
Train
&
Go

TEAM MEMBERS

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Electrical Engineer

Team / Object Detection Lead

Raleigh, MS

Slade Hicks

Electrical Engineer

Wireless Comm Lead

Laurel, MS

Brandon Waldrup

Electrical Engineer

Power Supply Lead

Laurel, MS

Kyler Smith

Computer Engineer

Motion Tracking Lead

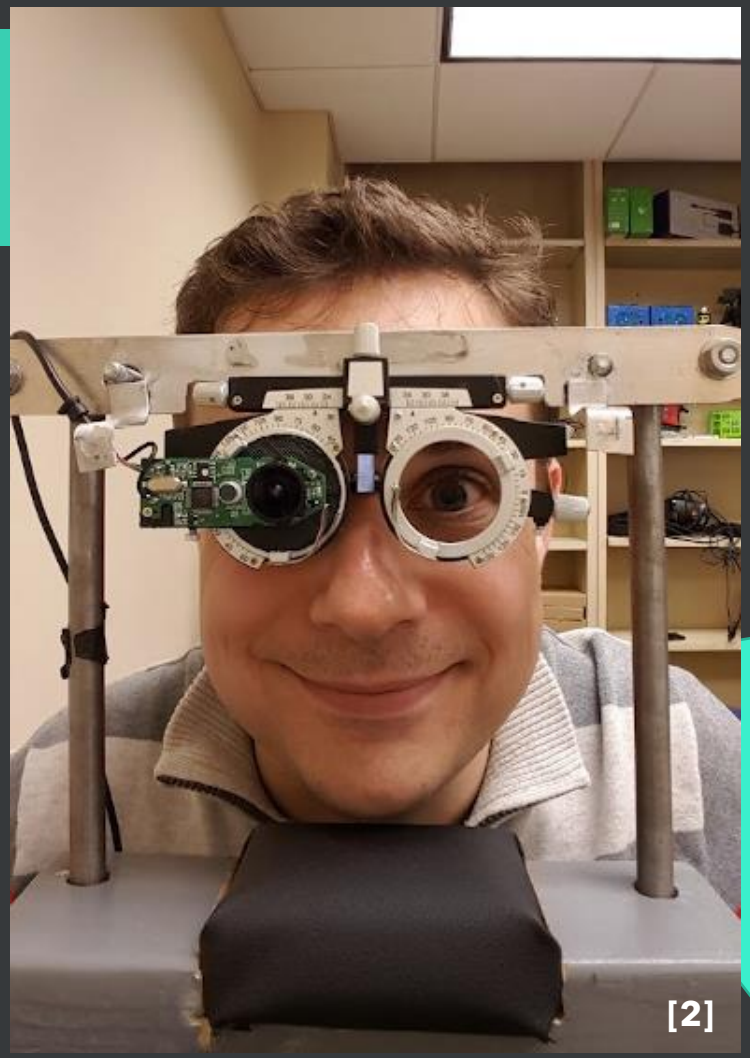
Southside, AL

INTERNAL ADVISOR

Dr. Ryan Green

- Assistant Professor, Mississippi State University
- Expertise in robotics and electromagnetics


[1]

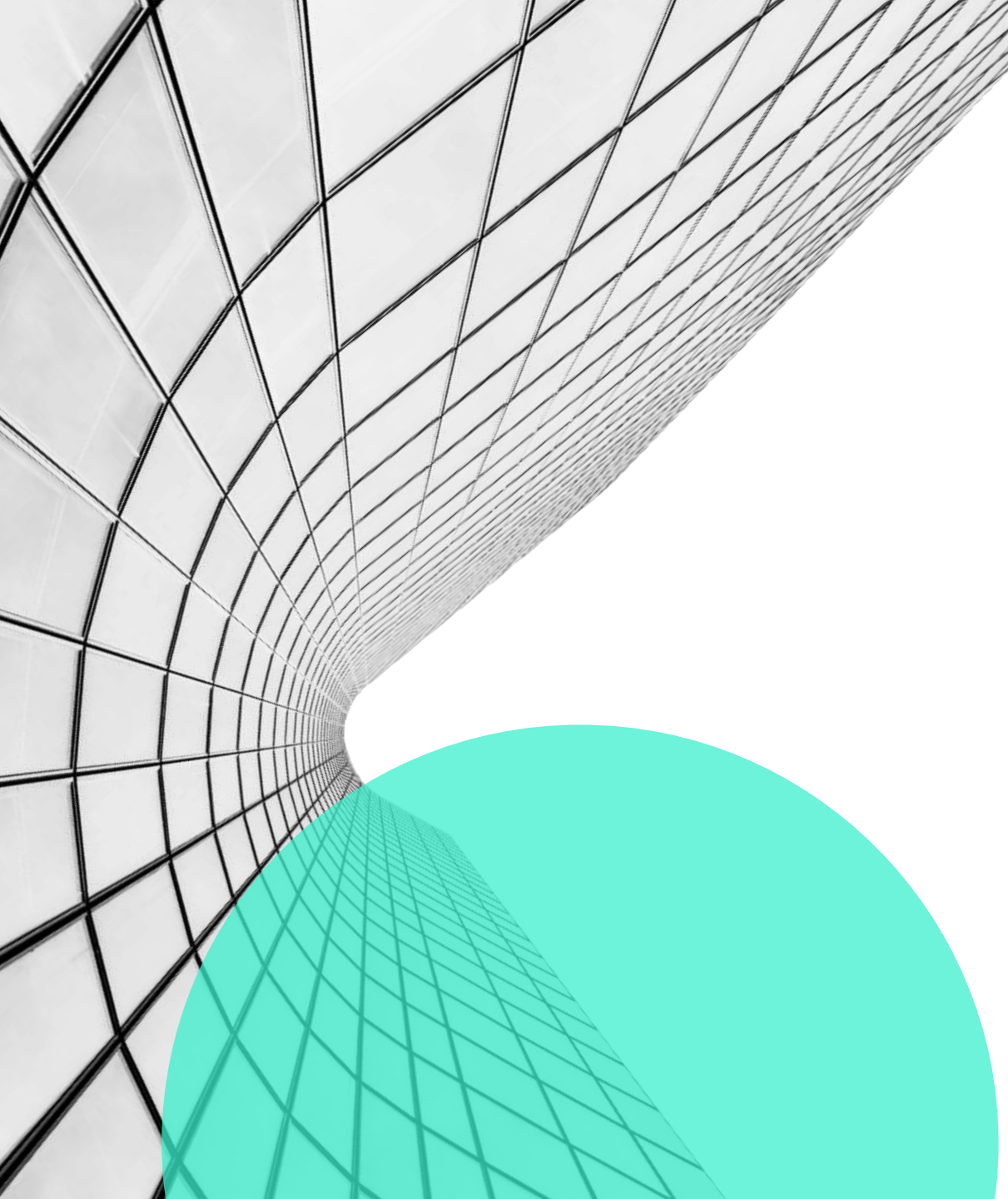

[2]

