Train
&
Go

# TEAM MEMBERS



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Electrical Engineer

Team / Object Detection Lead

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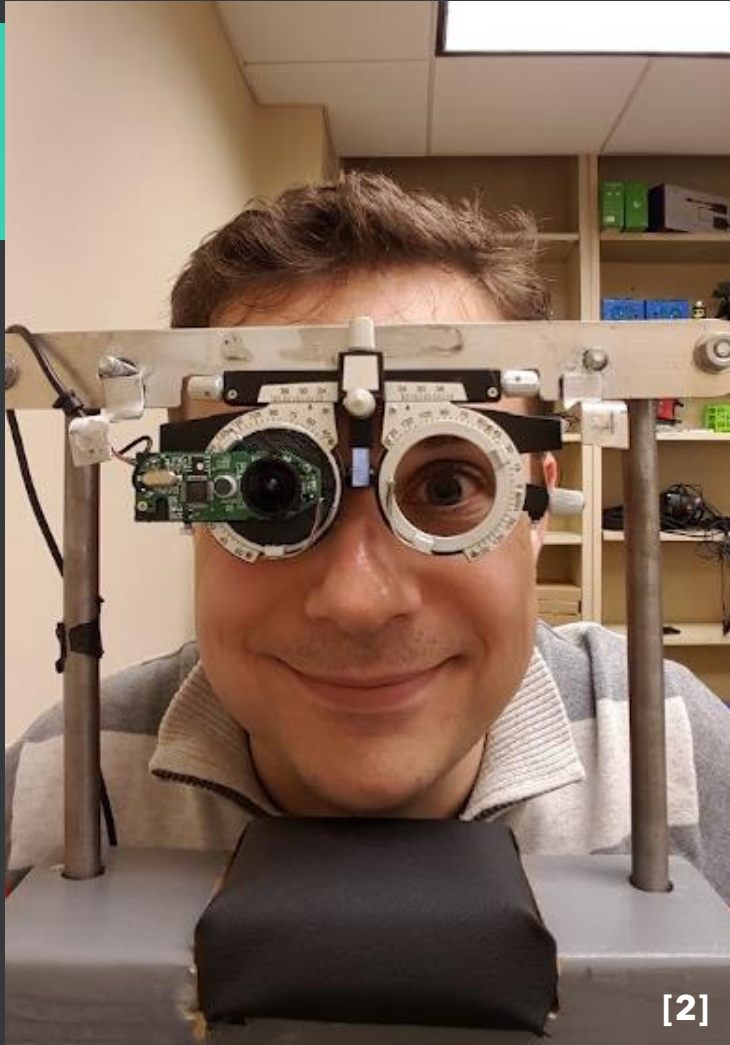
# INTERNAL ADVISOR

## 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 → Constraints → Approach → Progress

# 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

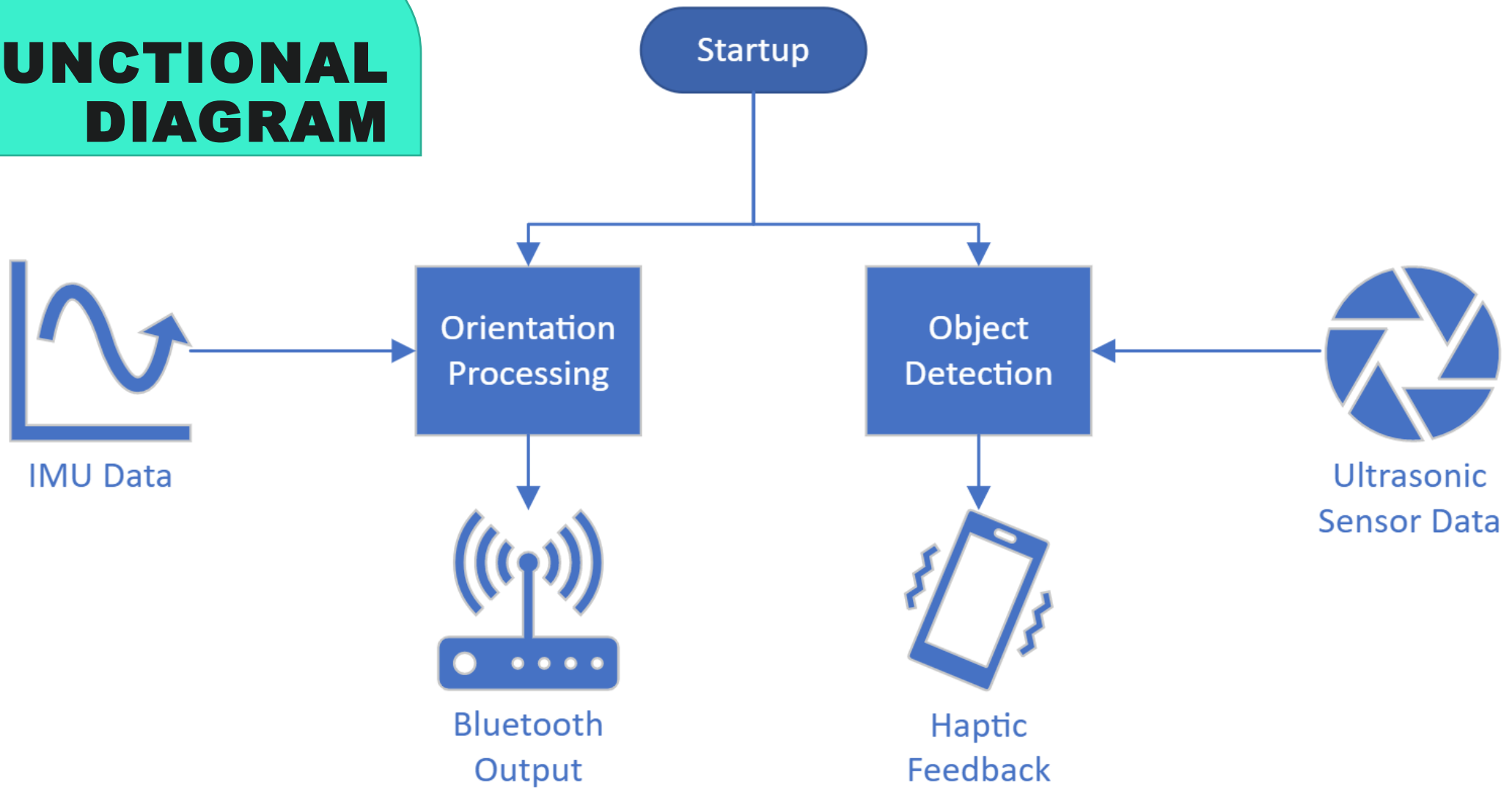| Name | Description |
| --- | --- |
| Wheelchair Speed | The system is attached to a wheelchair moving no faster than five miles per hour [7]. |
| Detection Distance | The system detects objects within a radius of no more than 2.2 meters. |
| Feedback Latency | This system's latency for sending feedback 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

