflectionPoint: Coordinate

BezierFinalPoint: Coordinate

Comments: string

Ball: ball

Dispose(): void

InitializeConnection(): void

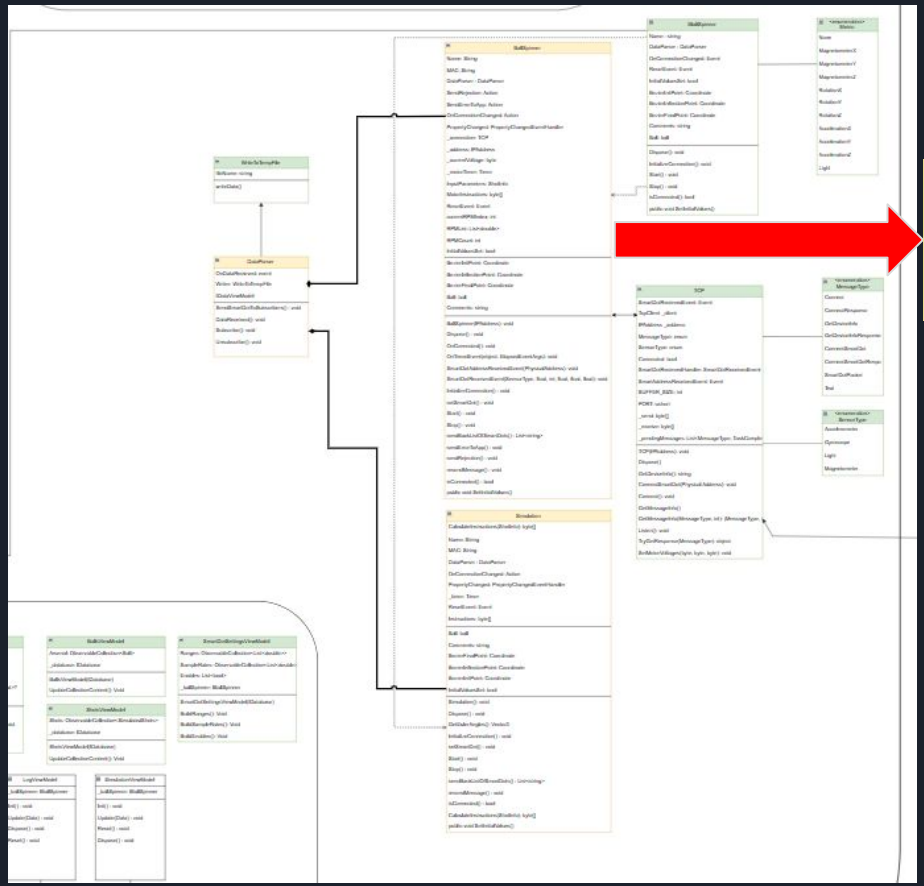
Start() : void

Stop() : void

isConnected(): bool

public void SetInitialValues()

BSA Backend



currentRPMIndex: int

RPMList: List<double>

RPMCount: int

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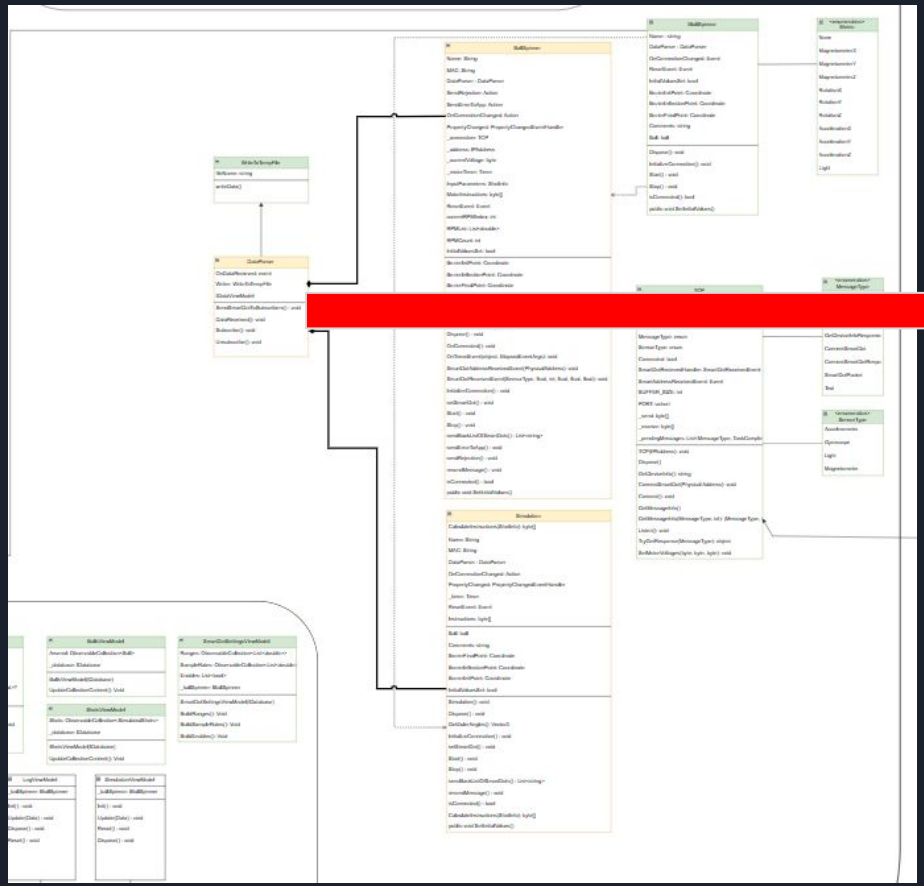
BSA Backend



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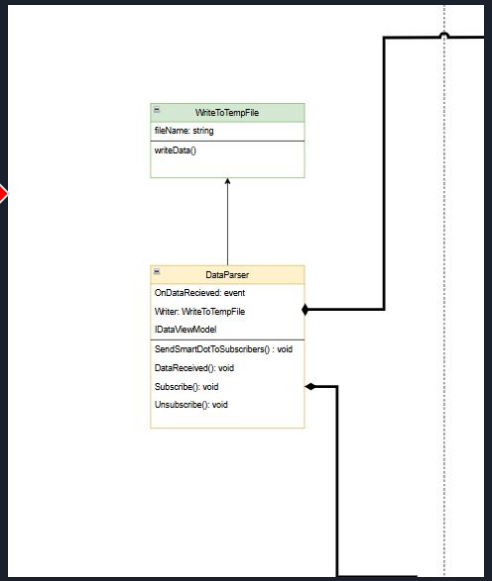

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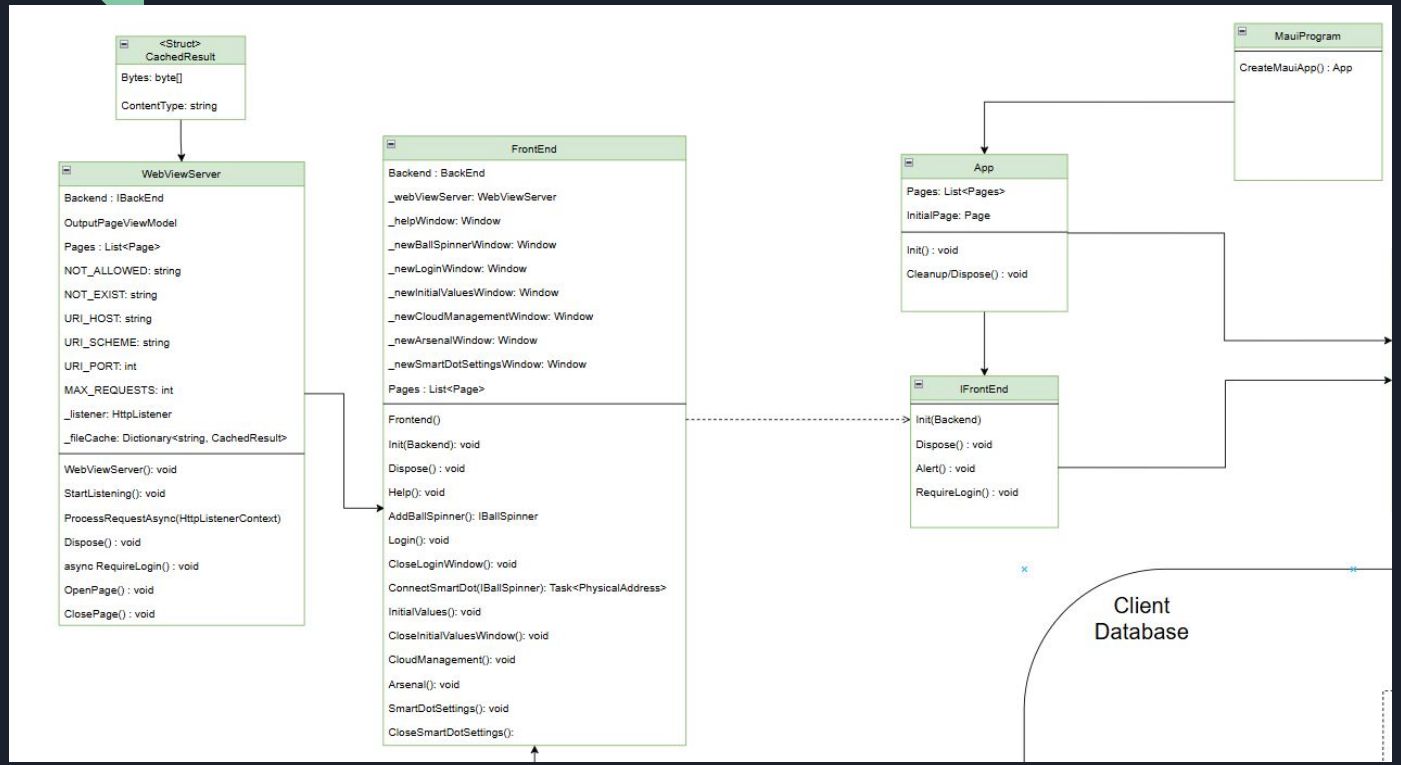

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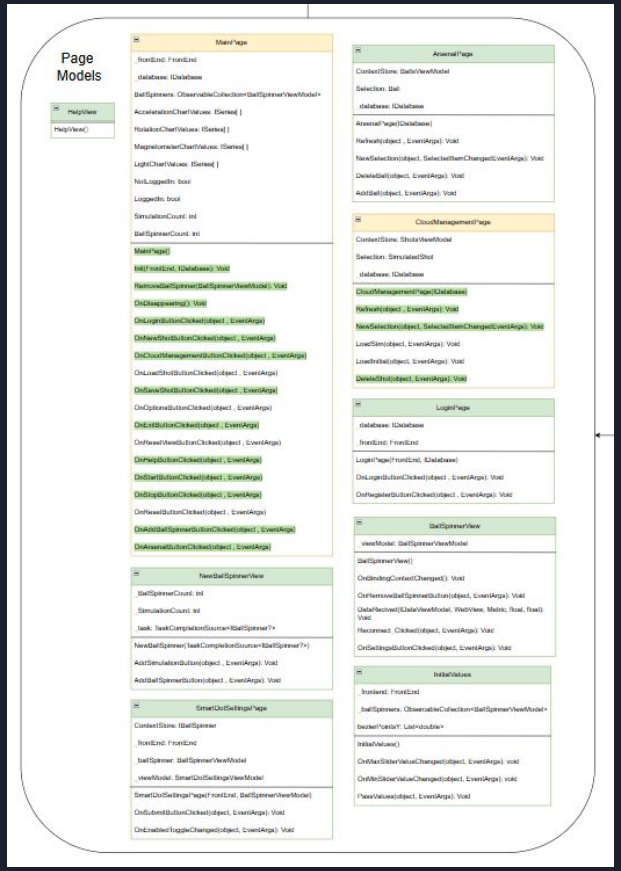

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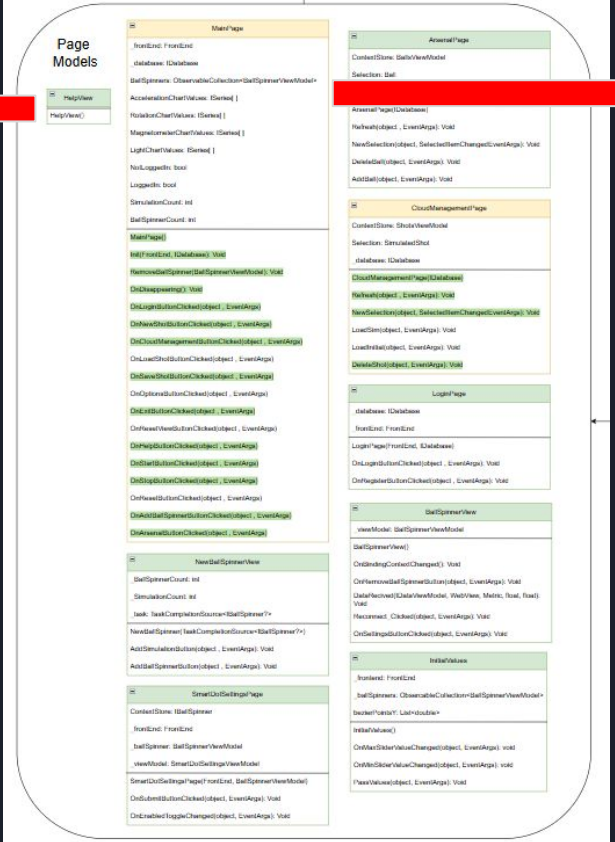
BSA Frontend

HelpView

HelpView()

Page Models



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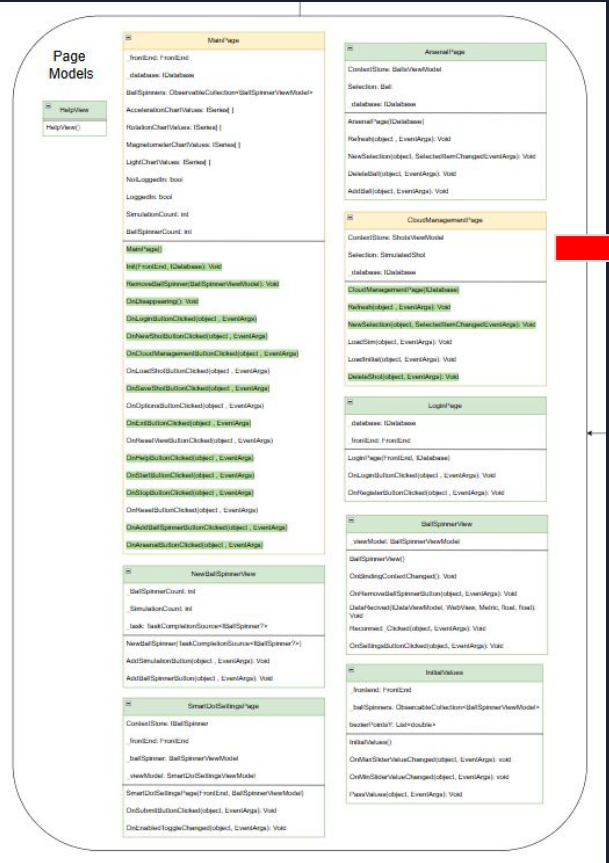