EXTERNAL ADVISOR

Dr. Adam Jones

- Assistant Professor, Mississippi State University
- Expertise in neuroscience, psychophysics, and virtual reality

OUTLINE



OVERVIEW

Problem

- 1 in 4 people in the U.S. have some form of disability [3]
- 1 in 10 have a mobility impairment [3]
- For people learning to use a power wheelchair it can be a slow and frustrating process
- Can cause personal injury or damage to property

[4]

Solution

- Training in virtual reality
- Improved spatial awareness
- Boost confidence

CONSTRAINTS

TECHNICAL CONSTRAINTS

Name	Description
Wheelchair Speed	The system is attached to a wheelchair moving no faster than five miles per hour [7].
Detection Distance	The system detects objects within a radius of no more than 2.2 meters.
Feedback Latency	This system's latency for sending feedback to the user in response to an object is no more than 250 milliseconds.
Sensor Accuracy	The system's false detection rate is less than 16 percent.
Wireless Range	The system can connect wirelessly to a Quest VR headset within 2.31 meters.
Wireless Latency	The wireless latency is less than 250 milliseconds.

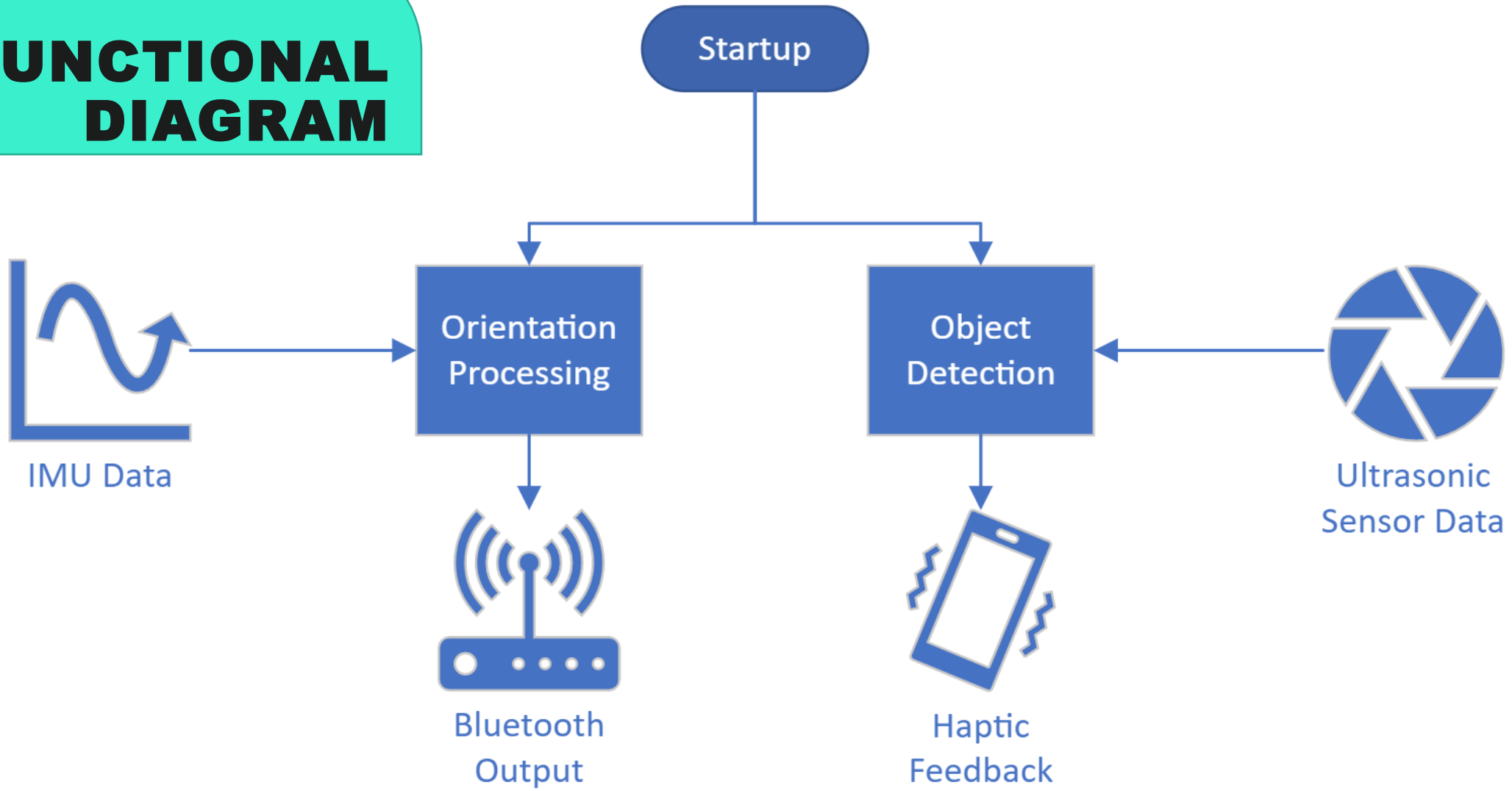
PRACTICAL CONSTRAINTS

Type	Name	Description
Sustainability	Reliability	Train and Go is designed to operate for at least five years without component failure.
Sustainability	Sensor Maintenance	Sensor connections are placed strategically to allow simple maintenance or replacement.
Usability	Product Versatility	Train and Go offers a flexible packaging system to attach to a variety of wheelchair designs and does not inhibit existing chair functionality.
Safety	Collision Detection	Train and Go provides the user with feedback to minimize the risk of collisions with obstacles.
Functionality	VR Communication	Train and Go communicates with a Quest VR headset.

ENGINEERING STANDARDS

Specific Standard	Standard Document	Specification / Application
IP-44	International Electrotechnical Commission Standard 60529	The system is protected from solid particles that are over 1 millimeter in size and from splashes of water [8].
Bluetooth	Institute of Electrical and Electronics Engineers 802-15.1	The system adheres to IEEE Bluetooth standards [9].
Protection Against Electric Shock	International Electrotechnical Commission Standard 62368	The electrical components of the system are isolated from the user to prevent electric shock [10].
Wheelchair Accessory	FDA 21 Code of Federal Regulations § 890.3910	Train and Go satisfies the FDA standards for a wheelchair accessory [11].