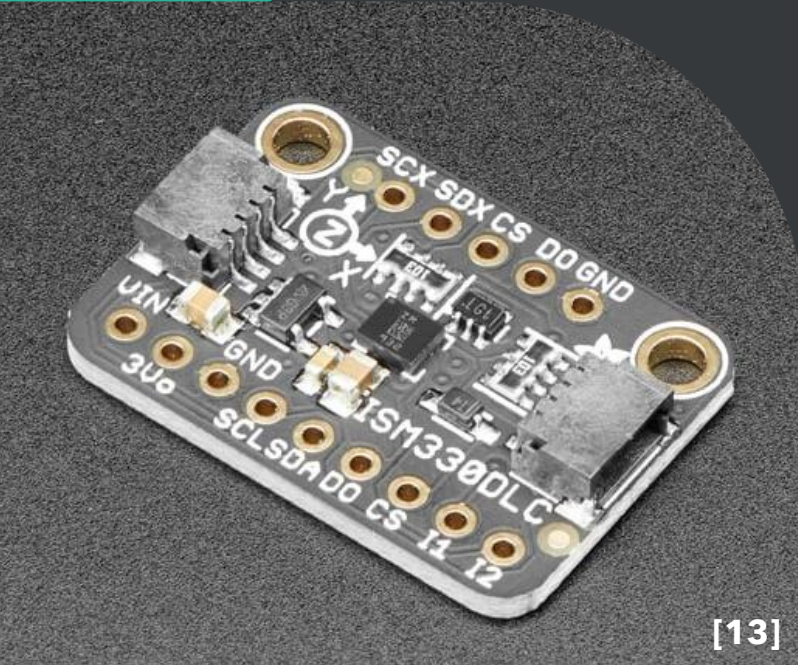| Specific Standard | Standard Document | Specification / Application |
|---|---|---|
| IP-44 | International Electrotechnical Commission Standard 60529 | The system is protected from solid particles that are over 1 millimeter in size and from splashes of water [8]. |
| Bluetooth | Institute of Electrical 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

Startup

Orientation Processing

Object Detection

IMU Data

Bluetooth Output

Haptic Feedback

Ultrasonic Sensor Data

# ASSEMBLY DIAGRAM

Rumble Motor

Power Source

Obstacle Detection Microcontroller

IMU

Orientation Microcontroller

Wiring

[12]

Ultrasonic Sensors

# APPROACH: HARDWARE

IMU

[13]

| Product | Input Voltage (V) | Current Usage (mA) | Linear Acceleration Zero-G Offset Value (mg) | Cost (USD) |
|---|---|---|---|---|
| Requirements | ≥ 3.3 | ≤ 5 | ≤ 25 | ≤ 50.00 |
| ISM330DHCX [13] | 3.3 | 1.2 | 10 | 20.00 |
| LSM6DSOX [14] | 3.3 | 0.55 | 20 | 12.00 |
| LSM6DSO32 [15] | 3.3 | 0.55 | 20 | 12.50 |

# ORIENTATION MICROCONTROLLER

| Product | Working Voltage (V) | Working Current (mA) | Clock Speed (Hz) | GPIO Pins | Cost (USD) |
|---|---|---|---|---|---|
| Requirements | 3.3 - 5 | ≤ 1,000 | ≥ 4K | ≥ 2 | ≤ 100.00 |
| Raspberry Pi 4B [16] | 5 | 3,000 | 1.5B | 40 | 152.00 |
| ESP32 [17] | 2.3 - 3.6 | 500 | 60M | 22 | 6.67 |
| Libre Le Potato [18] | 5 | 800 | 1.5B | 40 | 35.00 |
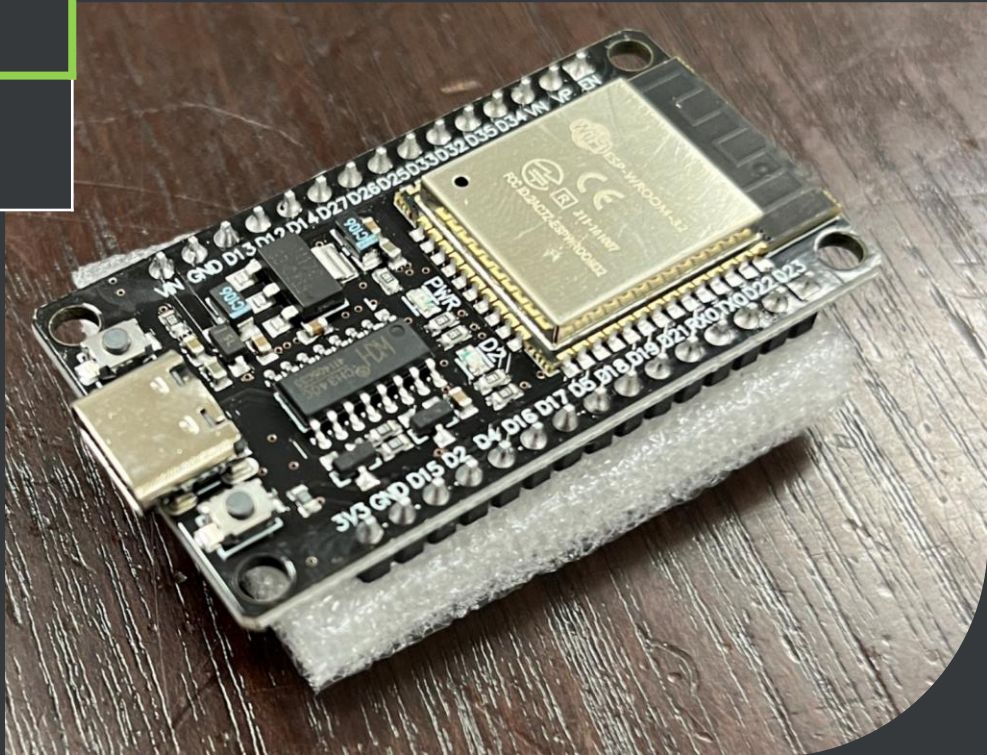
# ULTRASONIC SENSOR