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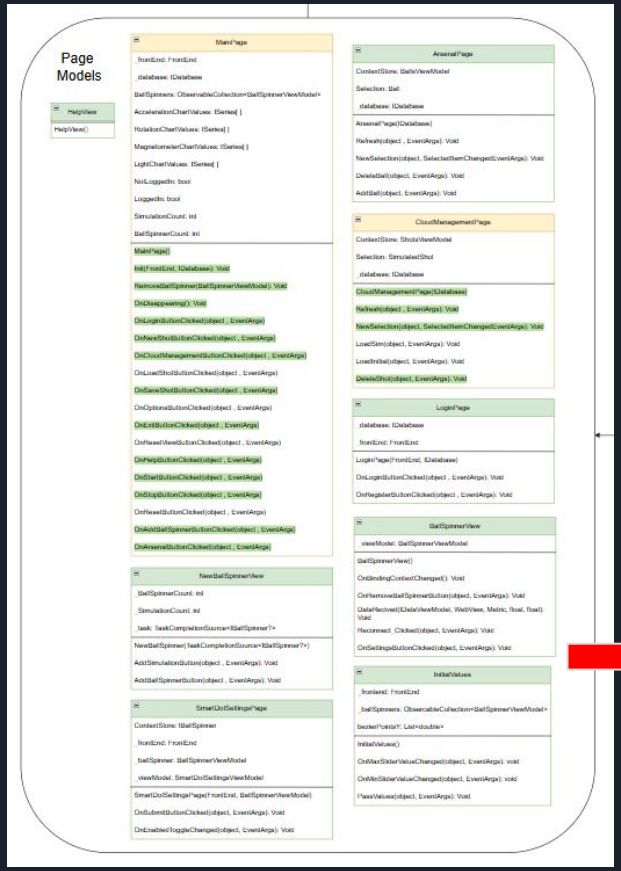

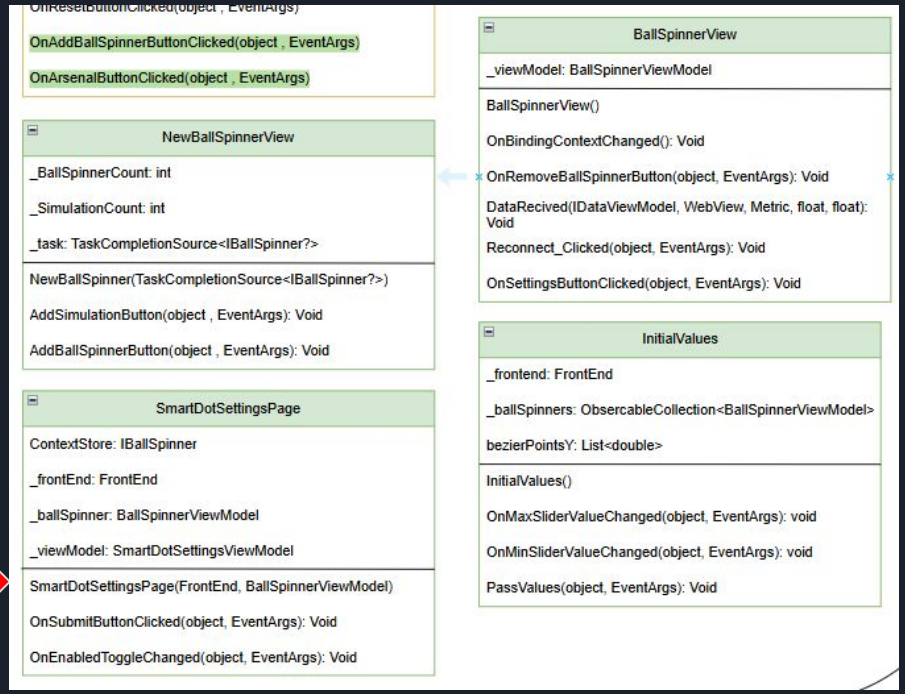

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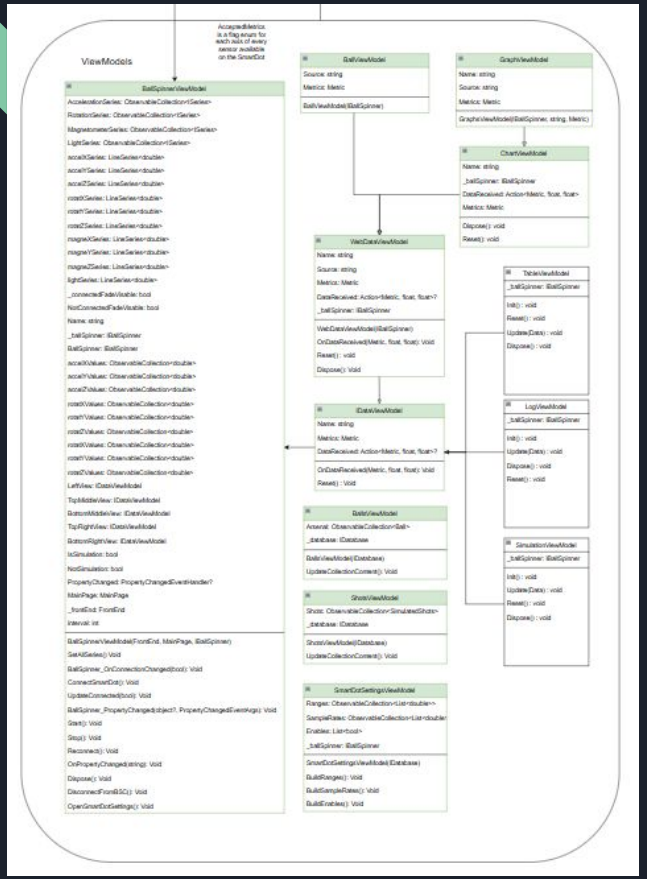

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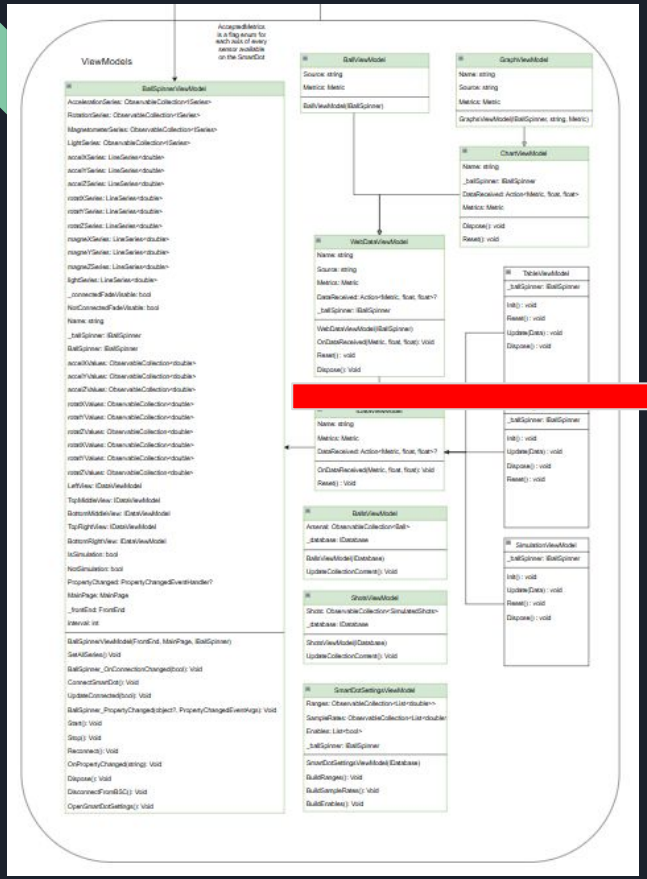

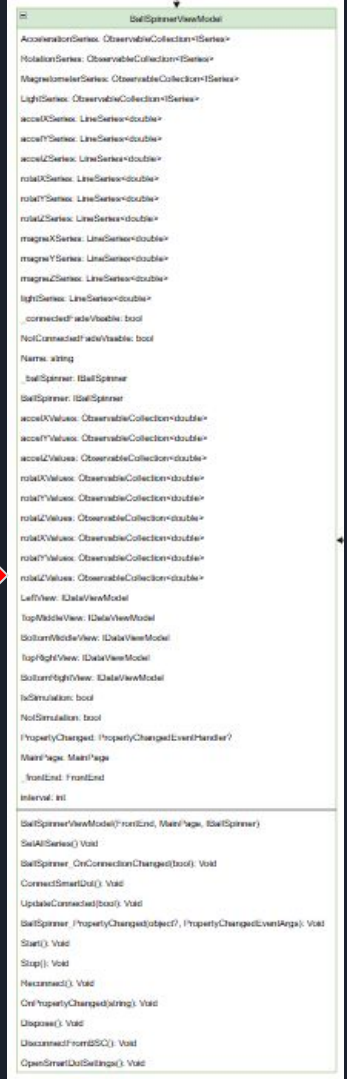

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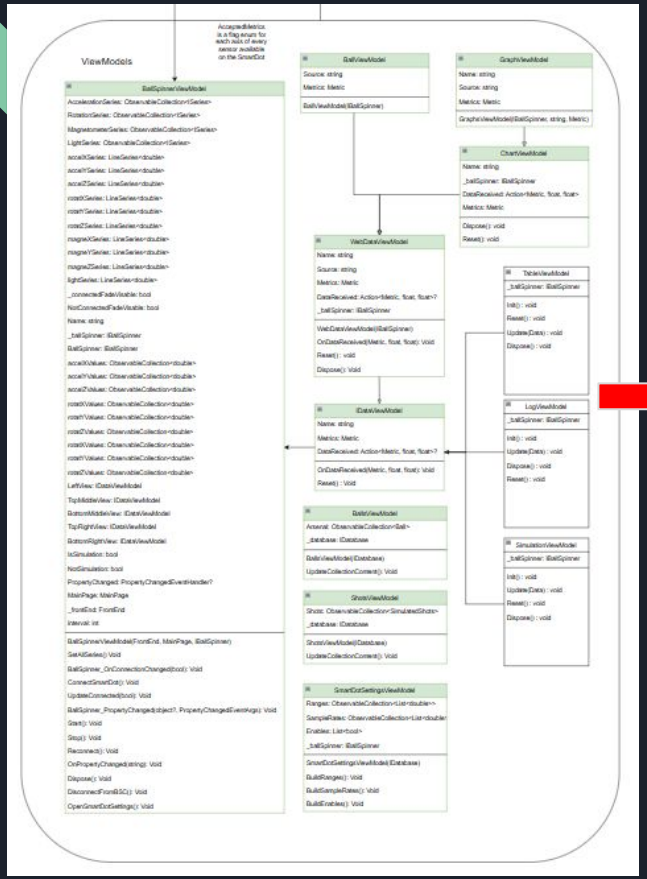

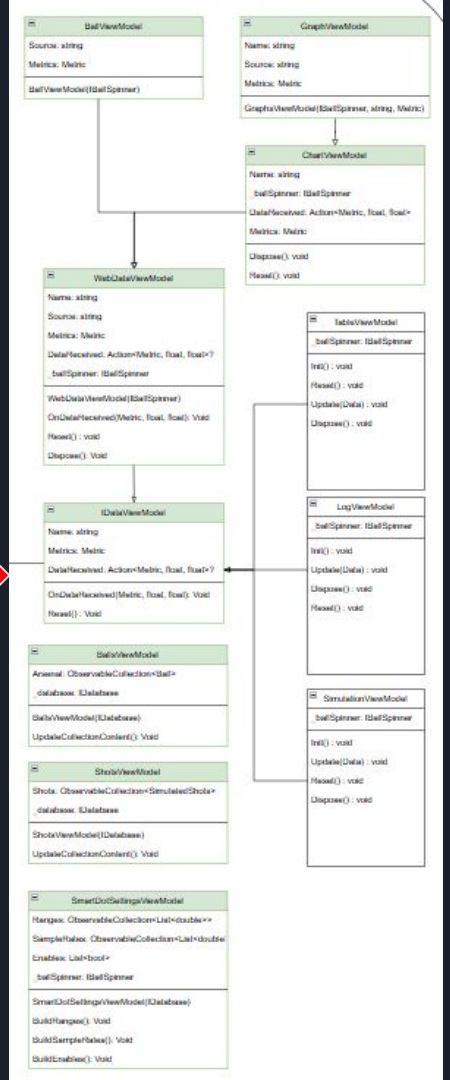

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Protocol

1. Setup Connection Messages

a) A_B_INIT_HANDSHAKE: previously (APP_INIT)

Msg Type (0x01)	Msg Size (0x0001)	Random Start Byte (1 Byte)

b) B_A_INIT_HANDSHAKE_ACK: previously (APP_INIT_ACK)

Msg Type (0x02)	Msg Size (0x0001)	Repeated Random Byte (1 Byte)

c) A_B_NAME_REQ: previously (BSC_NAME_REQ)

Msg Type (0x03)

d) B_A_NAME: previously (BSC_NAME)

Msg Type (0x04)	Msg Size (2 Bytes)	ASCII NAME (Up to 255 Bytes)

2. Setup SmartDot Connection

a) A_B_START_SCAN_FOR_SD: previously (SMARTDOT_SCAN)

Msg Type (0x05)

b) B_A_SCANNED_SD: previously (SMARTDOT_SCAN)

Msg Type (0x06)	Msg Size (2 Bytes)	BLE MAC Address (6 Bytes)	Name in ASCII (Up to 255 Bytes)

c) A_B_CHOSEN_SD

Msg Type (0x07)	Msg Size (2 Bytes)	BLE MAC Address (6 Bytes)	Name in ASCII (Up to 255 Bytes)

d) B_A_RECEIVE_CONFIG_INFO

Msg Type (0x08)	Msg Size (2 Bytes) 0x0008	Accel Sample Rates (2 Byte)	Gyro Sample Rates (2 Byte)	Mag Sample Rates (2 Byte)	Light Sample Rates (2 Byte)

Protocol

3. Sending Run Data

a) A_B_RECEIVE_SD_CONFIG

Msg Type (0x09)	Msg Size (0x0004)	Set Config For SD 2 Bytes

b) A_B_SD_TOGGLE_TAKE_DATA

Msg Type (0x0A)	Msg Size (0x0001)	On or off byte (1 byte)

c) B_A_SD_SENSOR_DATA

Msg Type (0x0B)	Msg Size (0x0013)	Sensor Type (1 Byte)	Sample Count (3 Byte)	In-between Time (4 Byte)	"X-axis" data (4 Bytes)	"Y-axis" data (4 Bytes)	"Z-axis" data (4 Bytes)

d) A_B_MOTOR_INSTRUCTIONS

Msg Type (0x0C)	Msg Size (0x0003)	Motor1 Speed (4 Bytes)	Motor2 Angle (4 Bytes)	Motor3 Angle (4 Bytes)