FUNCTIONAL DIAGRAM



HARDWARE

ASSEMBLY DIAGRAM

[12]

HARDWARE

Part Type	Part
Ultrasonic Sensor [13]	HCSR04
Rumble Motor [14]	Tatoko
DC-DC Converter [15]	Yipin Hexha
VR Headset [16]	Meta Quest Pro
IMU [17]	ISM330DHCX
Detection Microcontroller [18]	Elegoo Mega
Orientation Microcontroller [19]	ESP32
Battery [20]	Zeee 2S Lipo
Voltage Rail [21]	Evemodel

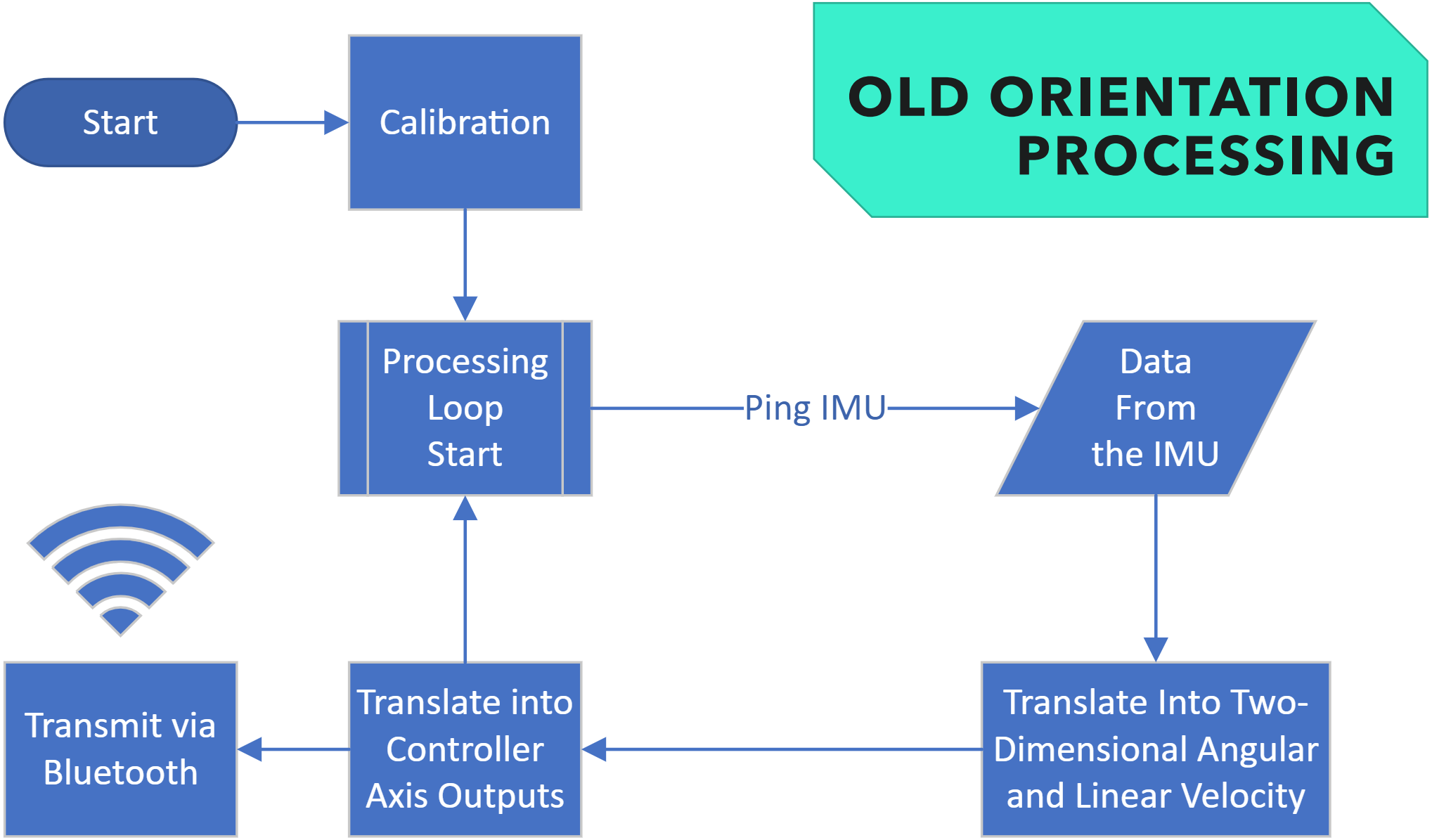
SOFTWARE

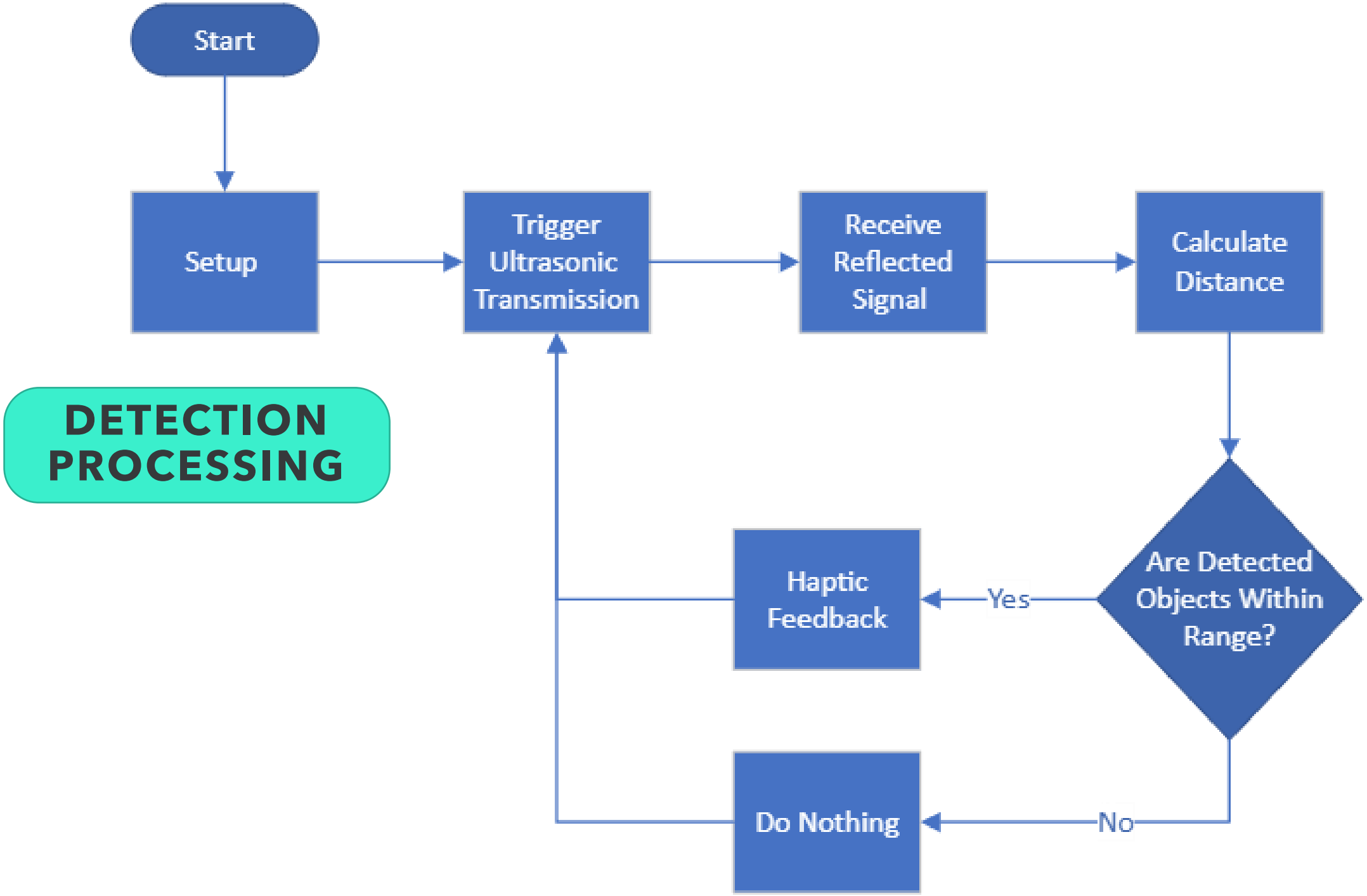
Meta [22]

ARDUINO™ [24]

UNREAL ENGINE [23]