| Product | Working Voltage (V) | Working Current (mA) | Max Range (m) | Measuring Angle (Degrees) | Cost (USD) |
|---|---|---|---|---|---|
| Requirements | 3.3 – 5 | ≤ 15 | ≥ 2.2 | N/A | N/A |
| RCWL-1601 [19] | 3.3 – 5 | 15 | 4.5 | 15 | 3.95 |
| US-100 [20] | 3.3 – 5 | 15 | 4.5 | X < 15 | 6.95 |
| HC-SR04 [21] | 3.3 – 5 | 15 | 4 | 15 | 1.30 |
| A02YYUW [22] | 3.3 – 5 | 8 | 4.5 | 60 | 17.88 |
| Grove [23] | 3.3 – 5 | 8 | 3.5 | 15 | 3.95 |
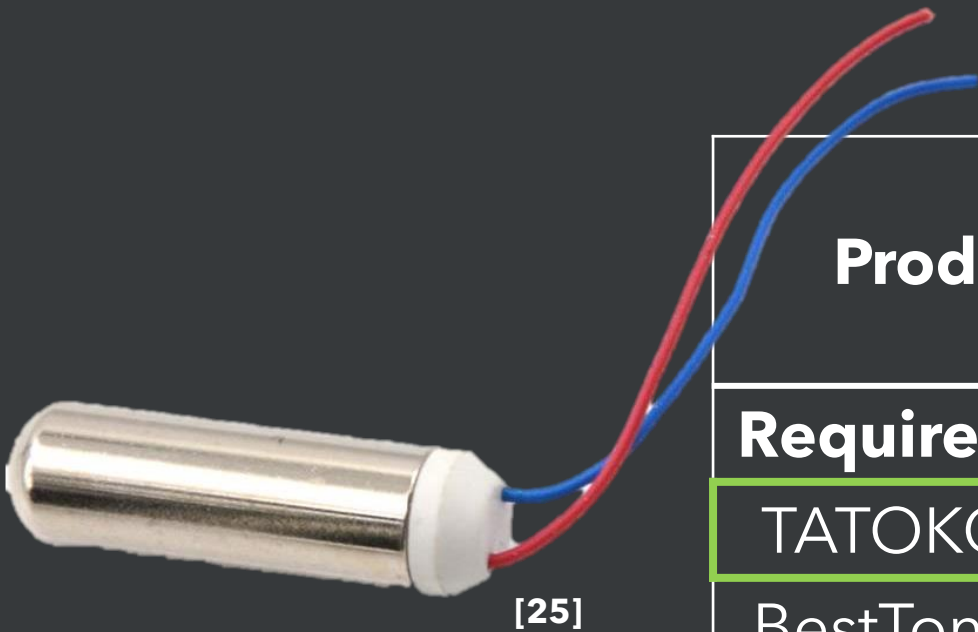
# RUMBLE MOTOR

| Product | Working Voltage (V) | Working Current (mA) | Rated Speed (rad/s) | Cost (USD) |
|---|---|---|---|---|
| Requirements | ≥ 3 | ≤ 25mA | ≥ 1675 | N/A |
| TATOKO [25] | 3 | 20 | 1675 | 2.14 |
| BestTong [26] | 1.5 | 20 | 837 | 1.19 |
| BOJACK [27] | 3 | 20 | 1675 | 3.50 |

[25]

[28]

| Product | Input Voltage (V) | Clock Speed (MHz) | Analog GPIO Pins | Cost (USD) |
|---|---|---|---|---|
| Requirements | N/A | ≥ 16 | ≥ 16 | N/A |
| Elegoo Mega [28] | 7 – 12 | 16 | 16 | 21.00 |
| Shield Buddy [29] | 7 – 12 | 300 | 16 | 129.94 |
| Arduino Mega [30] | 7 – 12 | 16 | 16 | 48.20 |

# BLUETOOTH TRANSMITTER

| Product | Working Voltage (V) | Working Current (mA) | Connectivity | Cost (USD) |
|---|---|---|---|---|
| Requirements | ≤ 5 | ≤ 500 | Bluetooth | ≤ 30.00 |
| DSD Tech HM-10 BT Module[31] | 3.6 – 6 | 50 | Bluetooth 4.0 BLE | 10.99 |
| ESP32 [17] | 2.3 – 3.6 | 500 | Bluetooth 4.2 | 6.67 |
| Adafruit Feather nRF52840 Express [32] | 3.7 | 500 | Bluetooth LE | 24.95 |
| Raspberry Pi 4 Model B [16] | 5 | 1300 | Bluetooth 5.0 | 152.00 |

