
Train
&
Go

TEAM MEMBERS

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- Mary Jasper Award
- Outstanding Contribution to the ECE Teaching Mission Award

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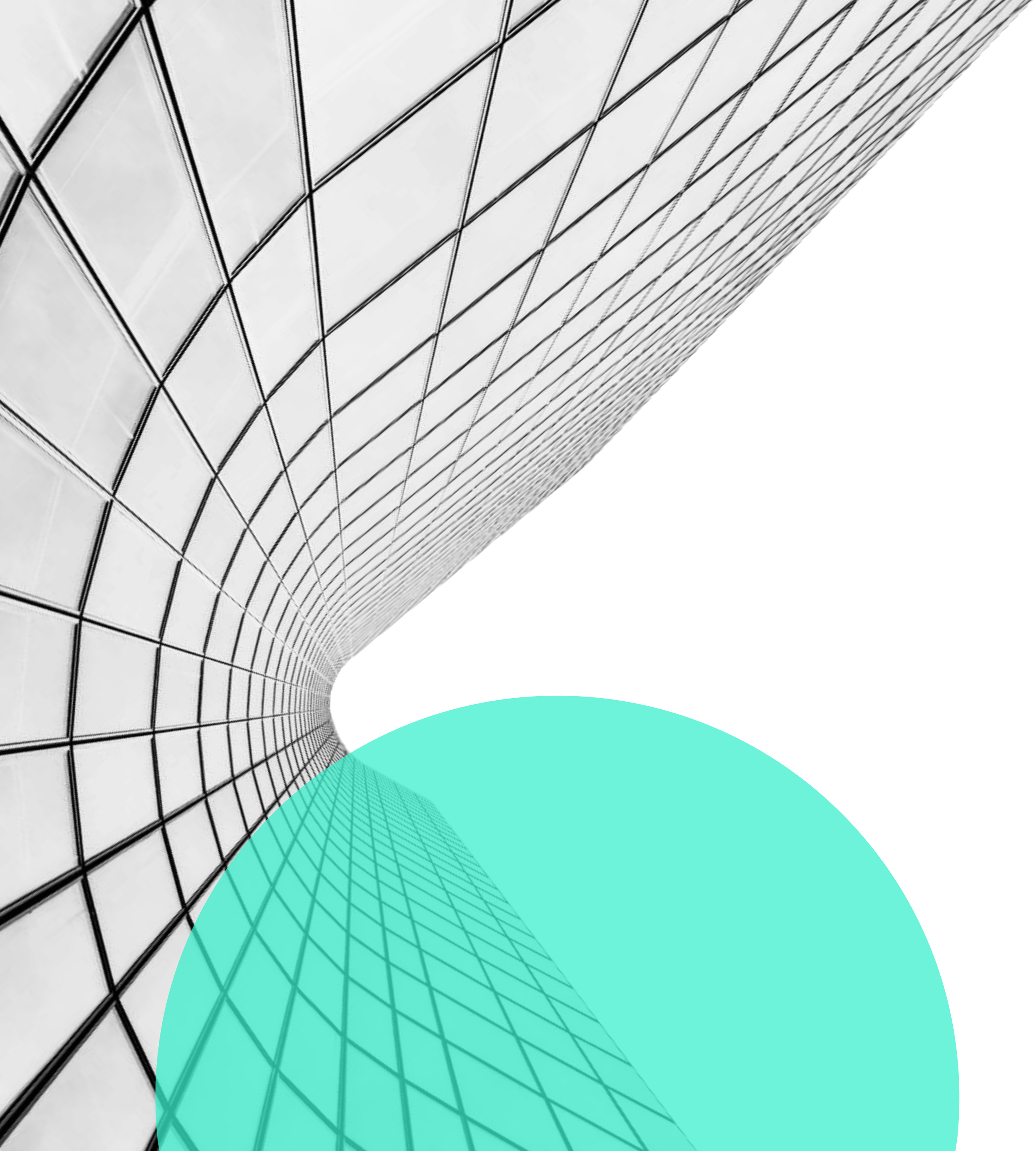
OUTLINE

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

[5]

CONSTRAINTS

[6]

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.