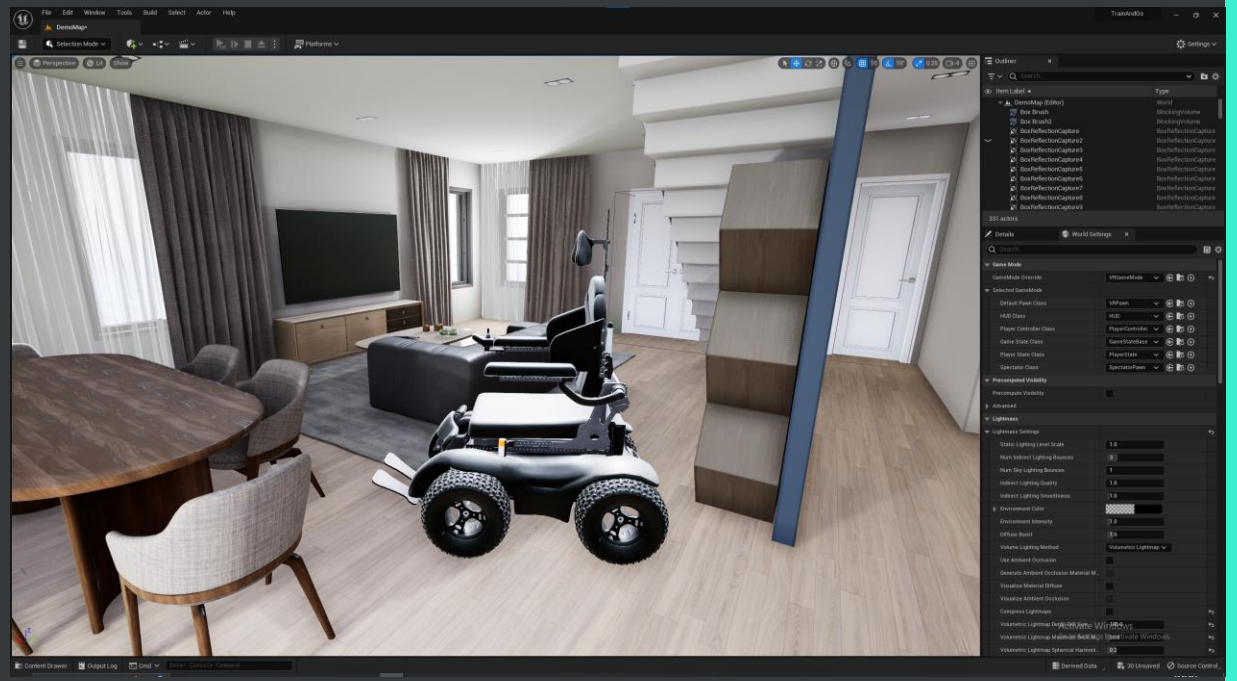
OLD ORIENTATION PROCESSING

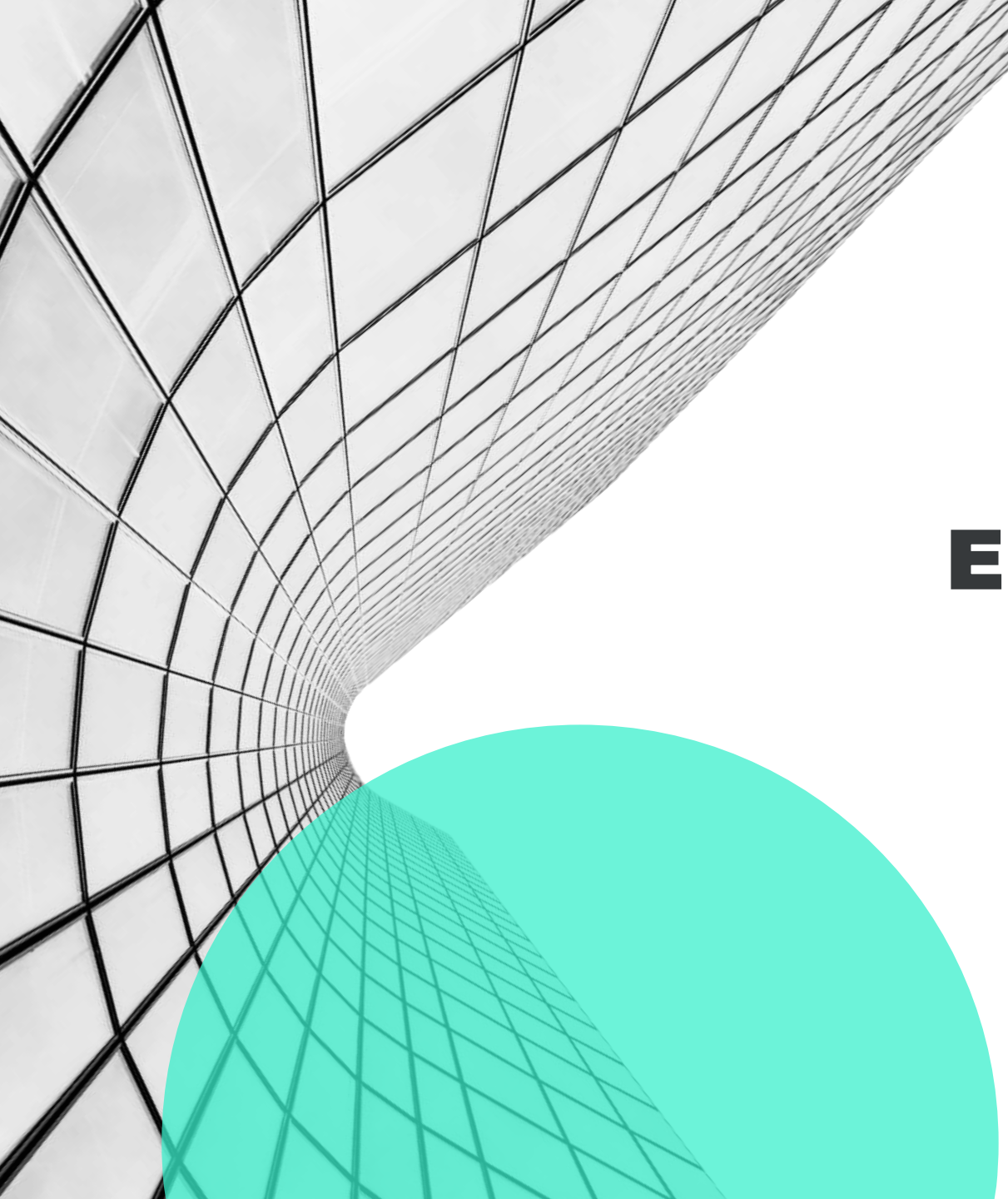



Start
Setup
Trigger Ultrasonic Transmission
Receive Reflected Signal