4. Terminate Processes

a) A_B_STOP_MOTOR

Msg Type (0x0D)

b) A_B_DISCONNECT_FROM_BSC

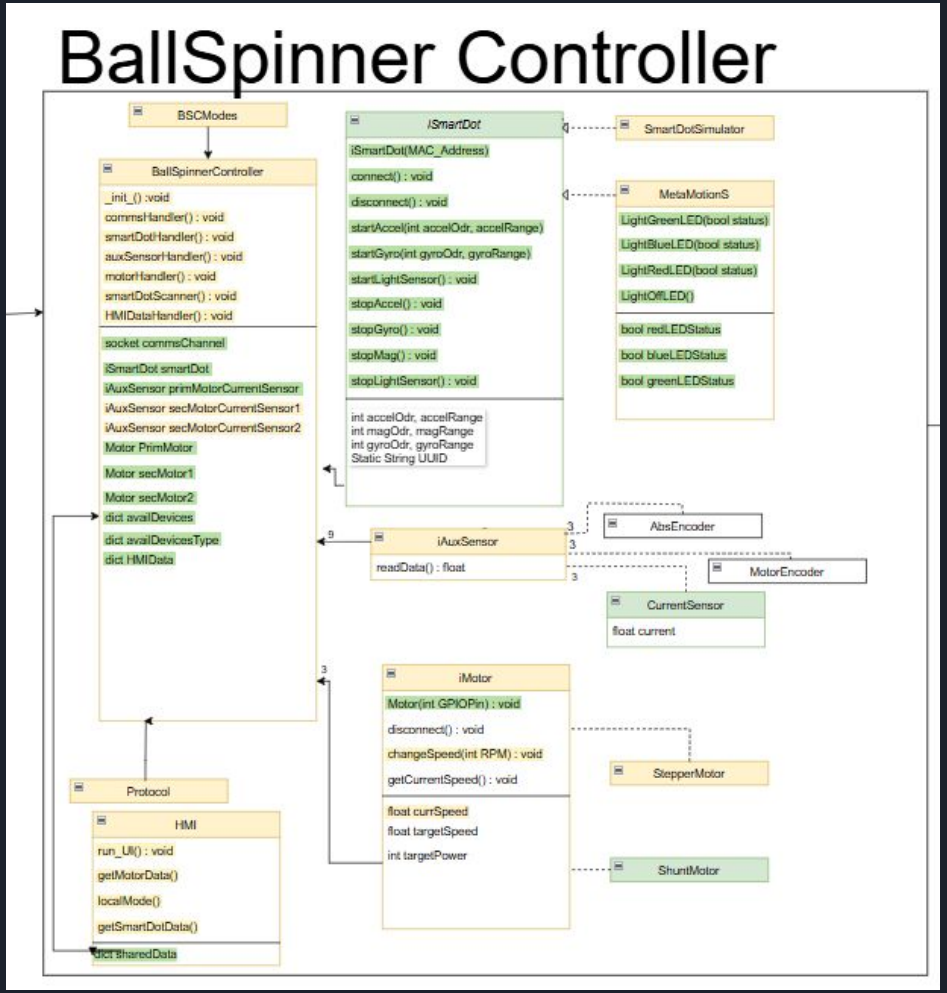
Msg Type (0x0E)

Ball Spinner Controller

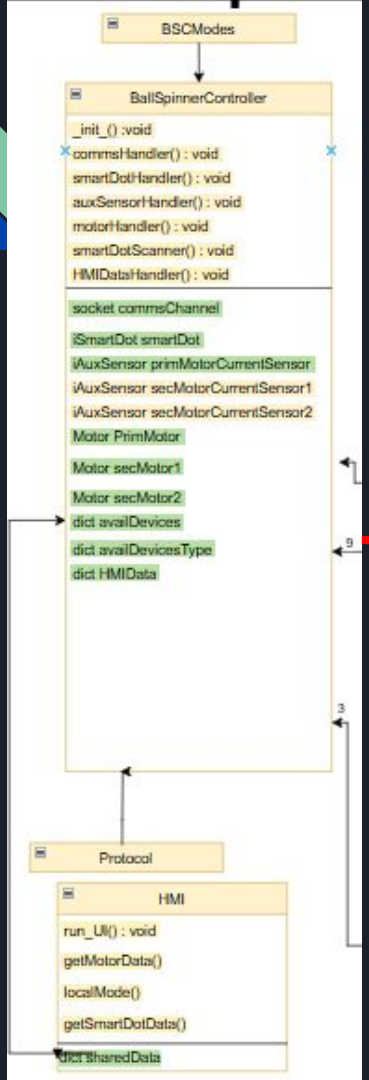
Implemented

Partially Implemented

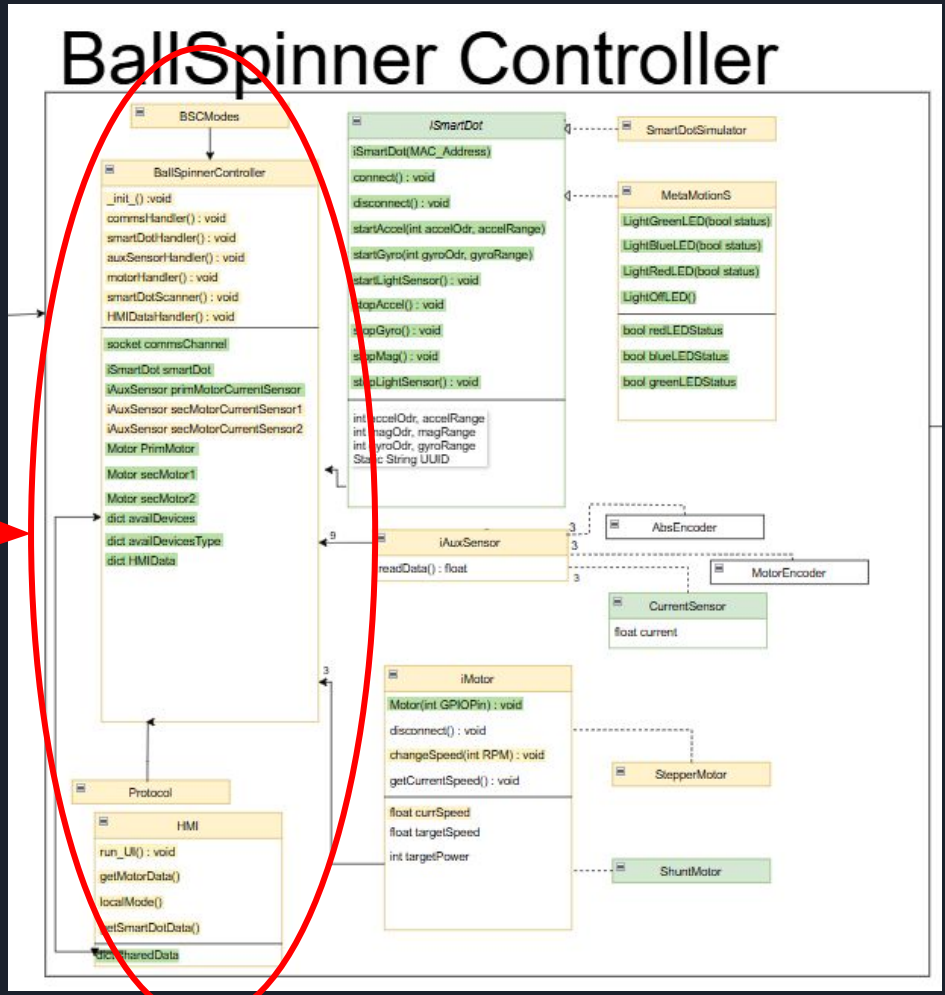
Not Yet Implemented



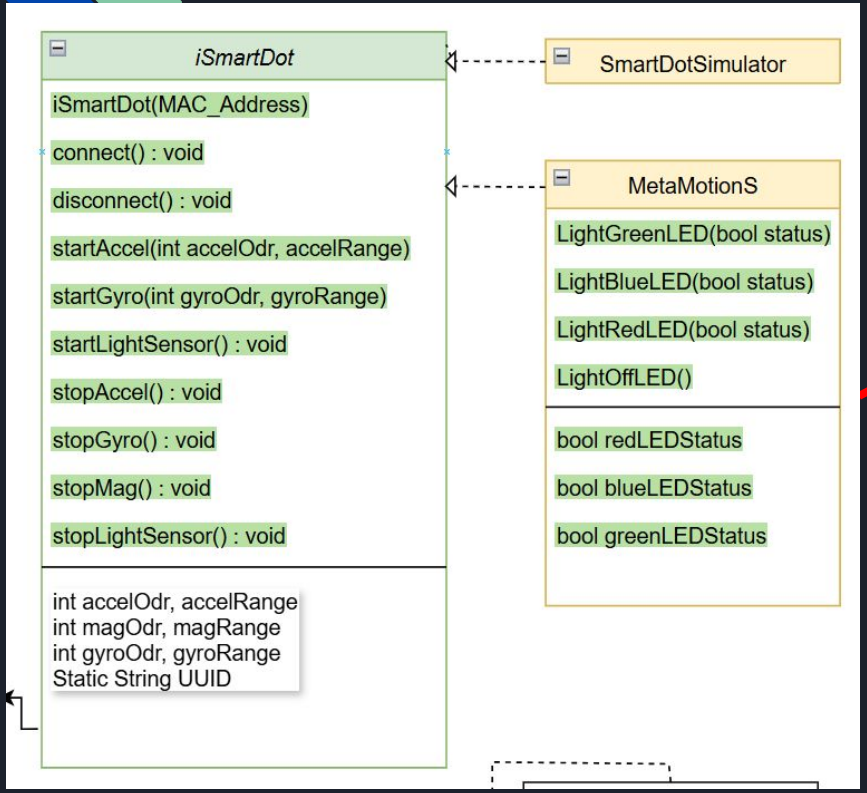
Current Design

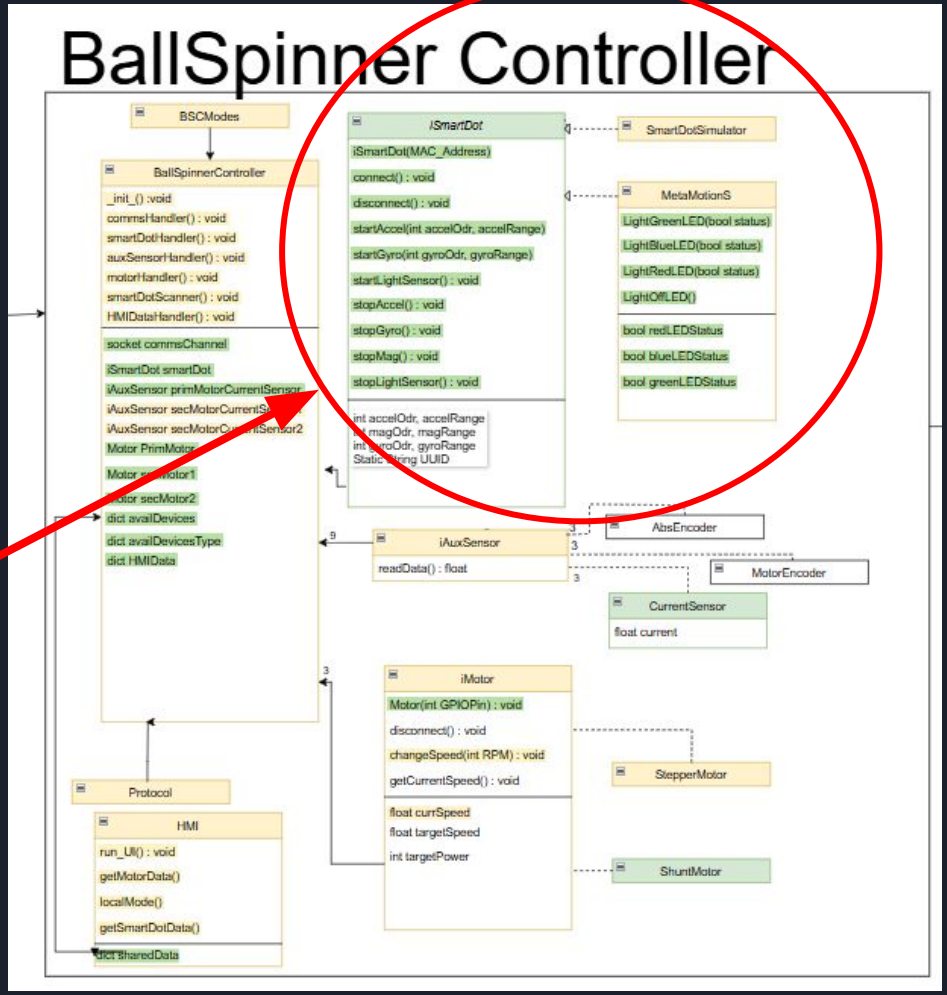


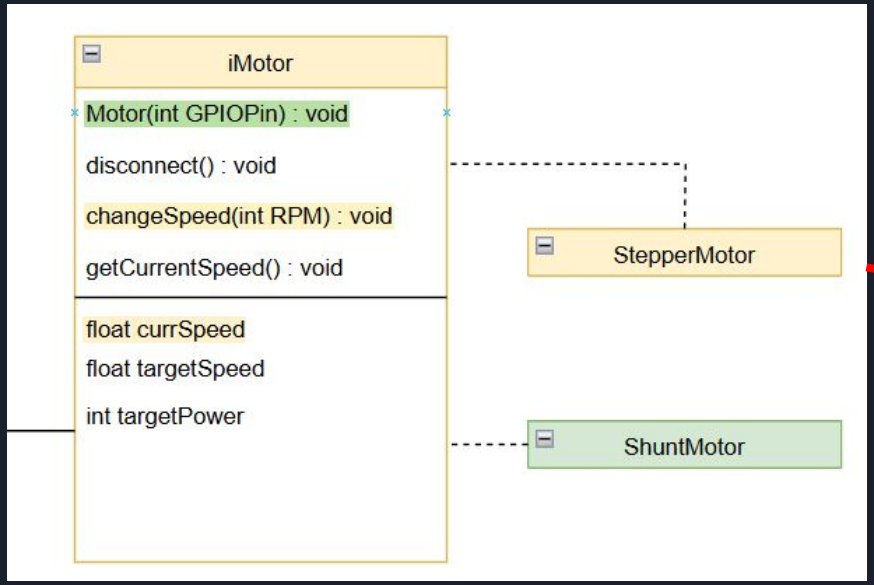
BallSpinner Controller



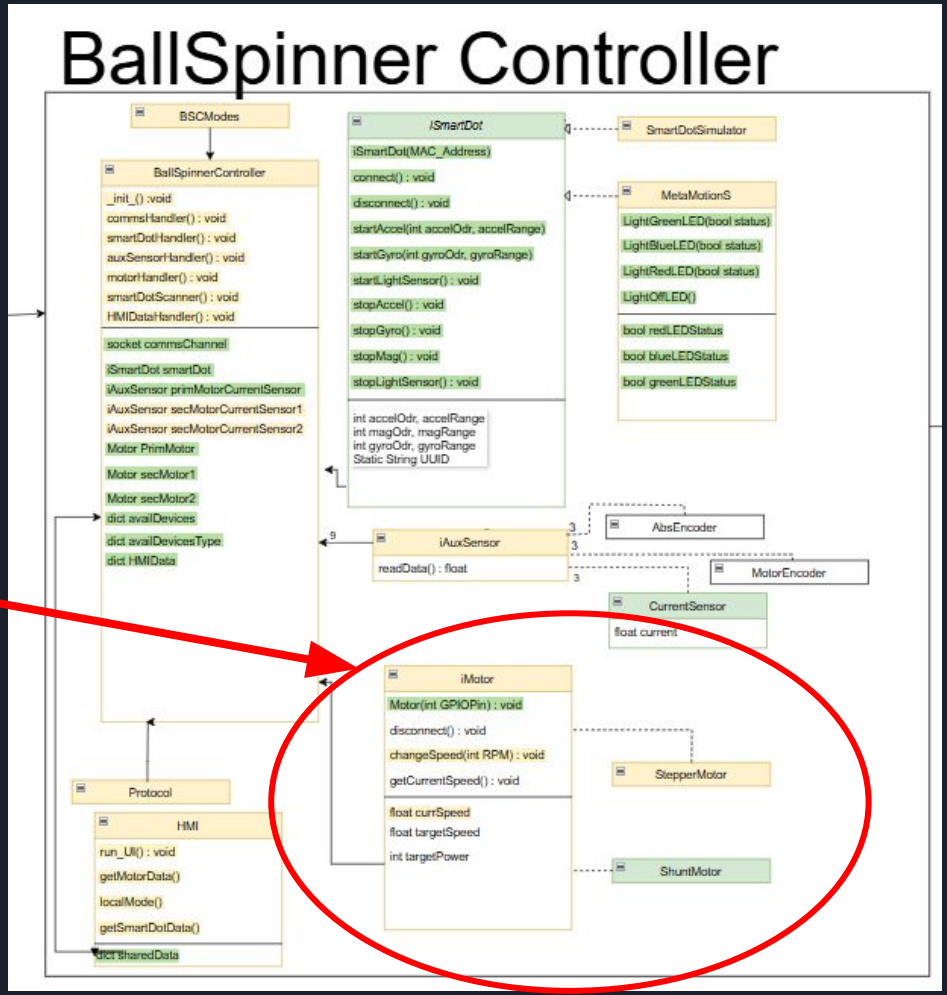
Current Design


iSmartDot
iSmartDot(MAC_Address)
connect() : void
disconnect() : void
startAccel(int accelOdr, accelRange)
startGyro(int gyroOdr, gyroRange)
startLightSensor() : void
stopAccel() : void
stopGyro() : void
stopMag() : void
stopLightSensor() : void
int accelOdr, accelRange
int magOdr, magRange
int gyroOdr, gyroRange
Static String UUID
SmartDotSimulator
MetaMotionS
LightGreenLED(bool status)
LightBlueLED(bool status)
LightRedLED(bool status)
LightOffLED()
bool redLEDStatus
bool blueLEDStatus
bool greenLEDStatus