[34]
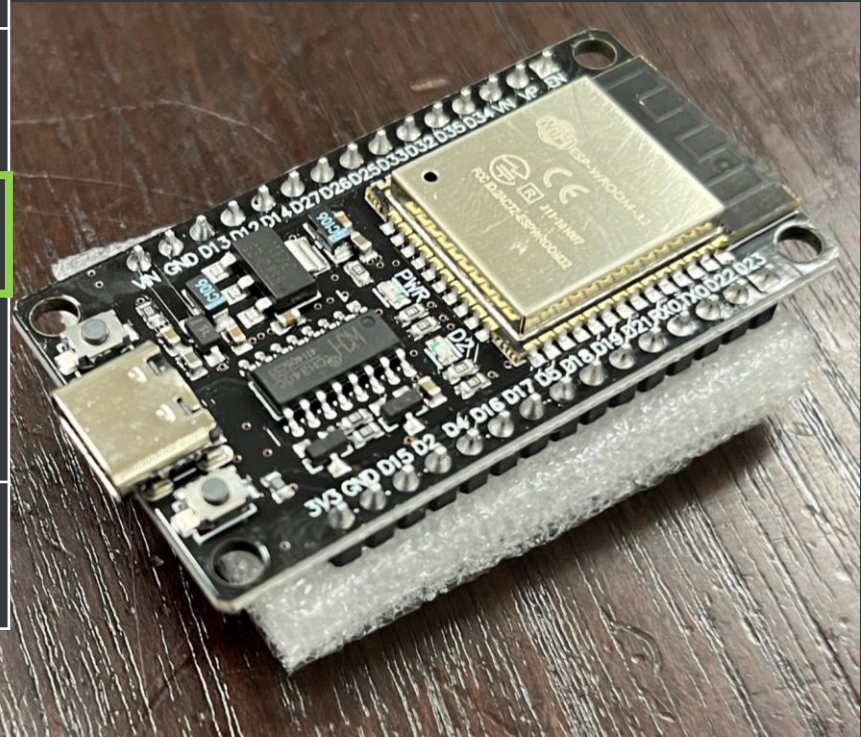
# POWER SOURCE/BATTERY

| Product | Working Voltage (V) | Working Current (mA) | Capacity (mAh) | Cost (USD) |
|---|---|---|---|---|
| Requirements | ≤ 7.4 | ≤ 3000 | ≥ 3000 | ≤ 100.00 |
| SoloGood RadioMaster TX16S [33] | 7.4 | 5000 | 5000 | 25.00 |
| Zeee 2S Lipo [34] | 7.4 | 5000 | 5400 | 38.00 |
| Razepony [35] | 7.4 | 5000 | 4800 | 22.00 |
| HXJNLDC [36] | 3.7 | 800 | 800 | 15.00 |

[37]
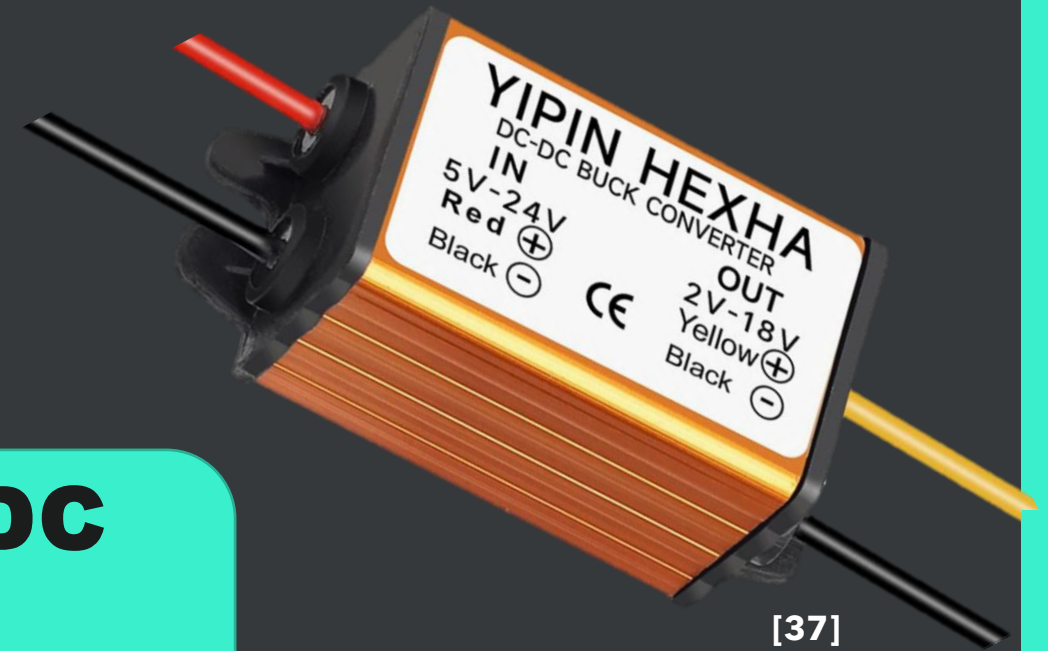
# POWER CONVERSION/DC-DC CONVERTER

| Product | Working Voltage (V) | Working Current (mA) | Cost (USD) |
|---|---|---|---|
| **Requirements** | **7.4 to 3.3** | **≥ 3000** | **≤ 20.00** |
| YIPIN HEXHA [37] | 24 – 5 to 2 – 18 | 3000 | 12.00 |
| Drok [38] | 8 – 22 to 3 – 15 | 3000 | 15.00 |
| Red Wolf [39] | 12 TO 3.3, 5, 6, AND 9 | 3000 | 14.00 |