Calculate Distance
DETECTION PROCESSING
Are Detected Objects Within Range?
Yes
Haptic Feedback
No
Do Nothing

VR ENVIRONMENT

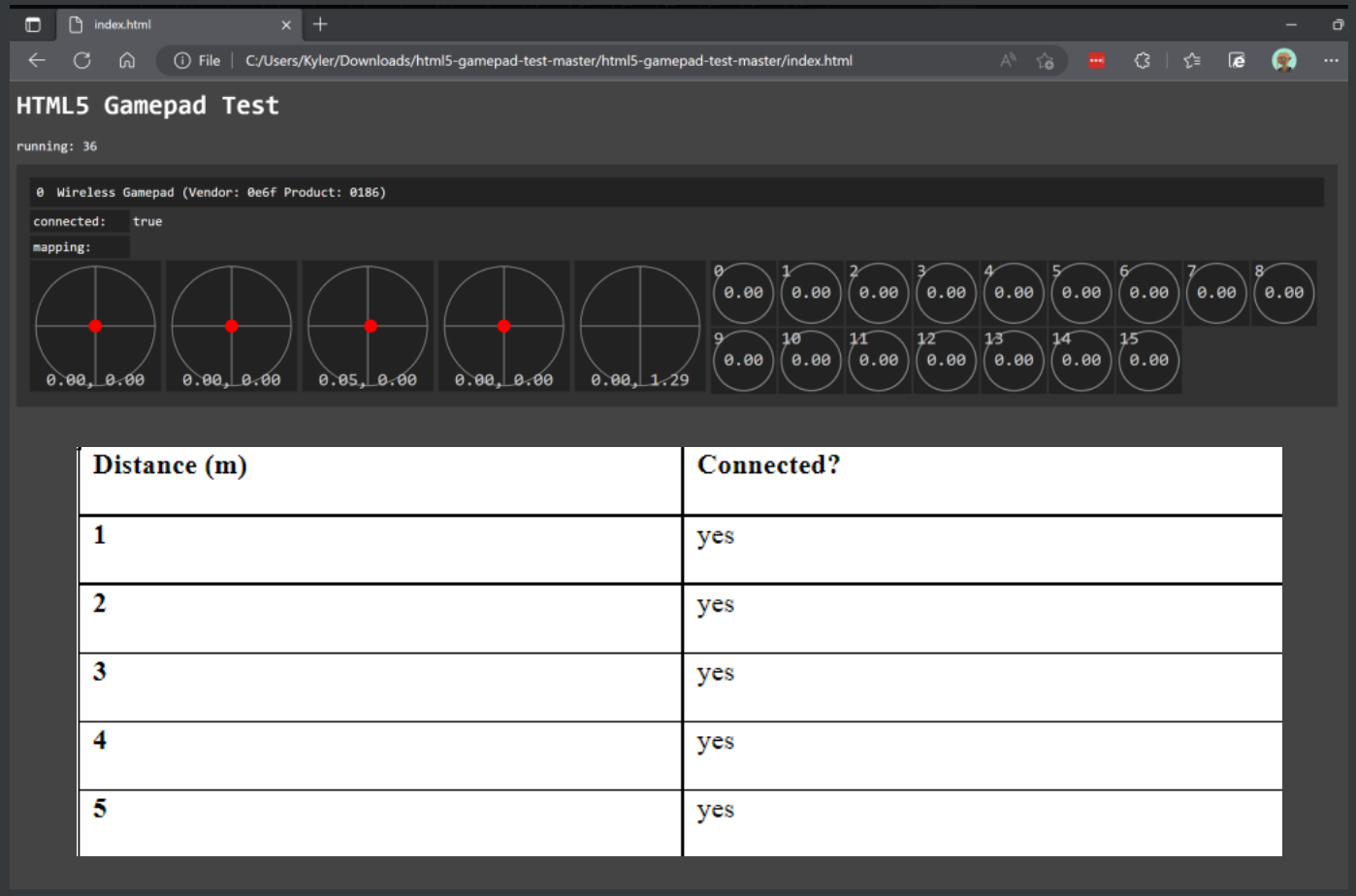
UNREAL ENGINE [23]