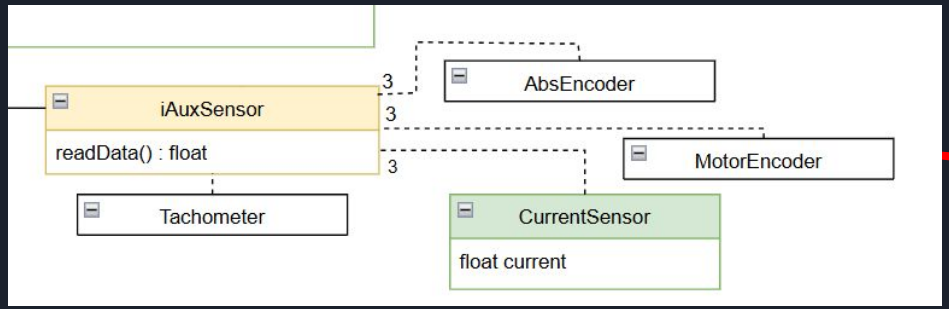

BallSpinner Controller
BSCModes
BallSpinnerController
init() :void
commsHandler() : void
smartDotHandler() : void
auxSensorHandler() : void
motorHandler() : void
smartDotScanner() : void
HMIDataHandler() : void
socket commsChannel
iSmartDot smartDot
iAuxSensor primMotorCurrentSensor
Motor PrimMotor
Motor secMotor1
Motor secMotor2
dict availDevices
dict availDevicesType
dict HMIData
iSmartDot
iSmartDot(MAC_Address)
connect() : void
disconnect() : void
startAccel(int accelOdr, accelRange)
startGyro(int gyroOdr, gyroRange)
startLightSensor() : void
stopAccel() : void
stopGyro() : void
stopMag() : void
stopLightSensor() : void
int accelOdr, accelRange
int magOdr, magRange
int gyroOdr, gyroRange
Static String UUID
SmartDotSimulator
MetaMotionS
LightGreenLED(bool status)
LightBlueLED(bool status)
LightRedLED(bool status)
LightOffLED()
bool redLEDStatus
bool blueLEDStatus
bool greenLEDStatus
iAuxSensor
readData() : float
AbsEncoder
MotorEncoder
CurrentSensor
float current
iMotor
Motor(int GPIOPin) : void
disconnect() : void
changeSpeed(int RPM) : void
getCurrentSpeed() : void
float currSpeed
float targetSpeed
int targetPower
StepperMotor
ShuntMotor
Protocol
HMI
run_UI() : void
getMotorData()
localMode()
getSmartDotData()
dict SharedData



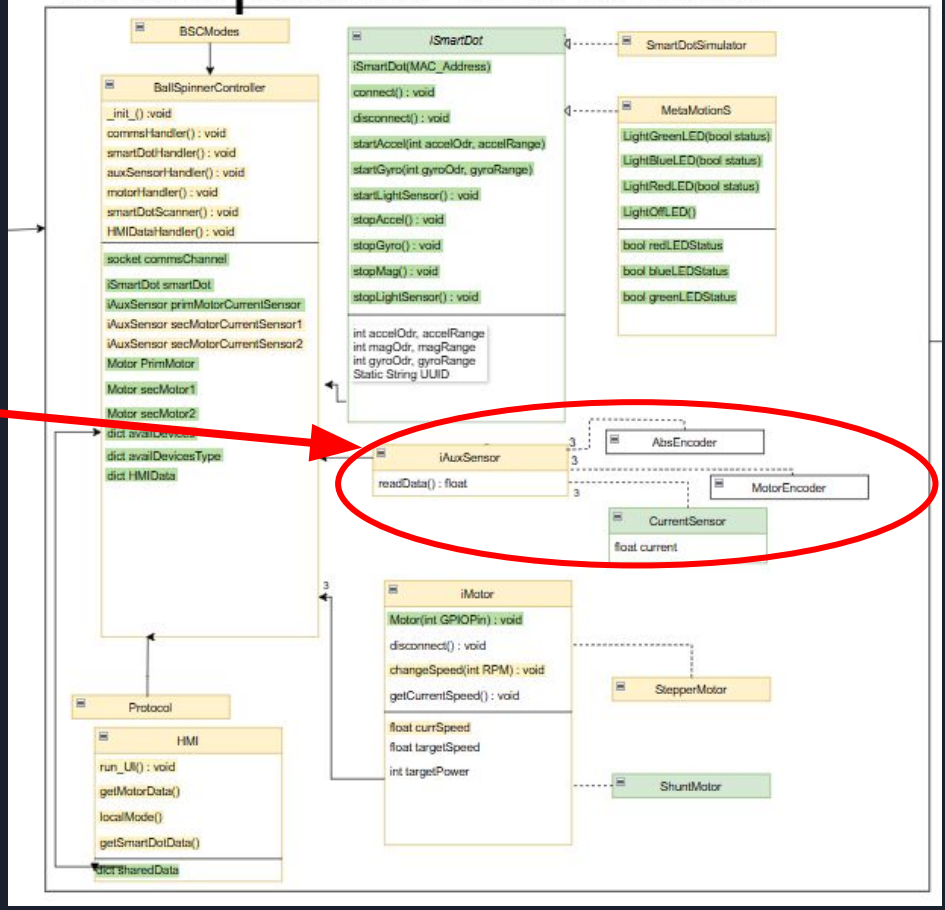
BallSpinner Controller



Current Design

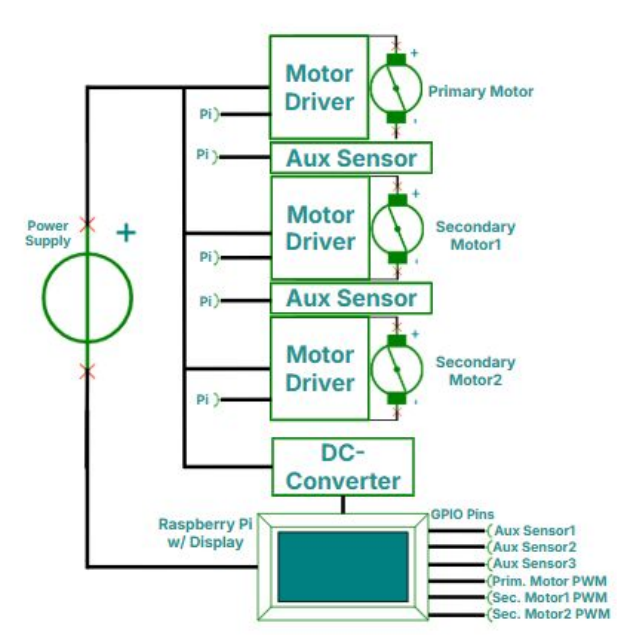


BallSpinner Controller

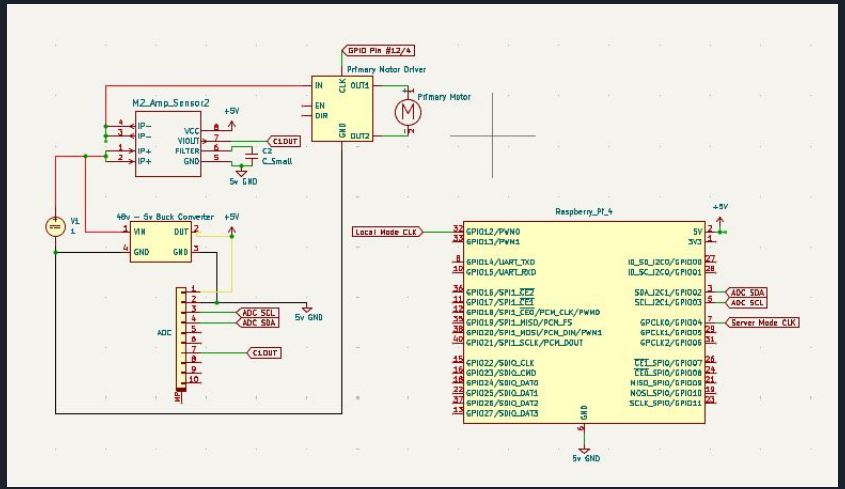


Current Design

Ball Spinner Controller

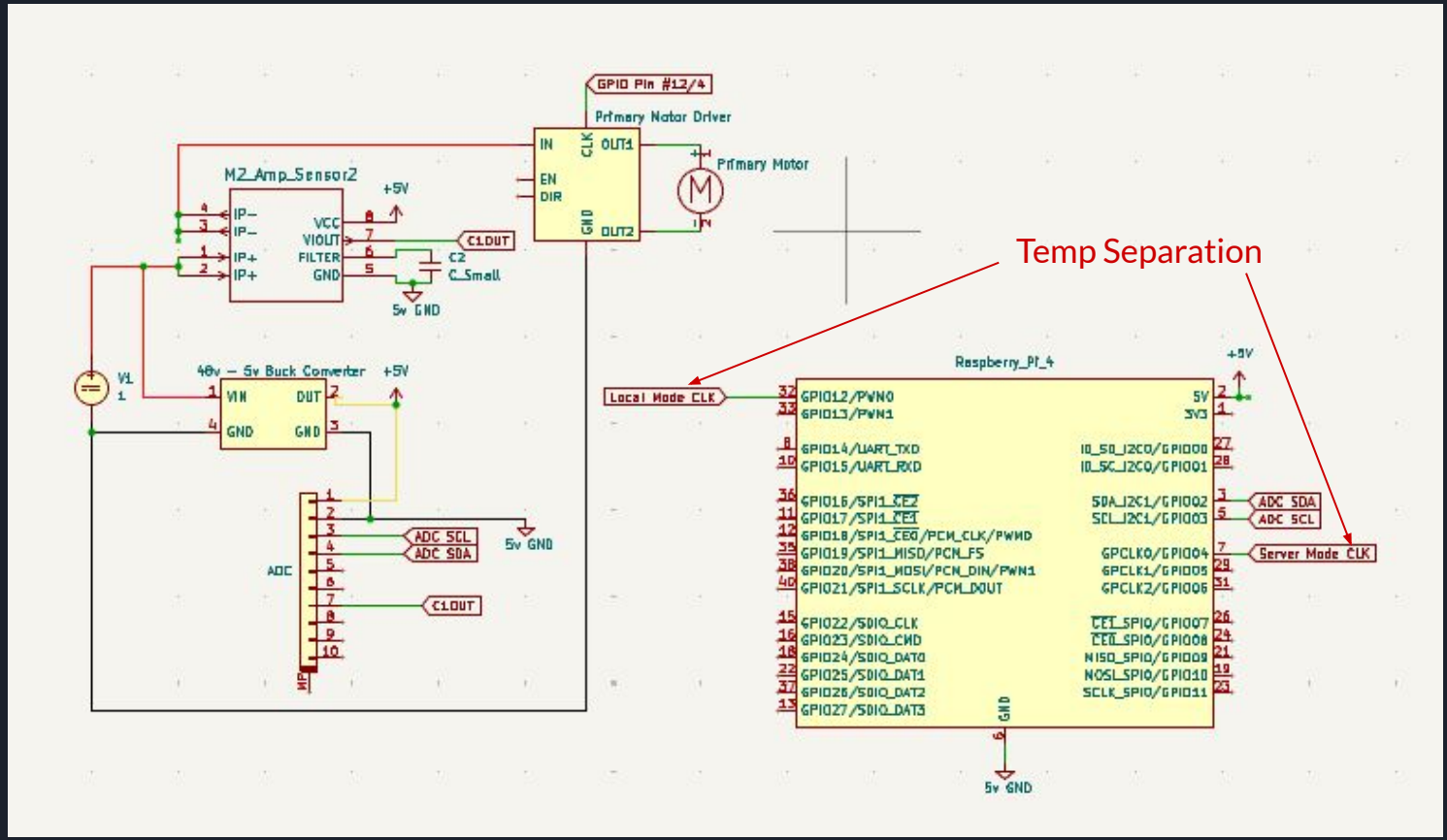


Stepper Motor Electrical Block Diagram



Current Electrical Schematic

Ball Spinner Controller



Current Design

Ball Spinner Team

- Implement Counterweight
  - Placed strategically to most counteract weight dist. without greatly affecting spinnability
- Cut and Resize Axle Rods
  - Lathe and cut steel rod
  - Shorten motor end axle
- Resize Gear Chain
  - Attach chain tensioners
- Create 2nd DoF Track