[40]

# POWER RAIL/TERMINAL BLOCK

| Product | Working Voltage (V) | Working Current (mA) | Number of Outputs | Cost (USD) |
|---|---|---|---|---|
| Requirements | ≥ 3.3 | ≥ 3000 | ≥ 10 | ≤ 20.00 |
| EVEMODEL PCB007 [40] | 24 | 10000 | 12 | 7.00 |
| OONO D1410 [41] | 48 | 16000 | 12 | 11.00 |
| HCDC D1338 [42] | 300 | 30000 | 12 | 18.00 |

# VR HEADSET


[47]

| Product | Weight (lbs) | Connection | Tracking | Cost (USD) |
|---|---|---|---|---|
| **Requirements** | **≤ 2** | **Wireless** | **On-board** | **≤ 1,500.00** |
| Valve Index [43] | 1.78 | Wired | Steam VR Base Stations | 750.00 |
| Meta Quest 2 [44] | 1.11 | Wireless | On-board | 400.00 |
| HTC Vive XR Elite [45] | 1.38 | Wireless | On-board | 1,100.00 |
| Meta Quest Pro [46] | 1.59 | Wireless | On-board | 1,000.00 |

SOFTWARE

Meta [48]

ARDUINO [50]

UNREAL ENGINE [49]