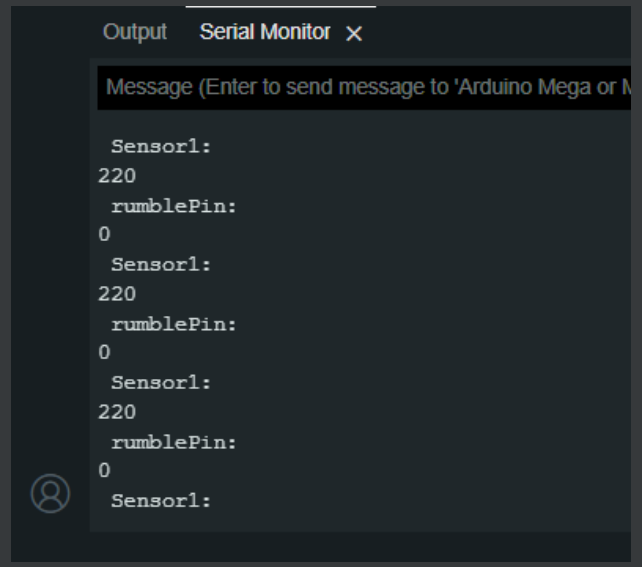
EVALUATION

BLUETOOTH CONNECTION RANGE



Distance (m)	Connected?
1	yes
2	yes
3	yes
4	yes
5	yes

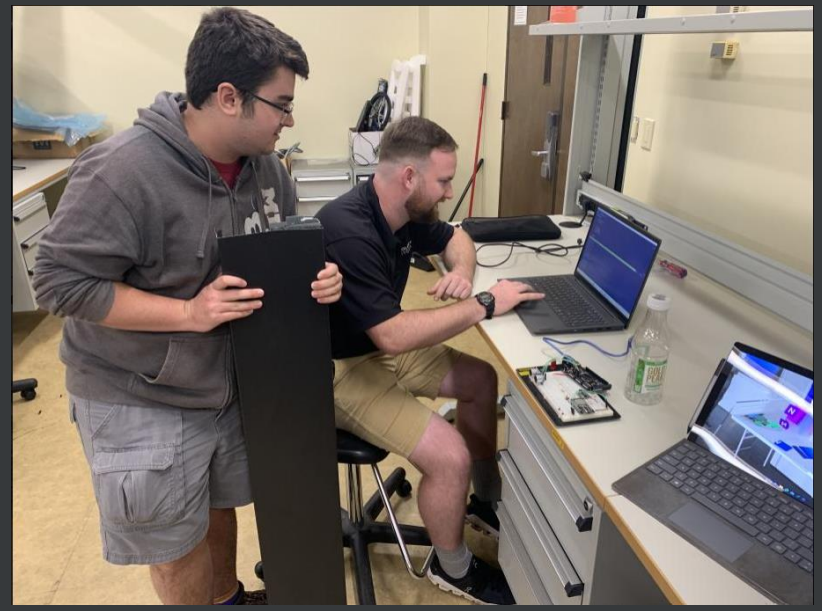
ULTRASONIC SENSOR



Actual Distance (m)	Sensor 1 (m)	Sensor 2 (m)	Sensor 3 (m)
0.40	0.44	0.45	0.44
0.60	0.65	0.63	0.65
0.80	0.86	0.82	0.84
1.00	1.04	1.03	1.03
1.20	1.20	1.21	1.20
1.40	1.41	1.41	1.40
1.60	1.61	1.61	1.60
1.80	1.83	1.82	1.80
2.00	2.03	2.03	2.00
2.20	2.25	2.23	2.21

SENSOR ACCURACY AND DISTANCE

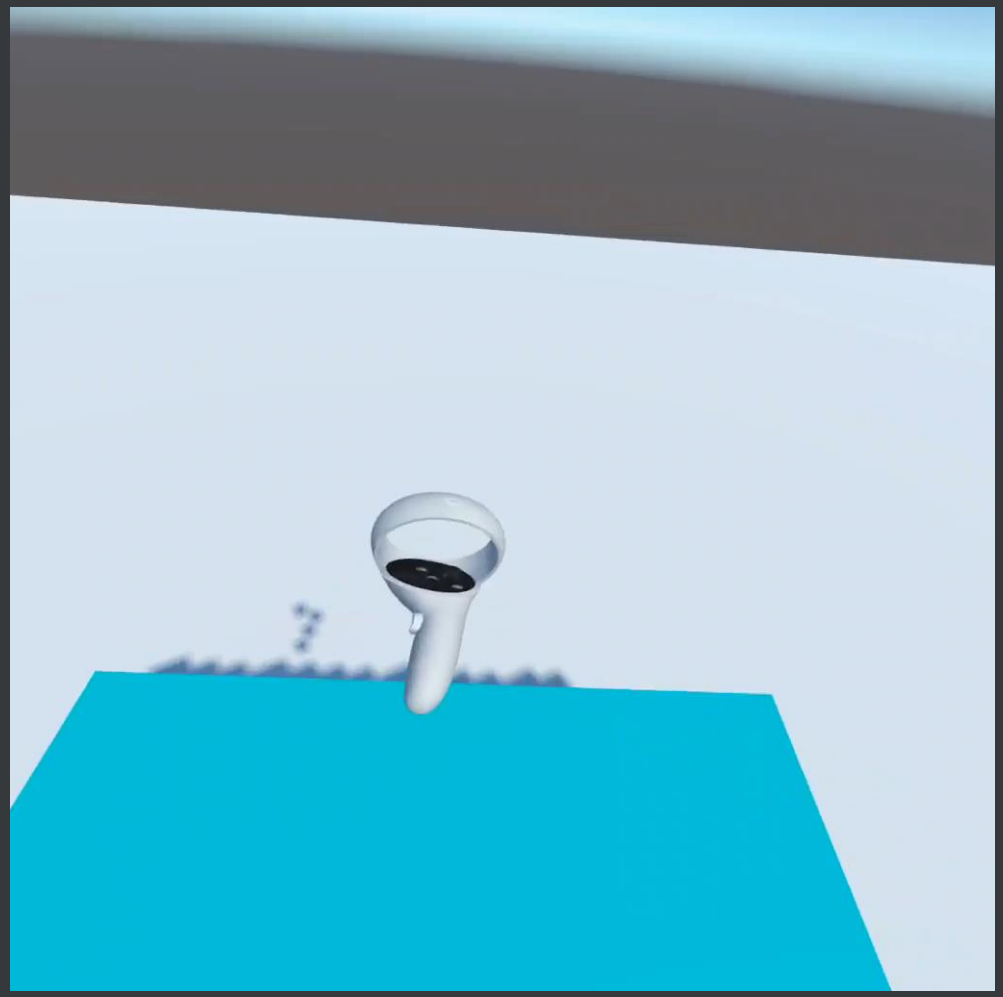
```
14:06:46.719 ->  Sensor1:
14:06:46.760 -> 29
14:06:46.760 ->  rumblePin:
14:06:46.760 -> 1
14:06:47.744 ->  Sensor1:
14:06:47.744 -> 19
14:06:47.744 ->  rumblePin:
14:06:47.744 -> 1
14:06:48.743 ->  Sensor1:
14:06:48.743 -> 19
14:06:48.743 ->  rumblePin:
14:06:48.783 -> 1
14:06:49.741 ->  Sensor1:
14:06:49.741 -> 19
14:06:49.741 ->  rumblePin:
14:06:49.782 -> 1
14:06:50.761 ->  Sensor1:
14:06:50.761 -> 19
14:06:50.761 ->  rumblePin:
14:06:50.761 -> 1
14:06:51.842 ->  Sensor1:
14:06:51.842 -> 1207
14:06:51.842 ->  rumblePin:
14:06:51.882 -> 0
14:06:52.860 ->  Sensor1:
14:06:52.860 -> 1207
14:06:52.860 ->  rumblePin:
14:06:52.903 -> 0
14:06:53.894 ->  Sensor1:
14:06:53.894 -> 1207
14:06:53.894 ->  rumblePin:
14:06:53.942 -> 0
14:06:54.886 ->  Sensor1:
14:06:54.918 -> 1207
14:06:54.918 ->  rumblePin:
14:06:54.918 -> 0
14:06:55.938 ->  Sensor1:
14:06:55.938 -> 1207
14:06:55.938 ->  rumblePin:
```