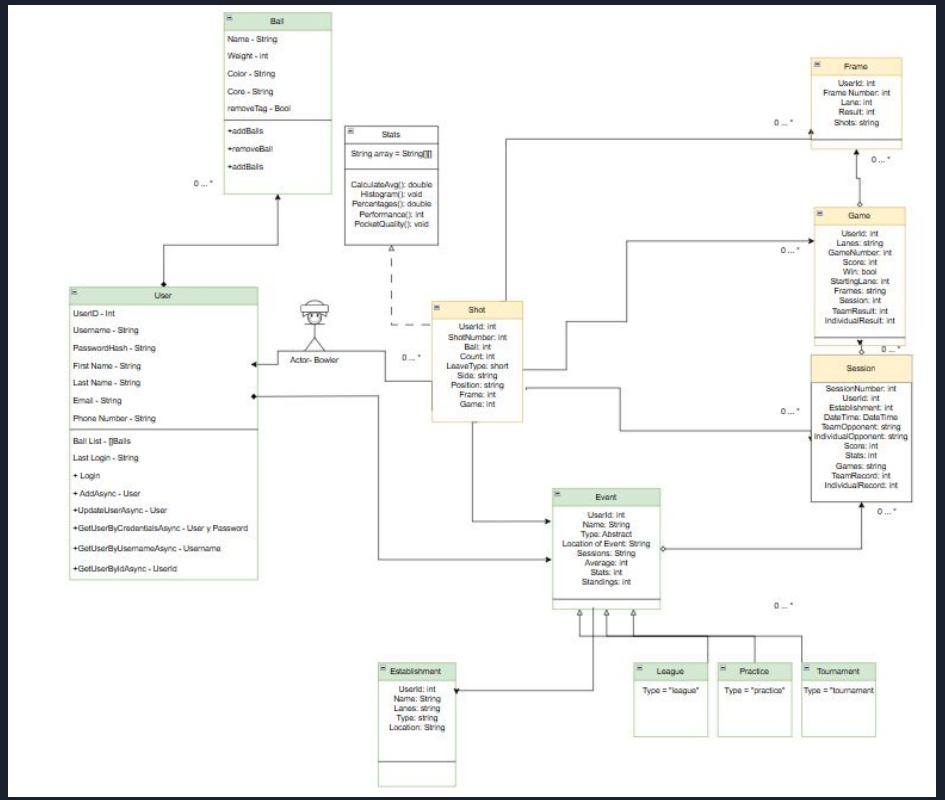
Current Design

Mobile Application Team

Implemented

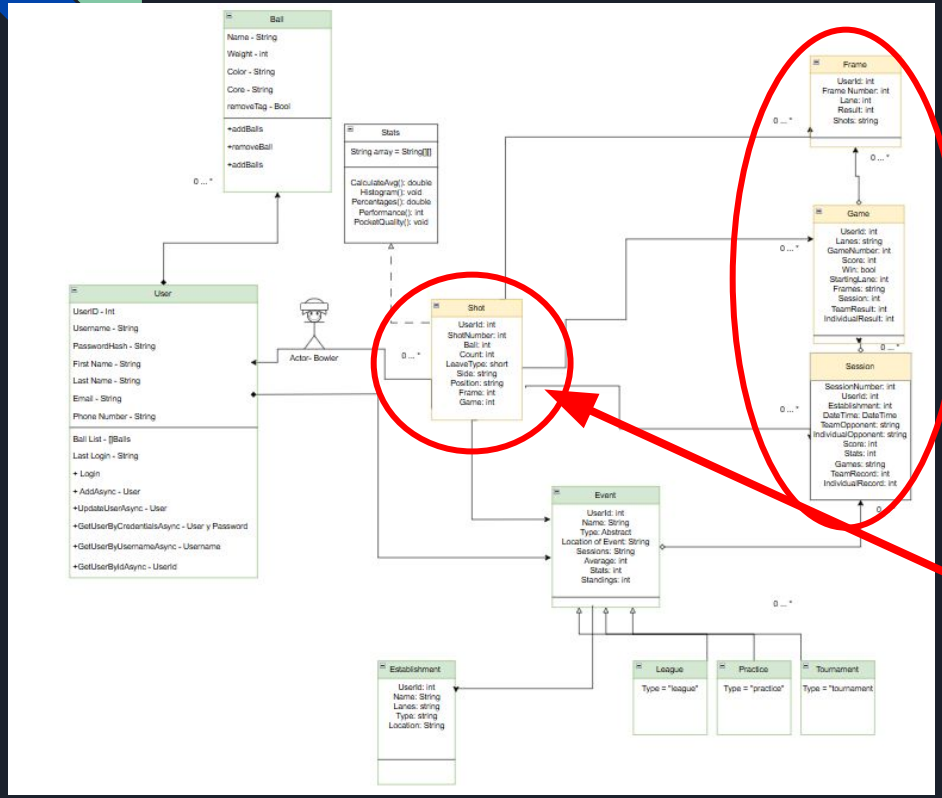
Partially Implemented

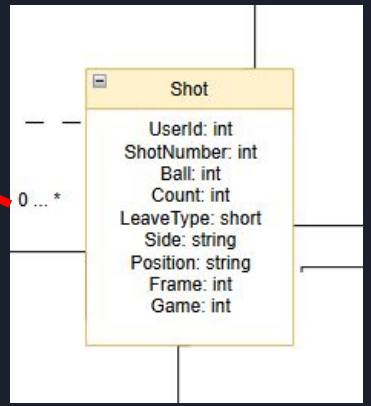
Not Yet Implemented

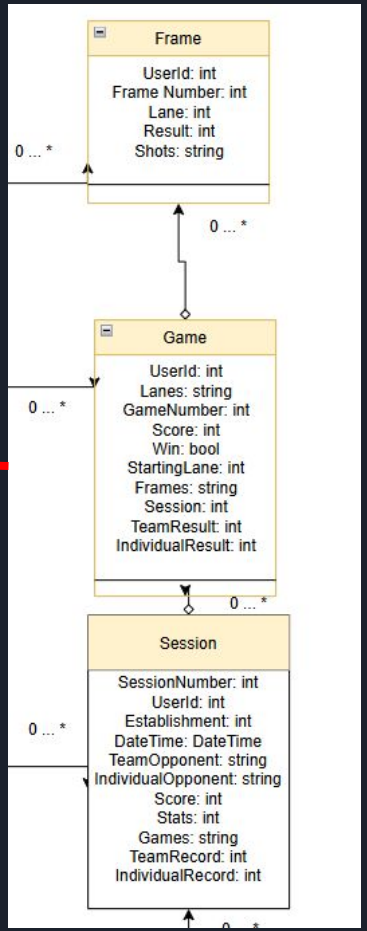


Current Design

Mobile Application Team

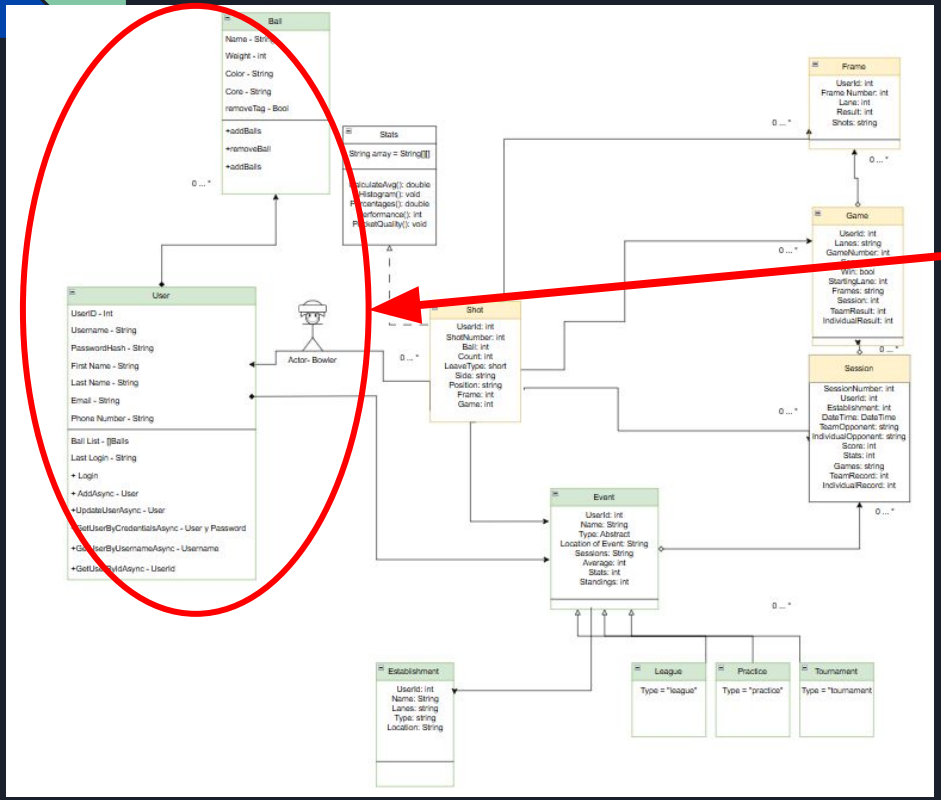


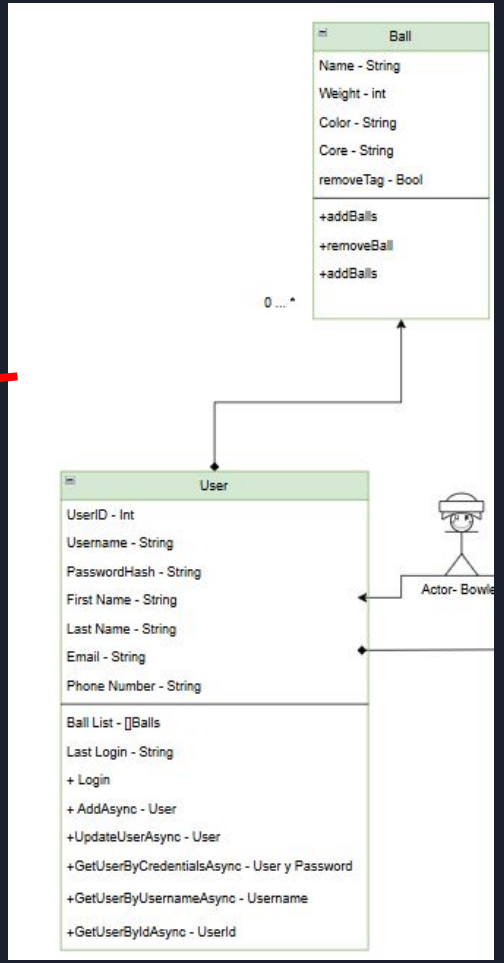




Current Design

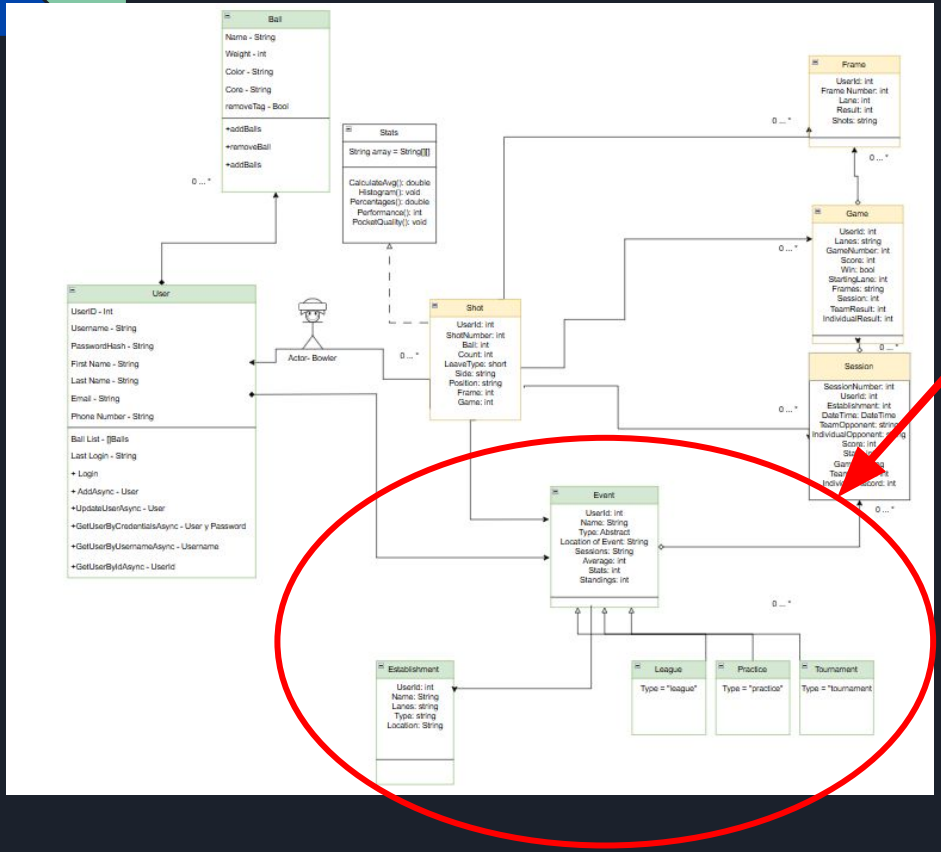
Mobile Application Team

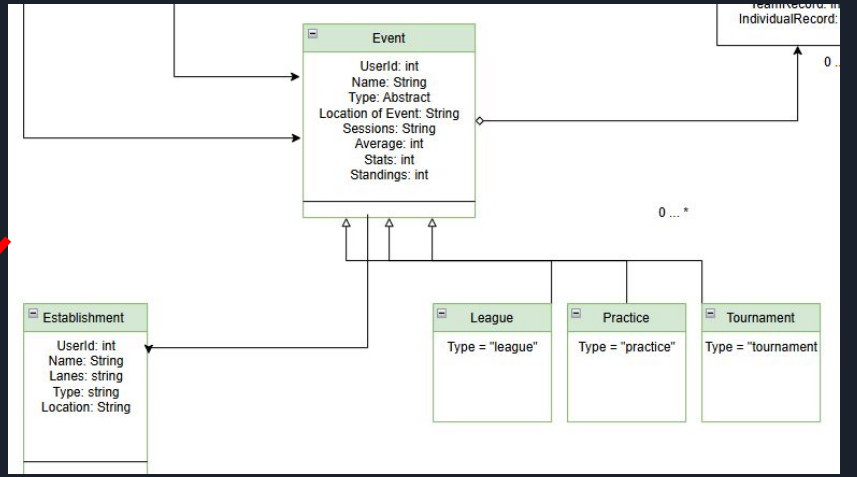




Current Design

Mobile Application Team



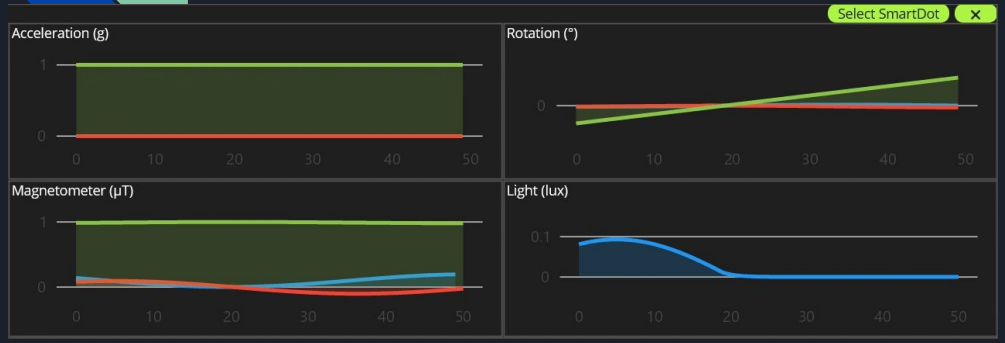


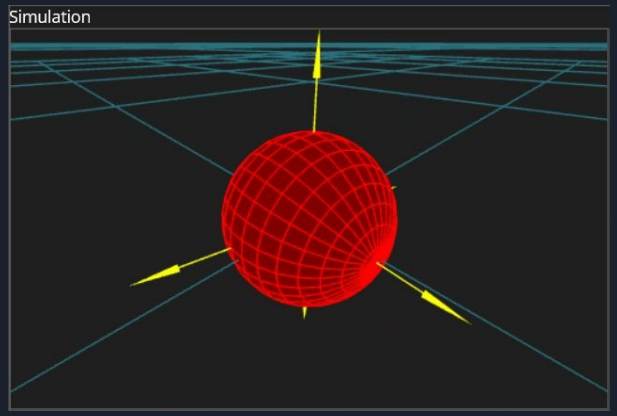
Current Design

Questions?