ORIENTATION PROCESSING

Start → Calibration → Processing Loop Start → Ping IMU → Data From the IMU → Translate Into Two-Dimensional Angular and Linear Velocity → Translate into Controller Axis Outputs → Transmit via Bluetooth
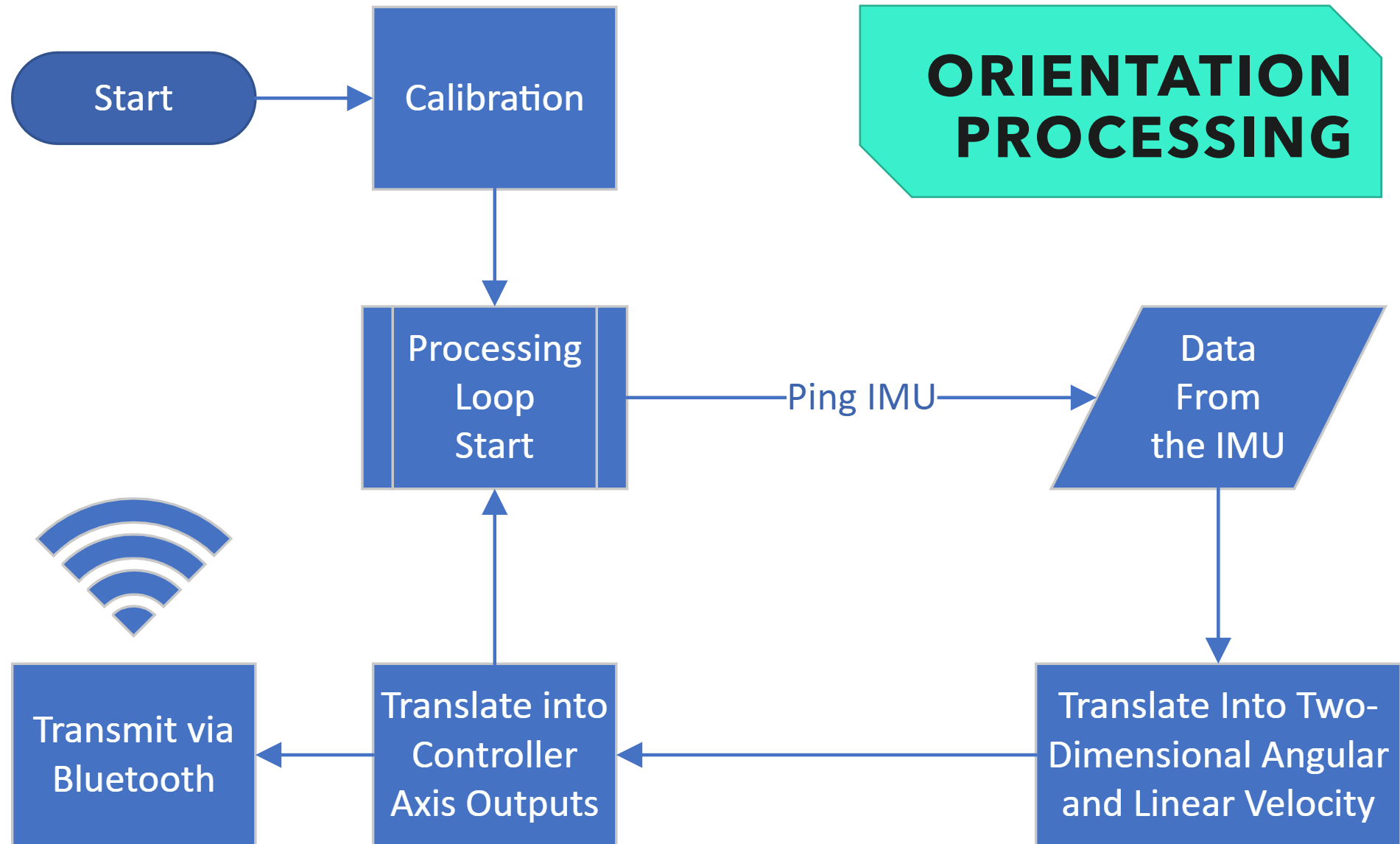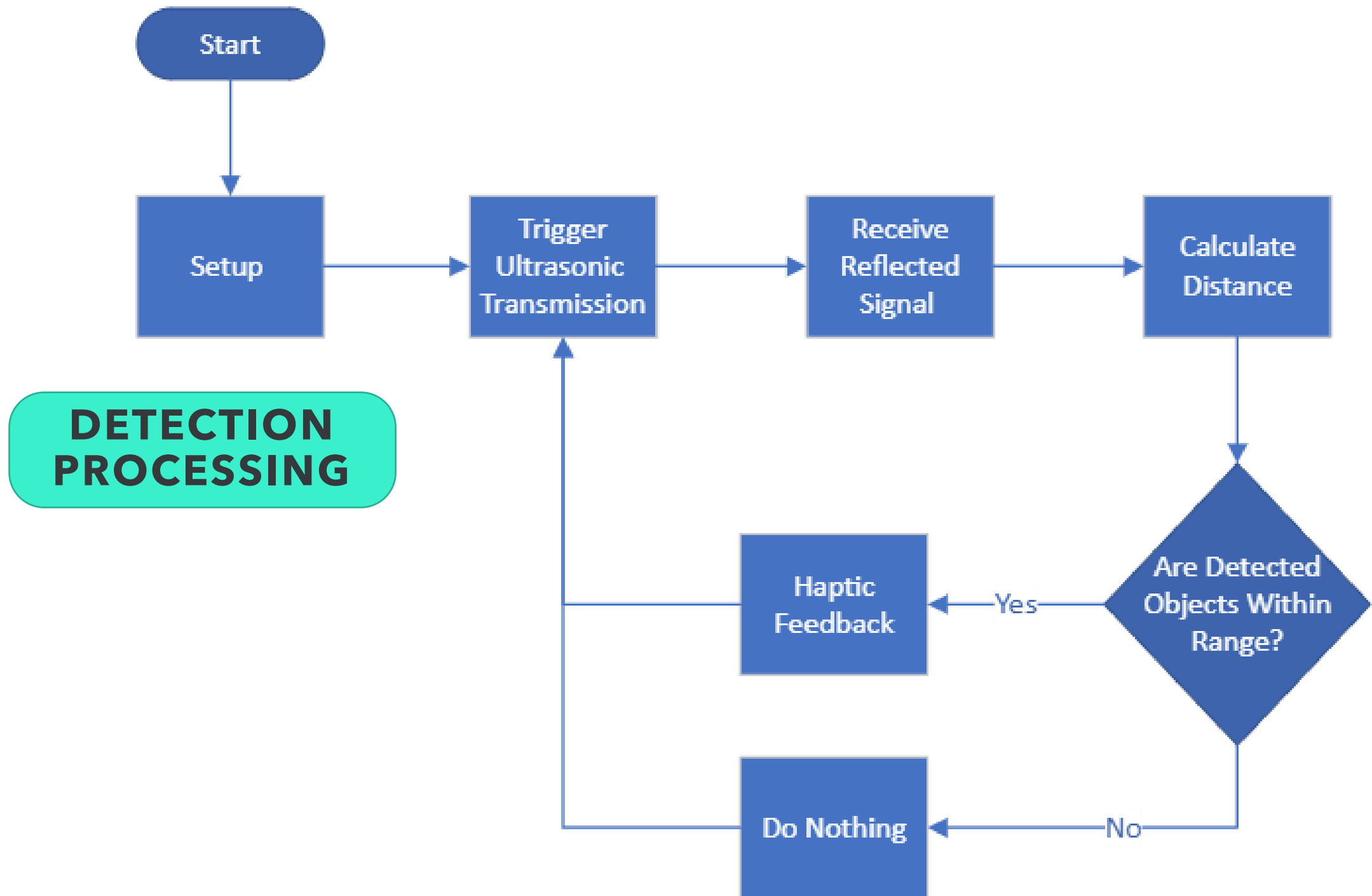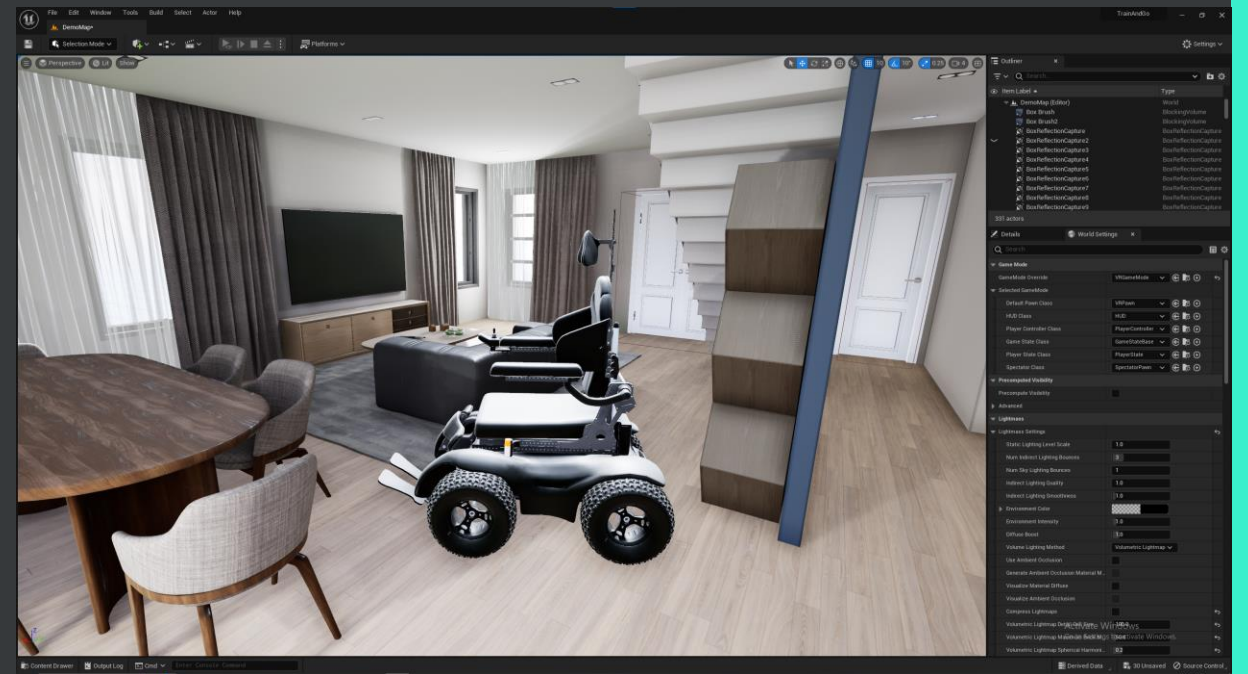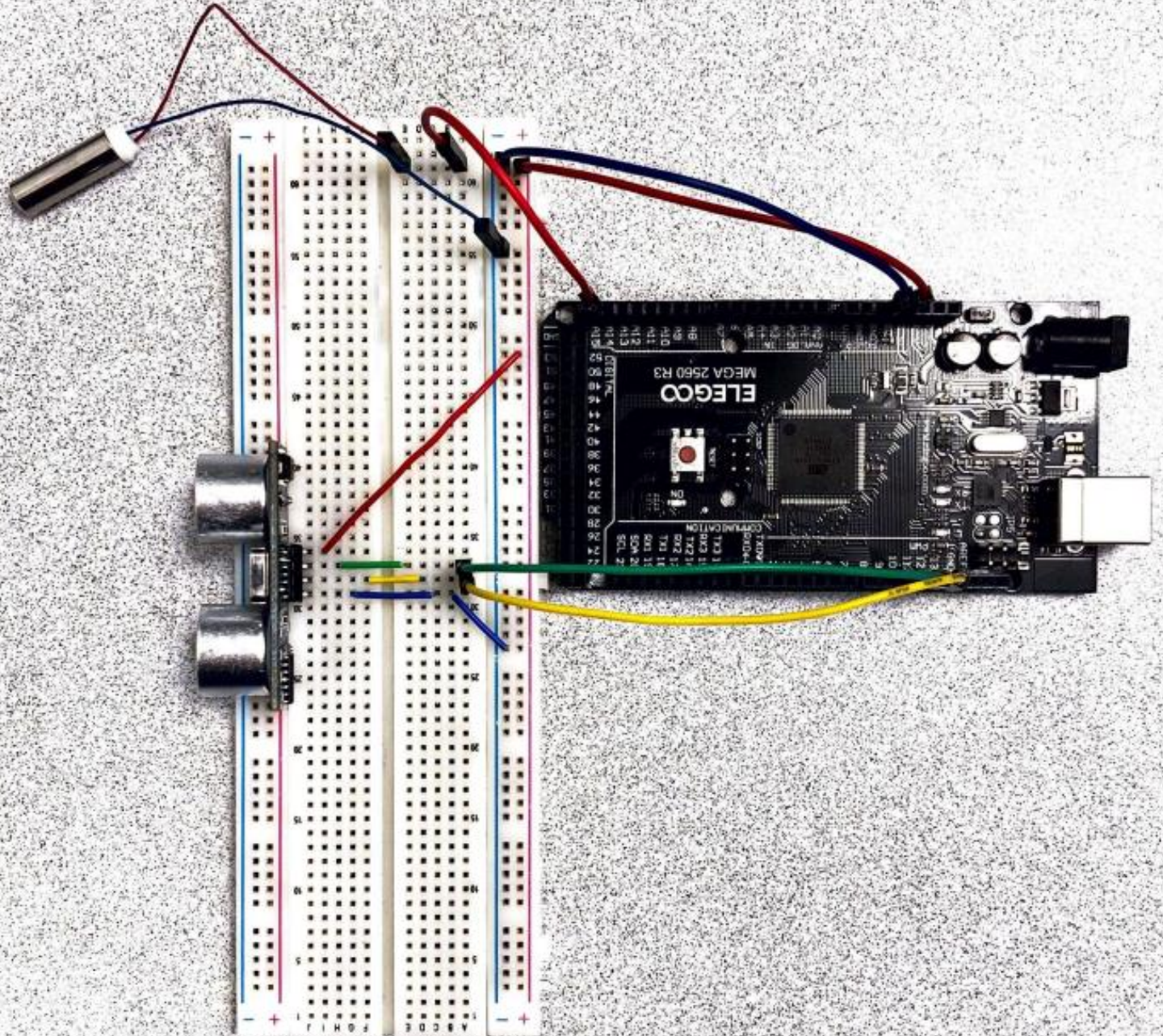
PROGRESS