Test Number	Latency (ms)
1	72
2	73
3	72
4	72
5	72
6	73
7	72
8	73
9	72
10	72

IP44 WATER RESISTANCE TEST

IMU ACCURACY



```
Measured Angle: 0
Measured Angle: -1
Measured Angle: -1
Measured Angle: -3
Measured Angle: -2
Measured Angle: 0
Measured Angle: 1
Measured Angle: 0
Measured Angle: 0
Measured Angle: 2
Measured Angle: -20
Measured Angle: -21
Measured Angle: -22
Measured Angle: -22
Measured Angle: -22
Measured Angle: -22
Measured Angle: -22
Measured Angle: -22
Measured Angle: -21
Measured Angle: -19
Measured Angle: -19
Measured Angle: 2
Measured Angle: -20
Measured Angle: -21
Measured Angle: -20
```

DRIFT TEST

Meta Touch Pro Controller Block Diagram

Created on Jan'23 by Limas Lin

Top-Facing
6DoF SLAM
OV7251 [Sunny]
640x480

Left-Front
6DoF SLAM
OV7251 [Sunny]
640x480

Right-Front
6DoF SLAM
OV7251 [Sunny]
640x480

Qualcomm
SnapDragon
662

Main PCB Top Side

Main PCB Bottom Side

B/Y
A/X
Home/Menu
3D Thumbstick
Index Trigger
Action Trigger
Touch Panel

ATMEL (Microchip)
ATSAMD20G17
ARM M0+ 128KFlash 16K SRAM

3x Hall Effect Sensors: Allegro A1392 & A1395

Z-Axis LRA
(On Index Trigger)

Z-Axis LRA
(On Thumb Rest)

Haptic Controller
Cirrus Logic
CS40L125

X-Axis VCM
(On Ctlr Lower Body)

Pressure Sensor
(used with stylus tip)

6-Axis IMU TDK
ICM-42686

WiFi + BLE
QCOM WCN3950

(Used for sending Ctlr SLAM data to HMD)

BLE5 Nordic
nRF52832

RF FEM
Skyworks 66111-11

RAM – 1GB LPDDR4
SK-Hynix H54G38AYRBX259-1G

ROM - 4GB eMMC FLASH
Toshiba THGBMNG5D1LBAIL

QCOM PMIC
PMI632 & PM4250

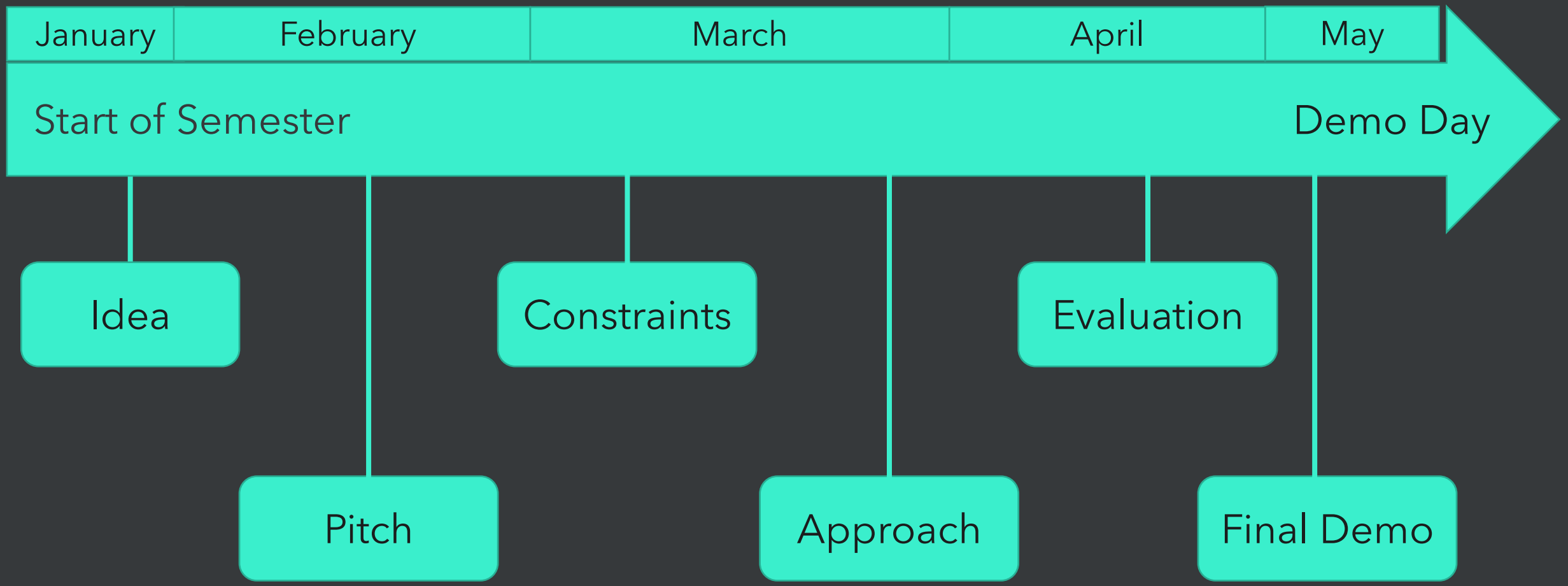
SCUD 16850 Li-Ion Battery
2880mAh/10.52Wh