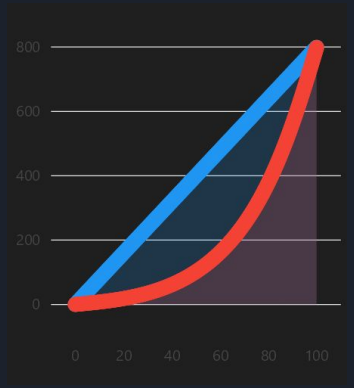
Current Implementation

Simulation (MS2 Goals)





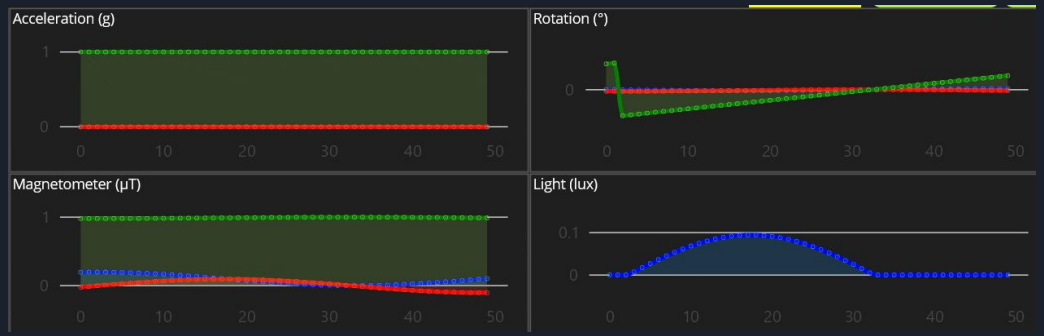
- Implement OpenTK for the ball visualization
- Improve graphs
  - X axis
  - Sizing
  - Scrolling
  - Bezier sliders
- Update the Unity game to work with the current version of MAUI

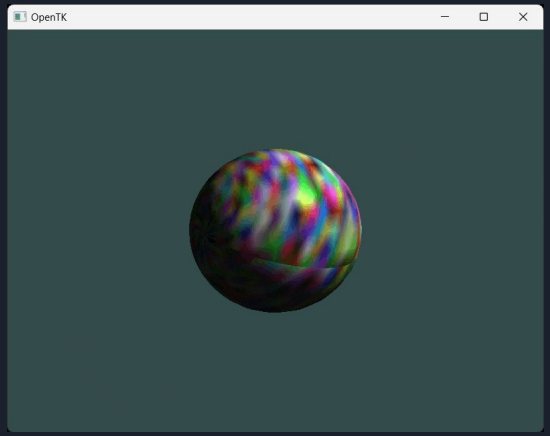


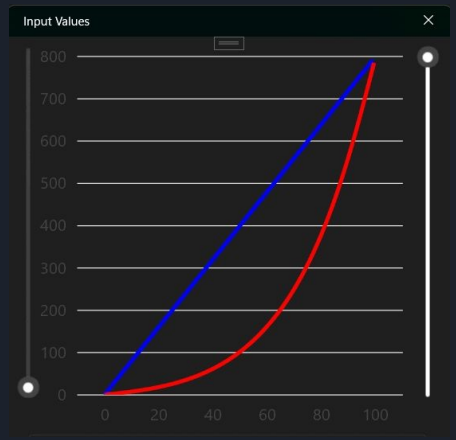
Current Implementation

Simulation (MS2 Achievements)

- Graphs updated
  - Points added
  - Animation stunted for better performance
- Bezier graph functional
  - Sliders change graph
- Ball visualization switch from Three.js to OpenTk
  - Ball is spinning
  - Textures
  - Controlling its XYZ
    - Direction
    - Angle
    - Speed







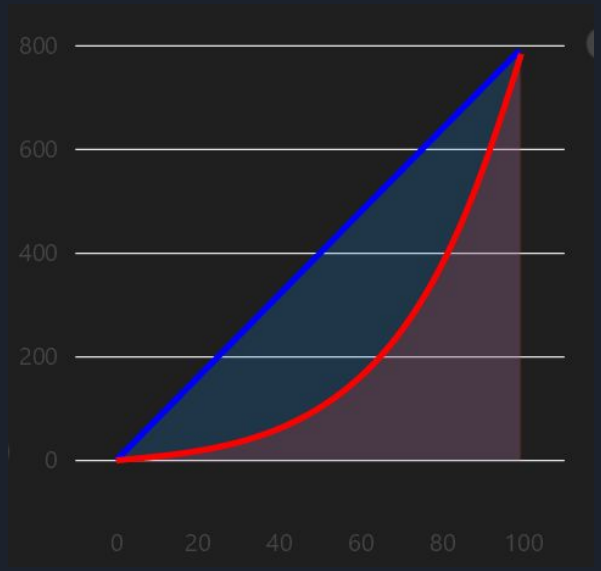
Current Implementation

BSA Backend/Cloud (MS2 Goals)

- Upload shot changes
  - Comments
  - Ball used
  - Initial values
- Upload and view saved sensor modules
- Send motor instructions based on Bezier curve
- Add testing to CI/CD pipeline
- Implement local database

BSA Backend/Cloud (MS2 Achievements)

- Upload shot changes
  - Comments
  - Ball used
  - Initial values
  - Issue fixed that limited # of values that could be sent
- Get list of shots endpoint updated
- Send motor instructions based on Bezier curve
- Testing added to CI/CD pipeline



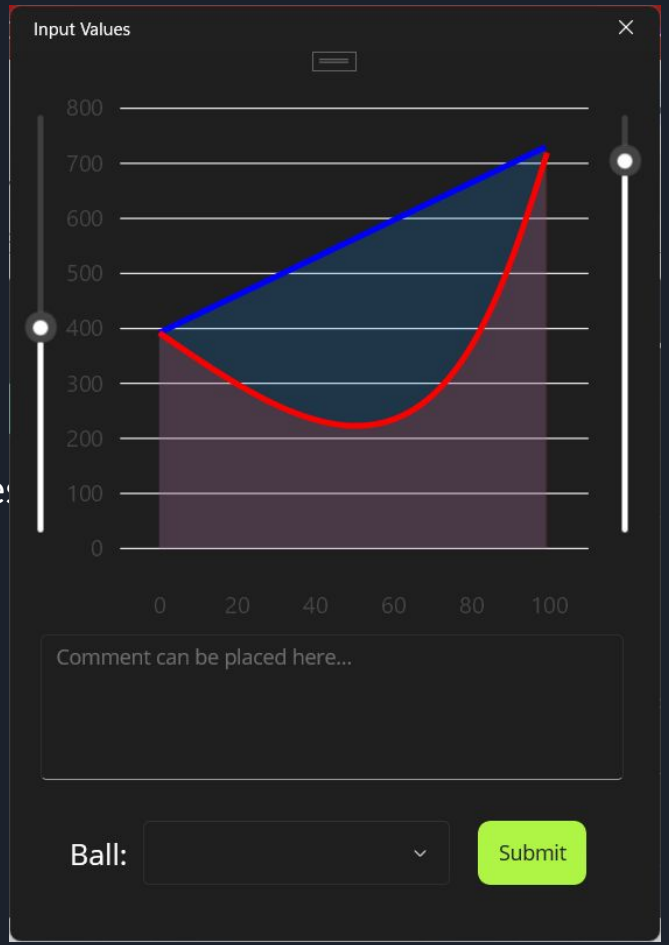
BSA Frontend (MS2 Achievements)

Goals

- Finalize Design of the initial values page
- Progress on functionality of the initial values page

Achievements

- Initial Values Page layout updated
- Initial Values Page functional

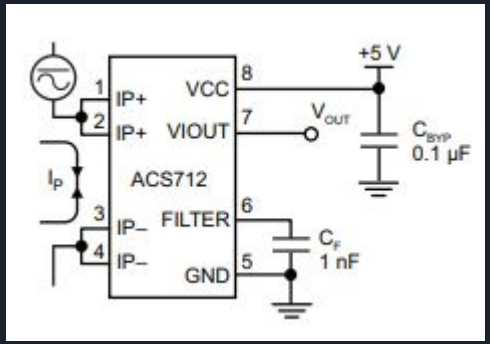


Current Implementation

Ball Spinner Controller (MS2 Goals)

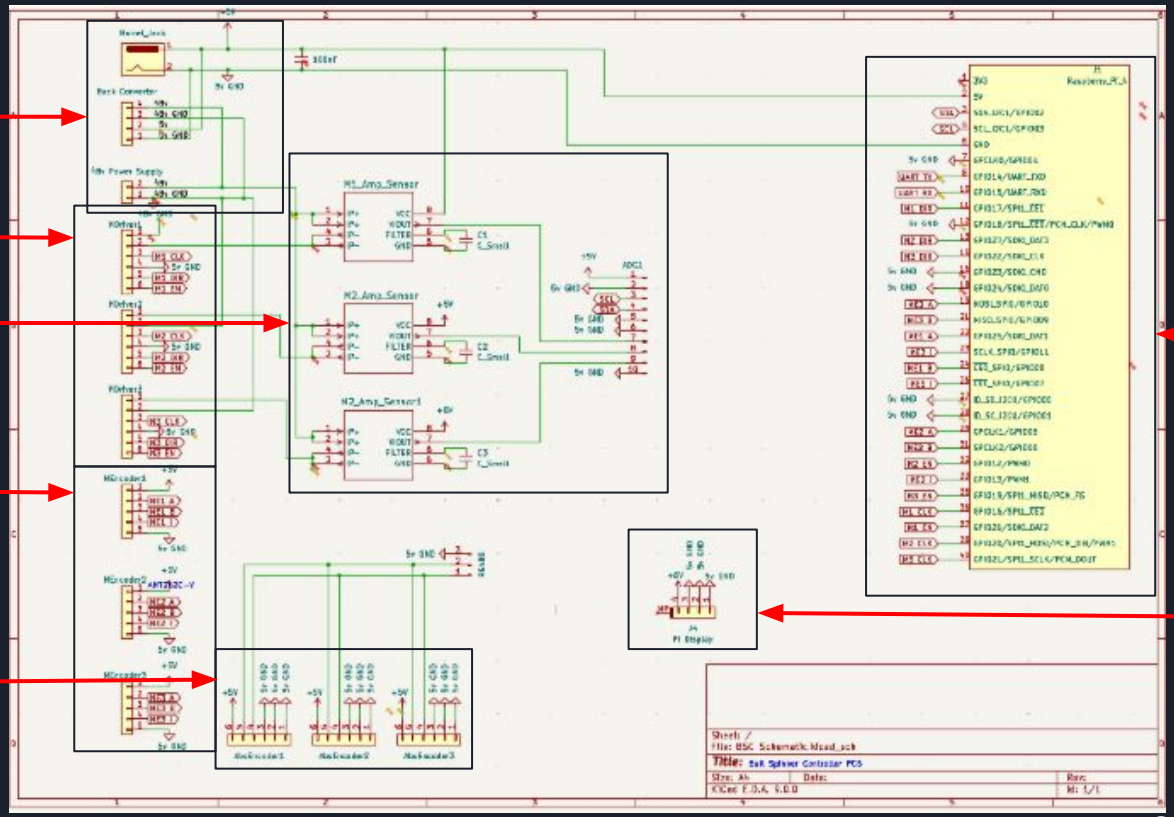
- Interface w/ motor encoders
- PCB and Housing Designs
- Interface w/ Amperage Sensors
- Protocol Messages for Error Messages Drafted

Ball Spinner Controller (MS2 Achievements)



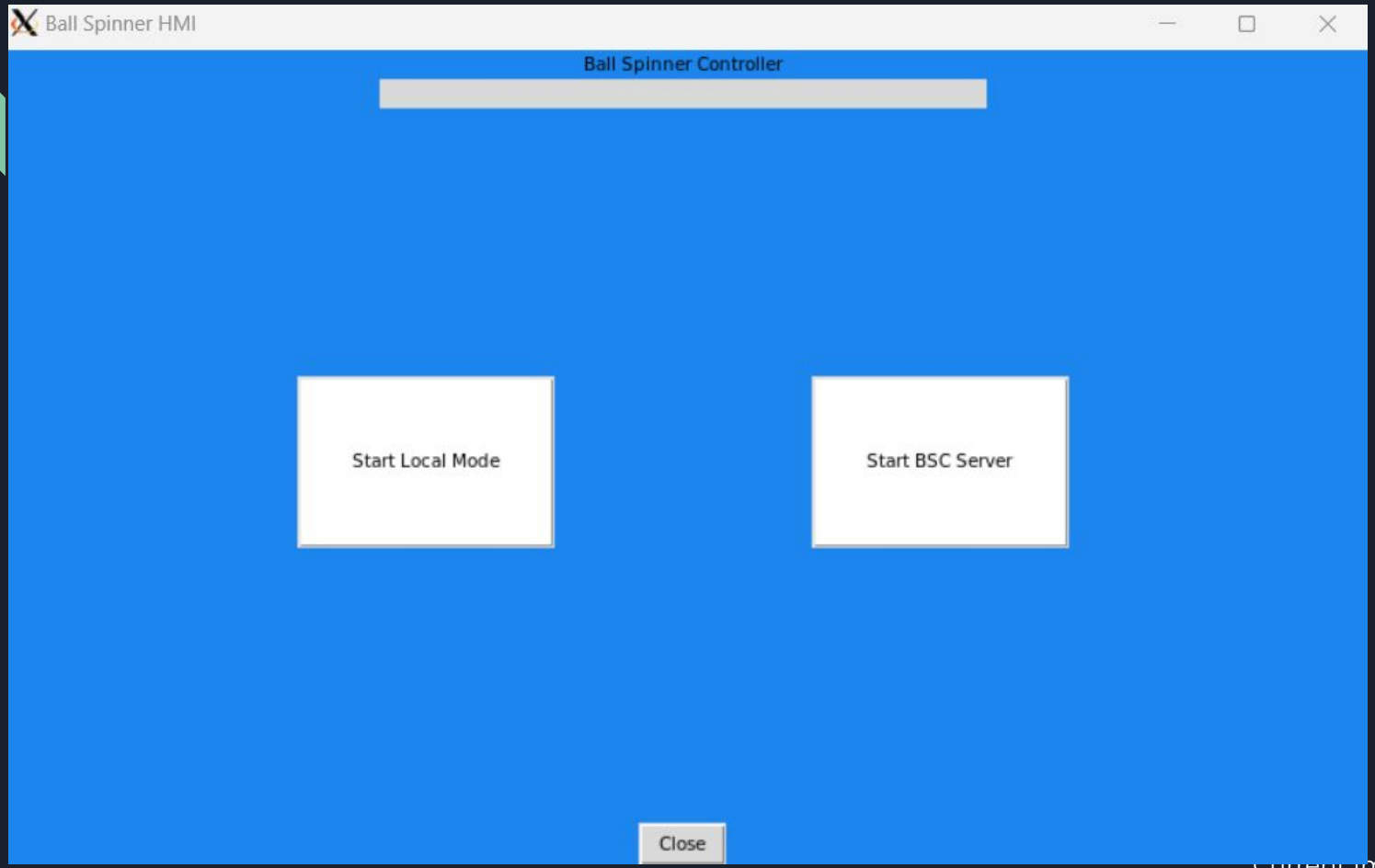
- Current Sensors Interface w/ BSC
- PCB Schematic nearing Completion for Capstone Expo
- All Crashes detected in BSC displayed on HMI
- Now interfaces w/ Stepper Motors instead of Shunt
- Minor Bugs:
    - Bluetooth Crashing
    - Power Cycling

Ball Spinner Controller (PCB Current Progress)