VR ENVIRONMENT

UNREAL ENGINE [49]

ULTRASONIC SENSOR
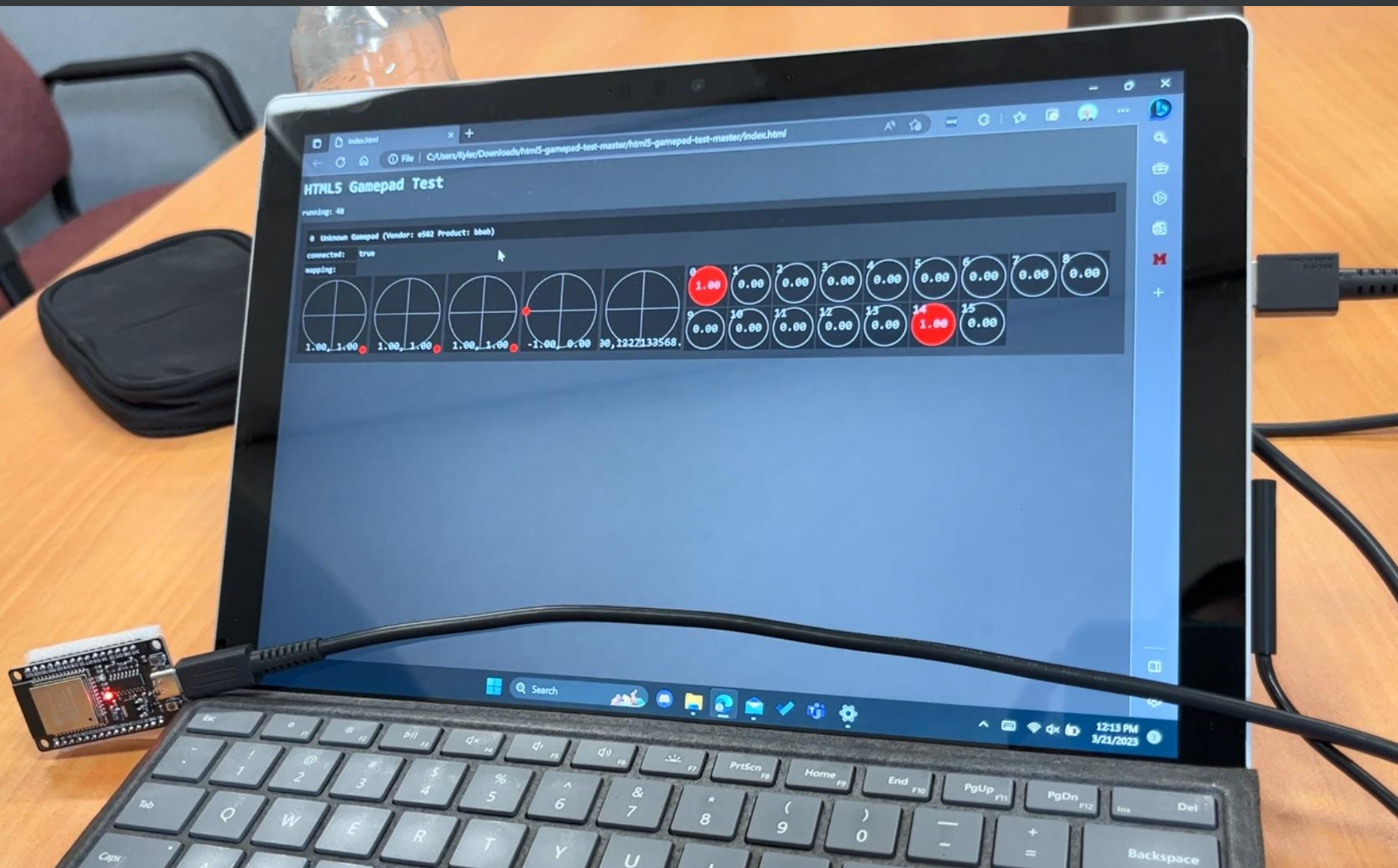
Sensor1:
30
rumblePin:
1
Sensor1:
30
rumblePin:
1
Sensor1:
30
rumblePin:
1

BLUETOOTH GAMEPAD

# IMU READINGS

```
Temperature 17.86 deg C
Accel X: -4.16   Y: -2.58            Z: 1.83 m/s^2
Gyro X: 7.18     Y: 2.94             Z: -1.00 radians/s

Temperature 17.80 deg C
Accel X: -9.07   Y: 1.48             Z: -2.40 m/s^2
Gyro X: -4.61    Y: 3.72             Z: 1.49 radians/s

Temperature 17.85 deg C
Accel X: -1.35   Y: 6.96             Z: -8.27 m/s^2
Gyro X: -20.01   Y: -2.94            Z: 3.02 radians/s
```
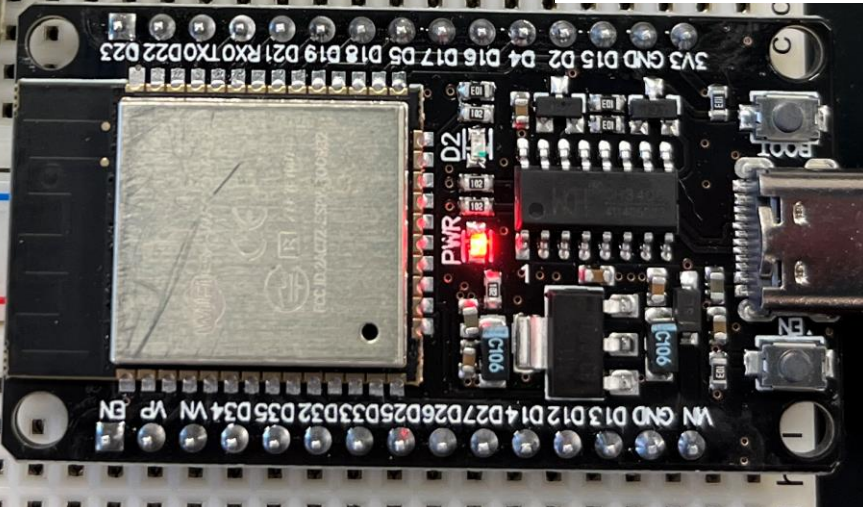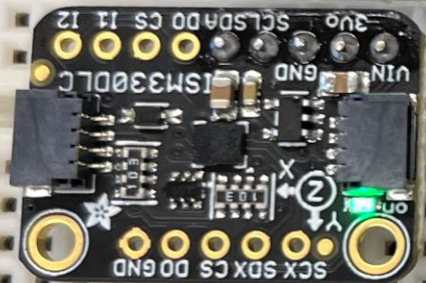
**CONCLUSION**

- Train and Go provides an enhanced VR wheelchair training experience

- Train and Go is currently still in the testing phase

- Train and Go's first prototype will be completed soon

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