Charging
Pogo Pins

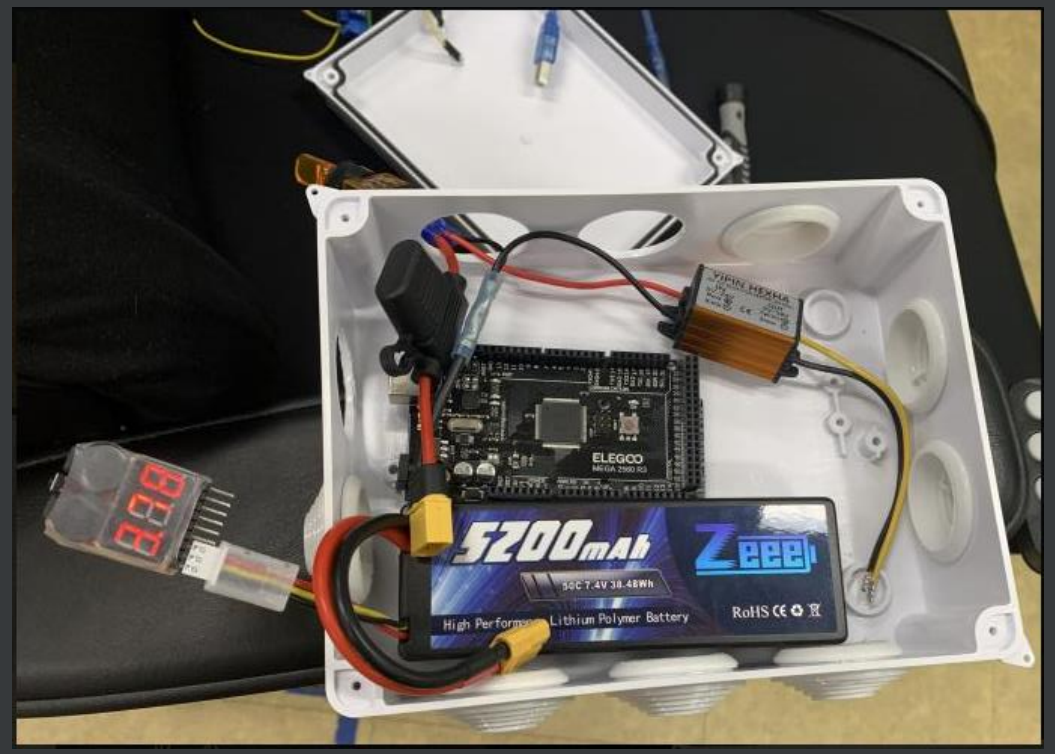
NEW APPROACH TO TRACKING ORIENTATION

PROGRESS

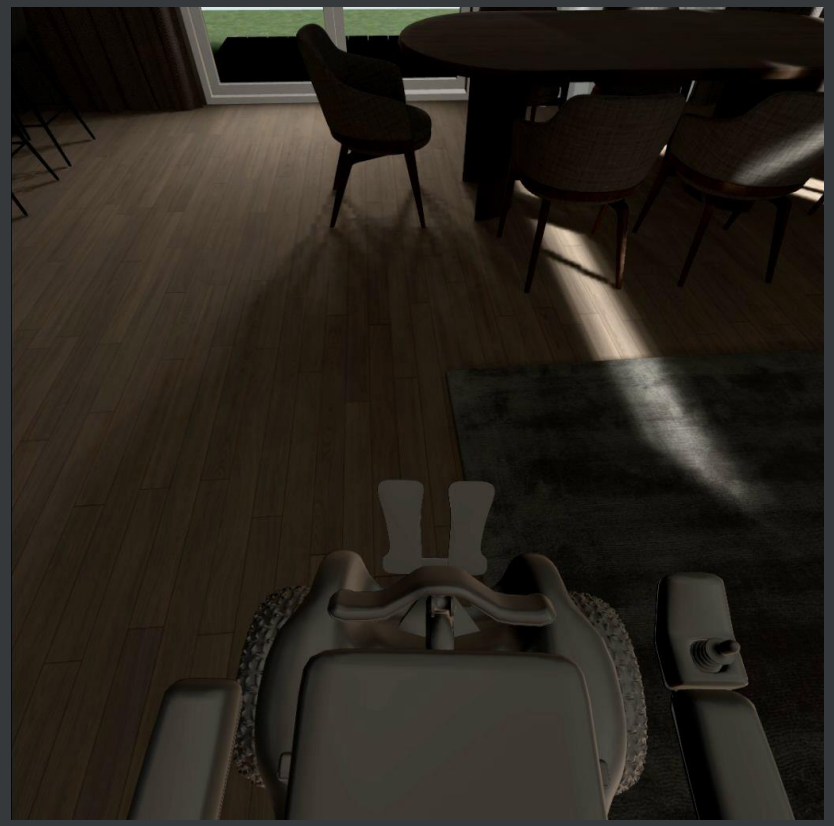
TIMELINE


January
February
March
April
May
Start of Semester
Demo Day
Idea
Pitch
Constraints
Approach
Evaluation
Final Demo

ASSEMBLY



VR ENVIRONMENT



VR ENVIRONMENT

FINAL TO DO LIST AND IMPROVEMENTS FOR REVISION: 02

What is left :

- Finish testing any remaining subsystems checks
- Finalize construction of the prototype for demo day

Future improvements:

- Develop a PCB for sensor connections inside the enclosure
- Curate additional VR environments
- Optimize obstacle detection and haptic feedback to be directional

CONCLUSION

- Train and Go provides an enhanced VR wheelchair training experience
- Train and Go ensures user safety during that training experience
- Train and Go empowers people with disabilities

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