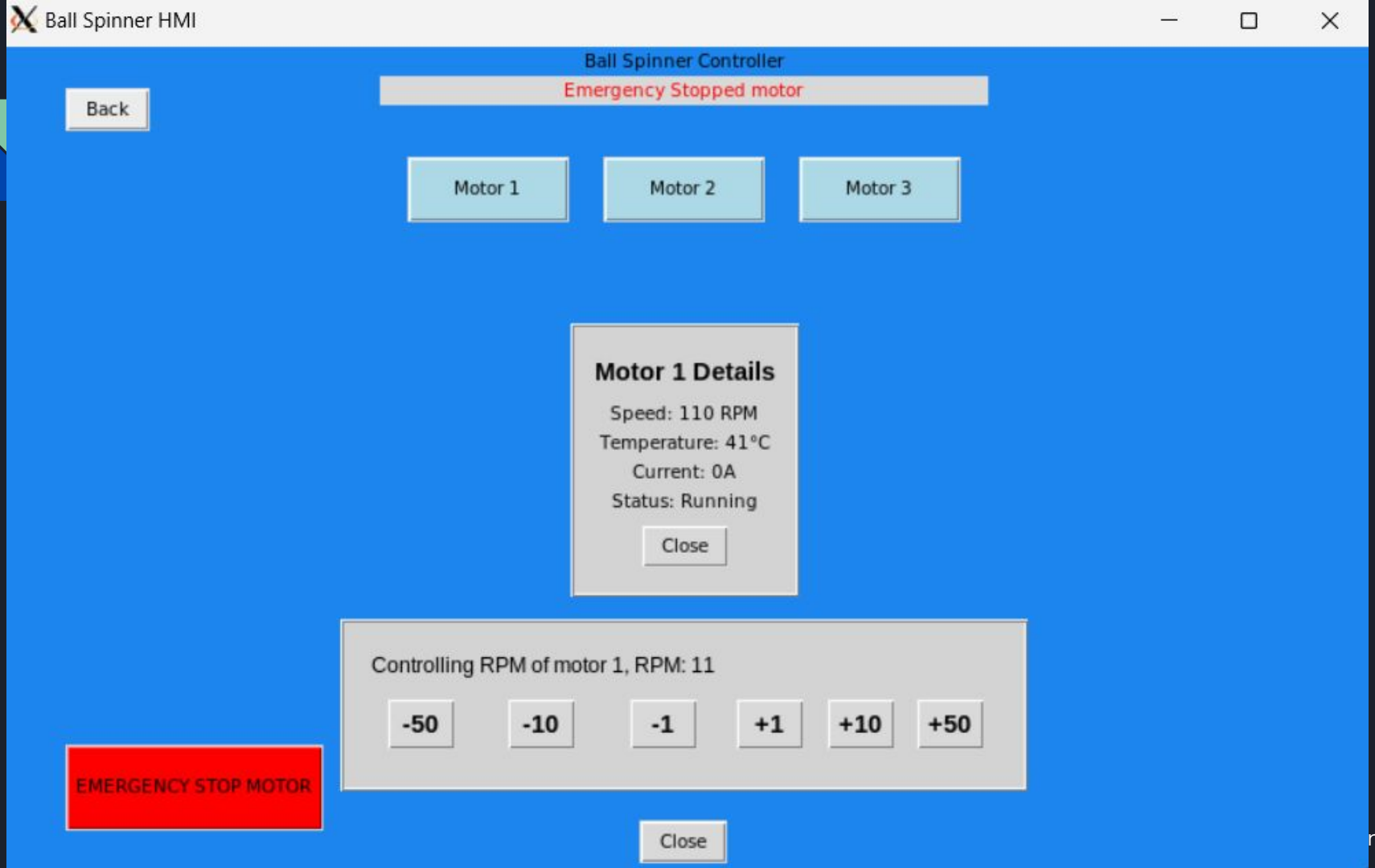


Current Implementation

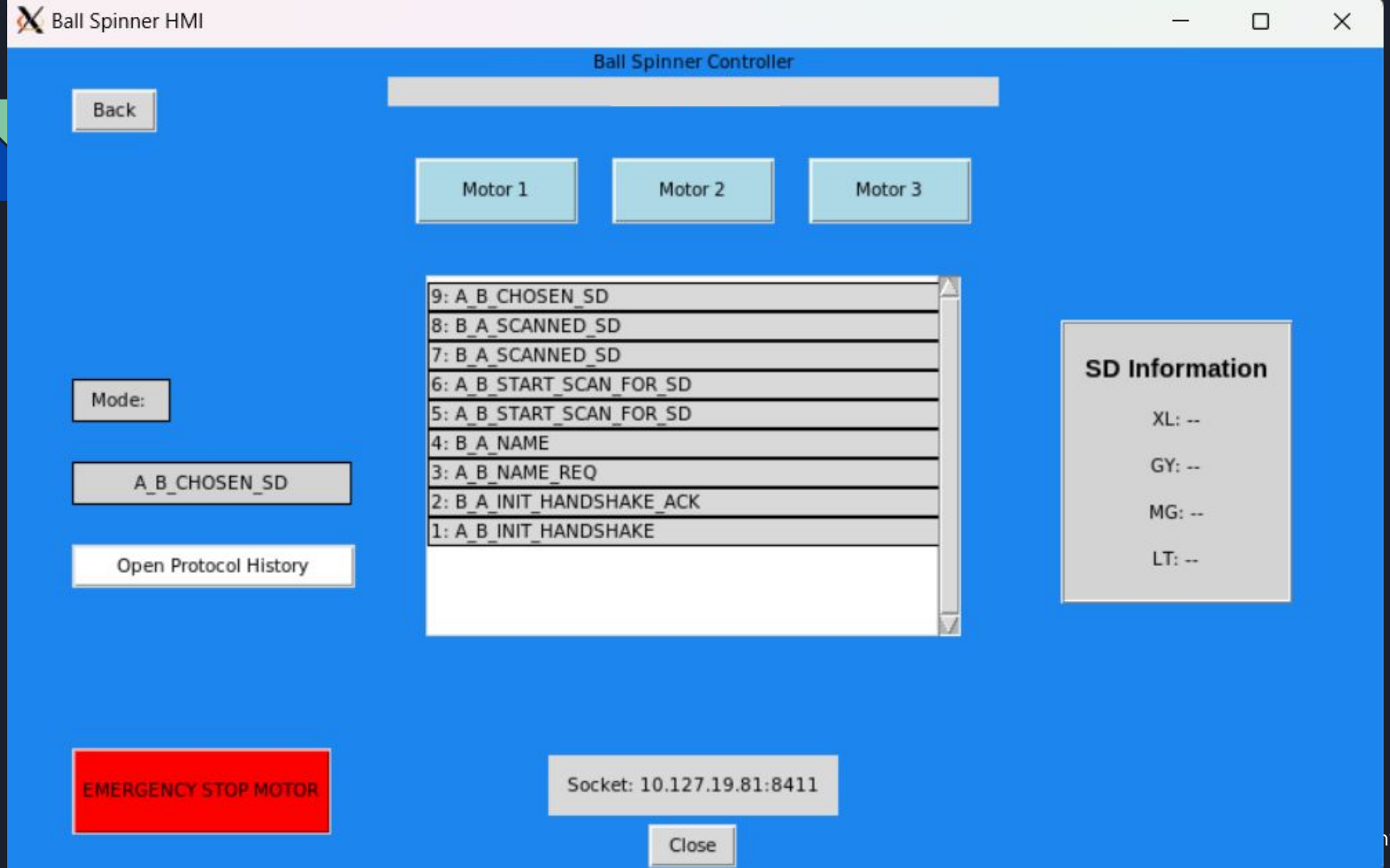
Ball Spinner Controller HMI



Current implementation

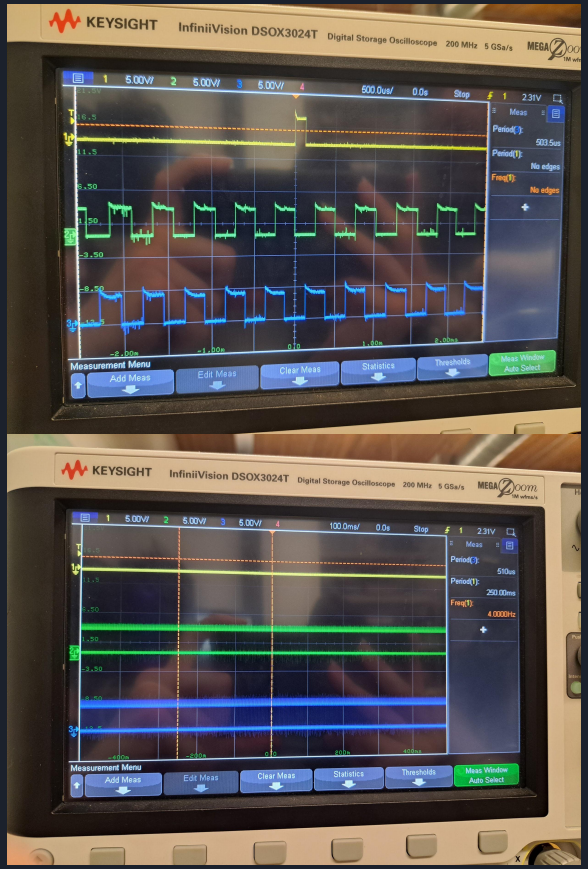

Ball Spinner HMI
Ball Spinner Controller
Emergency Stopped motor
Back
Motor 1
Motor 2
Motor 3
Motor 1 Details
Speed: 110 RPM
Temperature: 41°C
Current: 0A
Status: Running
Close
Controlling RPM of motor 1, RPM: 11
-50
-10
-1
+1
+10
+50
EMERGENCY STOP MOTOR
Close

ntation


Ball Spinner HMI
Ball Spinner Controller
Back
Motor 1
Motor 2
Motor 3
9: A_B_CHOSEN_SD
8: B_A_SCANNED_SD
7: B_A_SCANNED_SD
6: A_B_START_SCAN_FOR_SD
5: A_B_START_SCAN_FOR_SD
4: B_A_NAME
3: A_B_NAME_REQ
2: B_A_INIT_HANDSHAKE_ACK
1: A_B_INIT_HANDSHAKE
SD Information
XL: --
GY: --
MG: --
LT: --
Mode:
A_B_CHOSEN_SD
Open Protocol History
EMERGENCY STOP MOTOR
Socket: 10.127.19.81:8411
Close

Ball Spinner Team

- Encoder data/readings
  - Using the impulse to trigger the signal
    - Impulse-impulse is the time for 1 rotation
    - Singal A & B have 50 waves for a single rotation
  - XOR-ing the A and B signals can measure direction



Current Implementation

Ball Spinner Team

Proposal

- Manufacture axle rods
- Modify dimensions of current enclosure
- Size plates to house axle and motor
- Affix free-spinning axle to plate
- Research casting methods for polyurethane cups
- Creating a motor dampening support stand
- Assembly of prototype

Reality

- Manufactured axle rods (both wood and steel)
- 3D printed cups
- Motor dampening support stand created
- Prototyped first DoF
    - And started the second
- Axle and motor housed

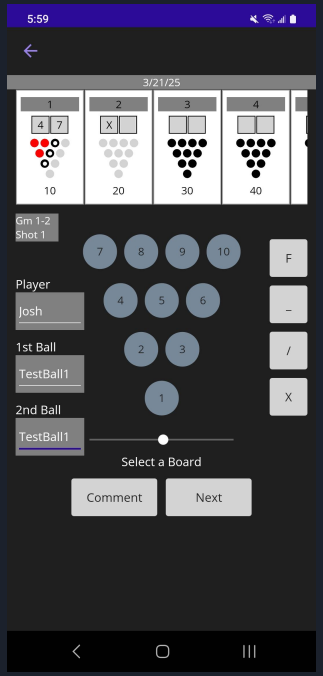
Mobile Application Team

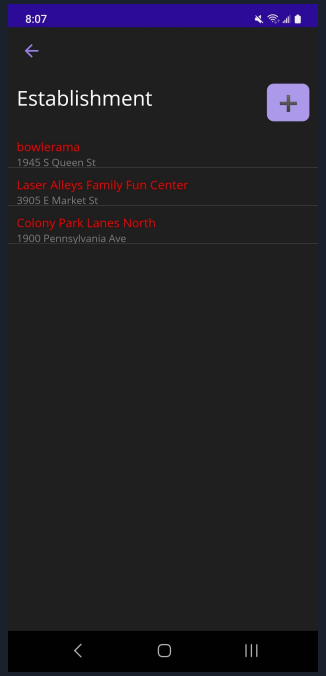
MS2 Goals

- Partial Game functionality
- Establishment page
- Expand Local database
  - Establishments, Sessions, Games, Shots
- Bluetooth connectivity
  - Smart Dot Connection
- Connection to cloud database

MS2 Achievements

- Updated shot page UI
- Expanded local database
- Partial game functionality
- Added establishment, session, and game creation

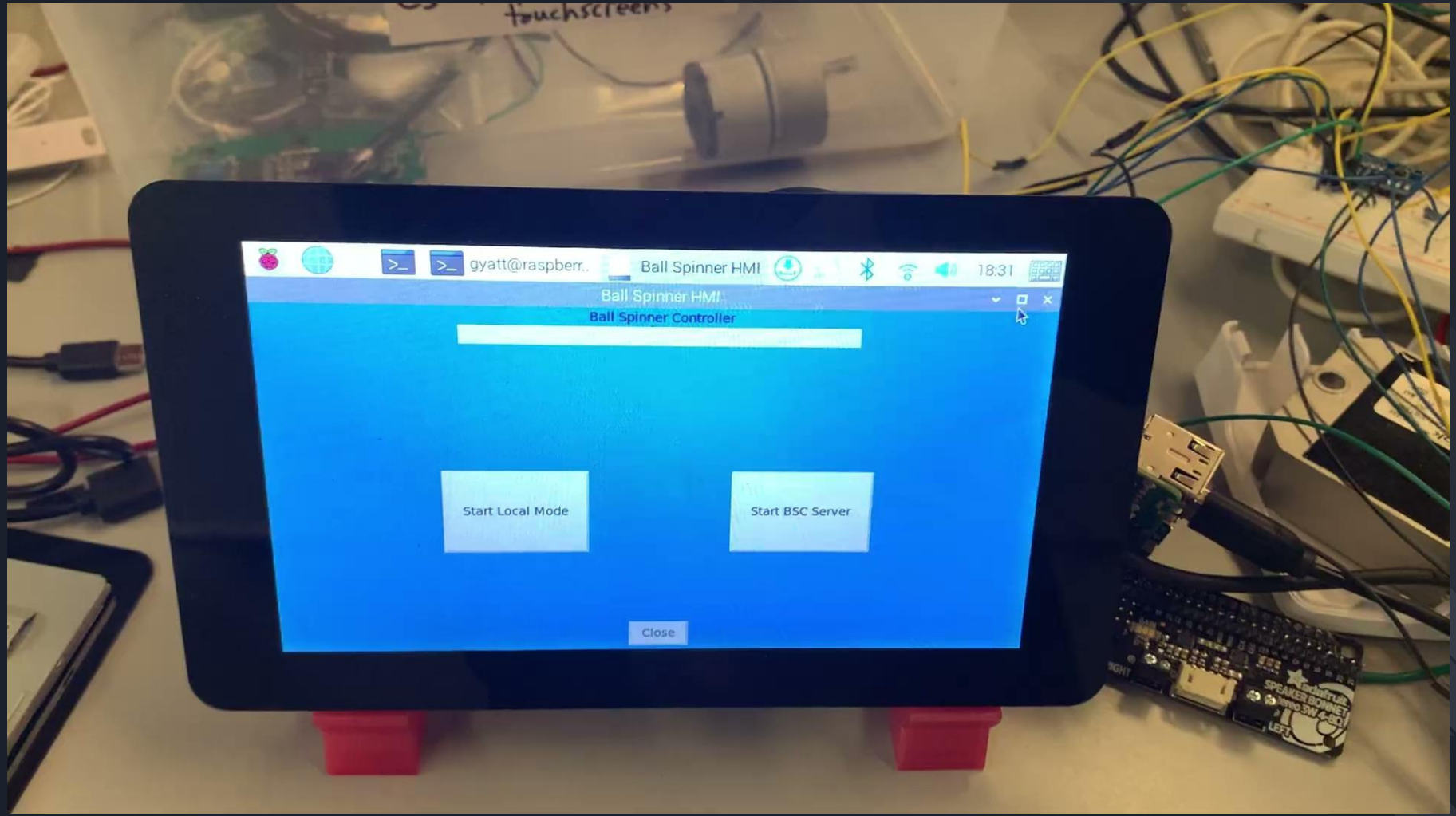


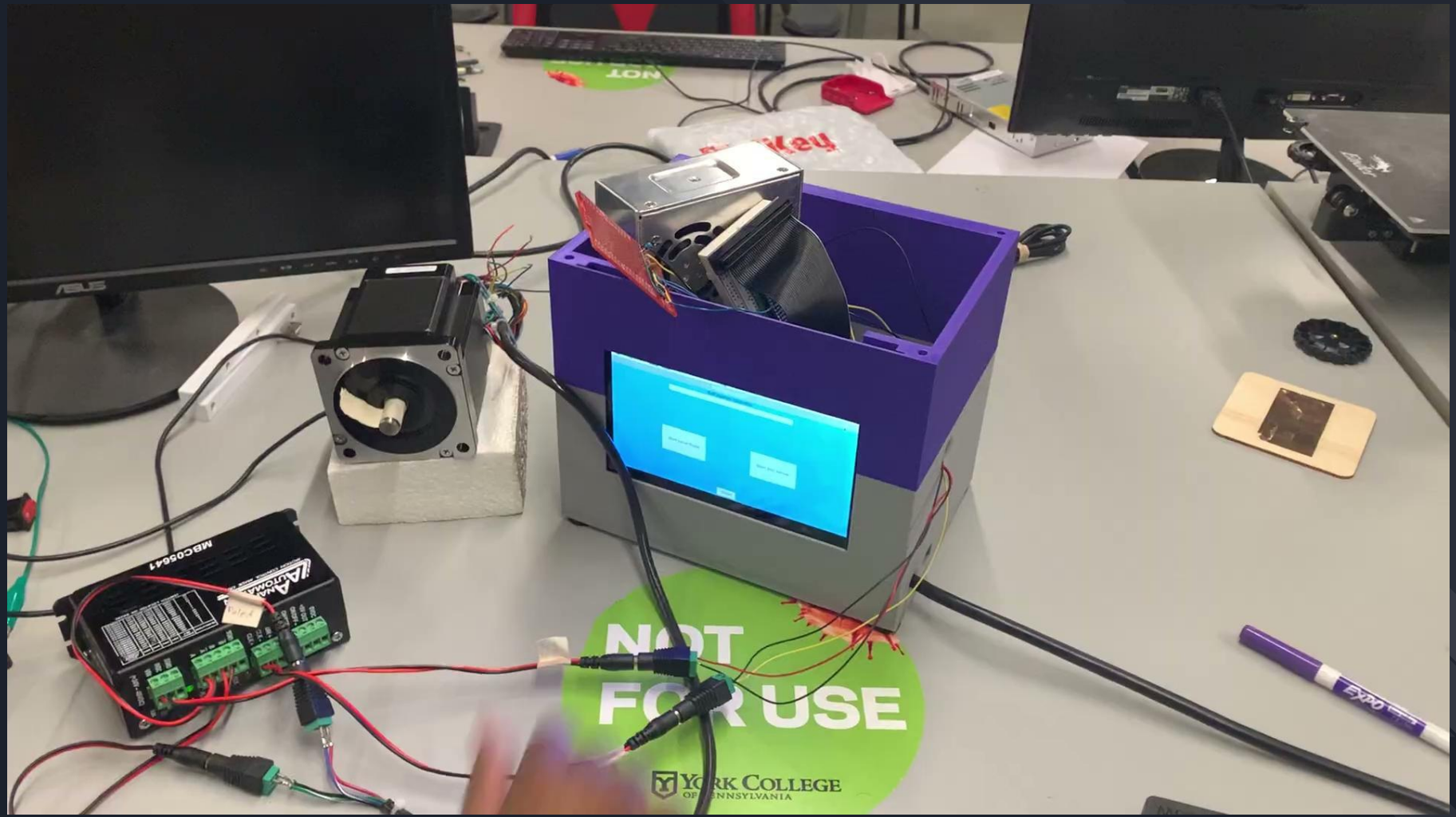


Current Implementation

Questions?

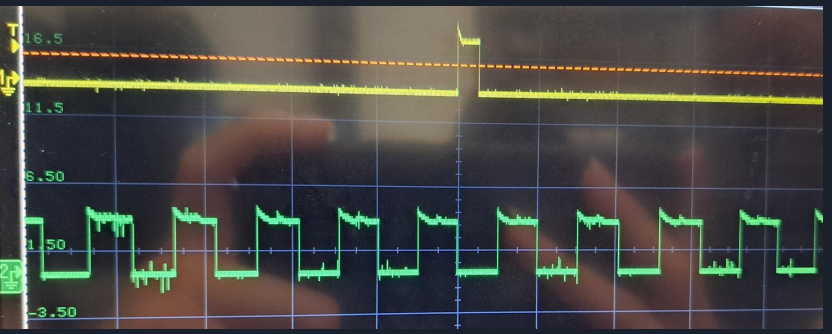
Demos


gyatt@raspberr..
Ball Spinner HMI
18:31
Ball Spinner HMI
Ball Spinner Controller
Start Local Mode
Start BSC Server
Close

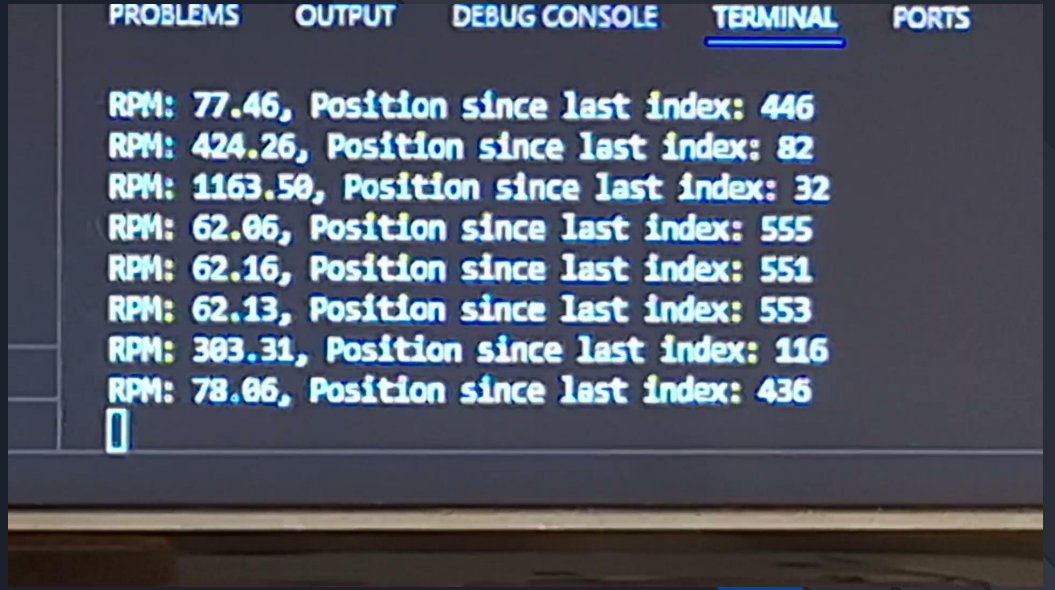

NOT
FOR USE
YORK COLLEGE
OF PENNSYLVANIA

Motor Encoder Readings

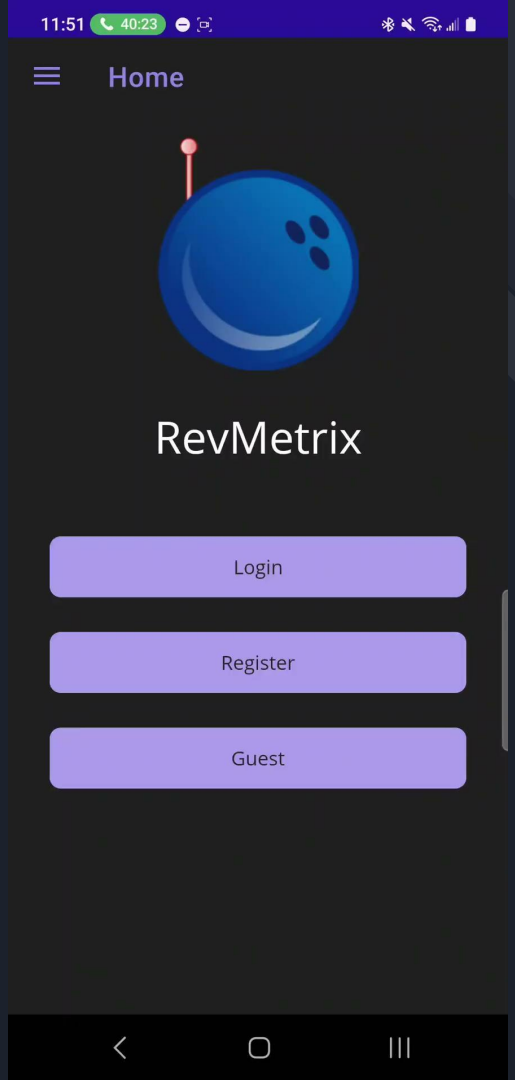
*Reads Rising Edge of each wave



$$Encoder\ RPM = \frac{1}{Time\ Between\ each\ Impulse\ (Seconds)} * \frac{60\ Seconds}{1\ minute}$$



*Missed Steps seem to Cause Inconsistent RPM


11:51
40:23
Home
RevMetrix
Login
Register
Guest

Mechanical Team Demo

Future Implementations

Simulation

- Port new simulation into BSA
- Axis and units for graphs
- Bezier inflection point automatic movement/controlled movement
- Update the Unity game to work with the current version of MAUI

BSA Backend/Cloud

- Motor instructions
- Save sensor modules to database
- Replace CSV with memory mapped files
- Save motor encoder data in database
- Replay shot feature with data from database
- Work with mobile team to get mobile schema in cloud

BSA Frontend

- Limit # Simulations and Ball Spinners to 1
- Registration page
- Sort arsenal page and shots page
- Prepare the Ball Spinner Application frontend for next semester

Ball Spinner Controller

- Improve encoder accuracy with Motor encoder
- Integrate encoders into system
- Finalize PCB Traces and print for Expo (Find Relays and fuses)
- Restructure Protocol Messages (Msg Types)

Ball Spinner Controller HMI

- Connect to smart dot in local mode
- Fix button position on motor controller (local)
- Investigate and draft smart dot data graphing
- Finish the pesky back button

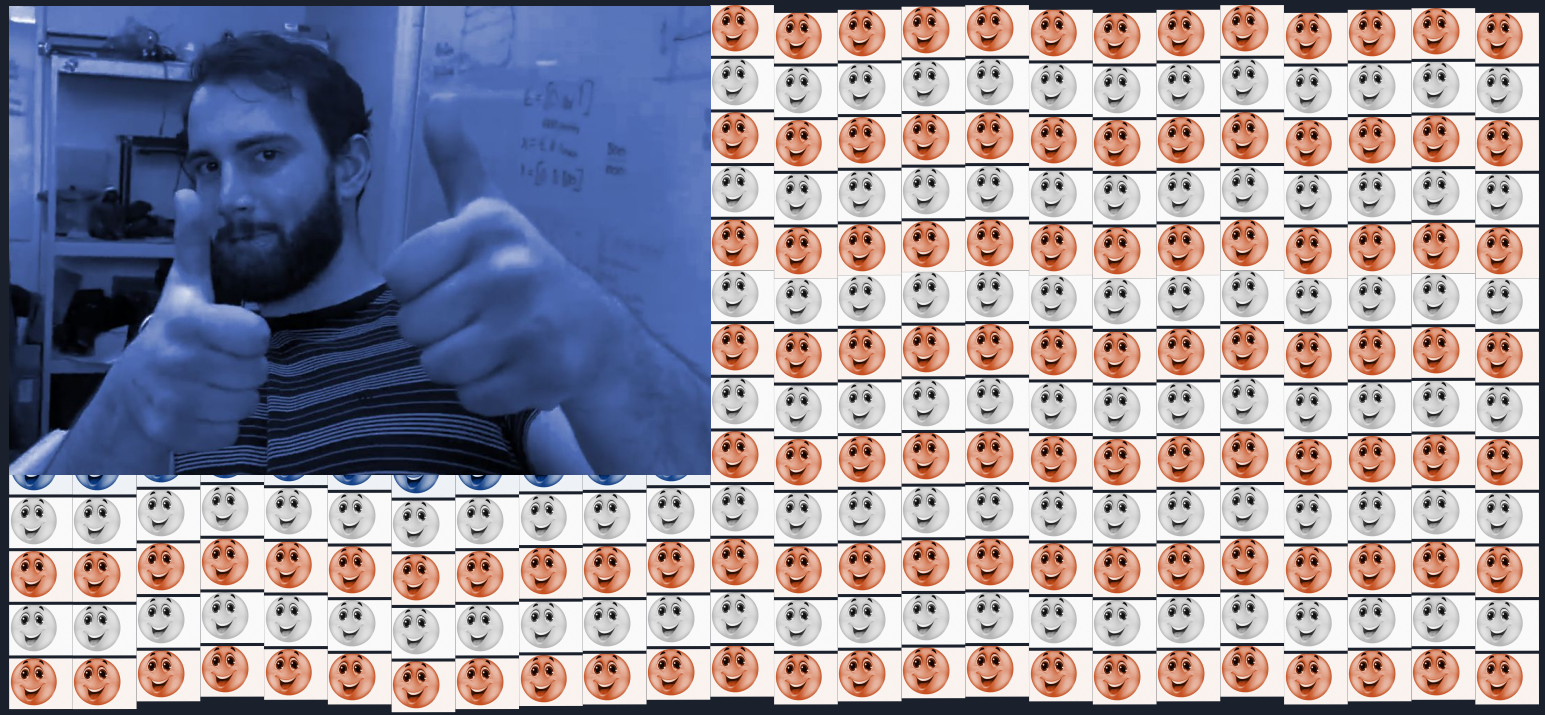
Ball Spinner Team

- Mechanism for third DoF
- Create an insert for smart module
- Magnetic Shielding for motor
- Motorize second DoF

Mobile Application Team

- Improved Game functionality
- Connection to cloud database
- Bluetooth/MMS (Stretch Goal)

Questions?



Please let Robert Fields graduate on May 17, 2025