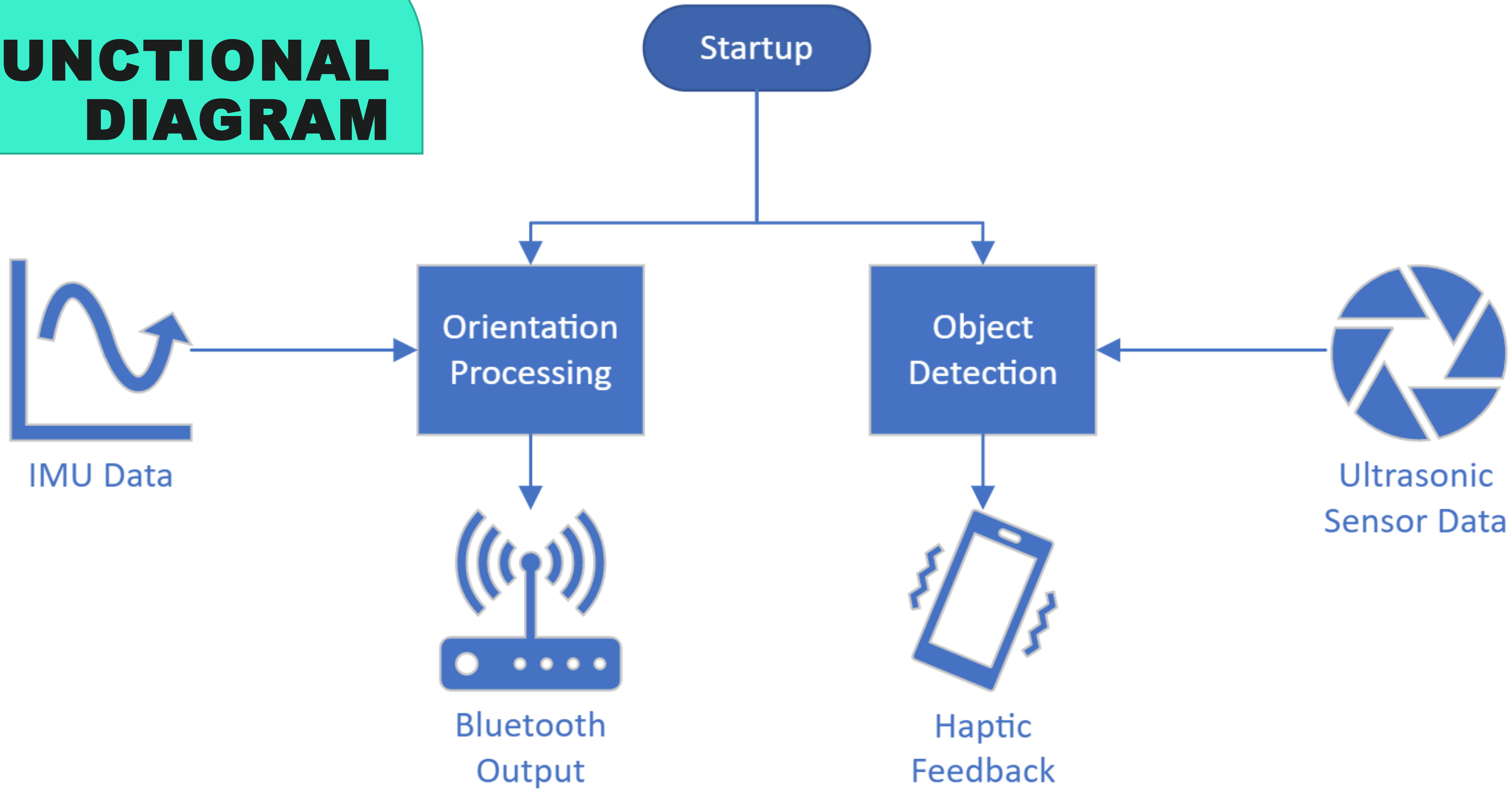
PRACTICAL CONSTRAINTS

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].

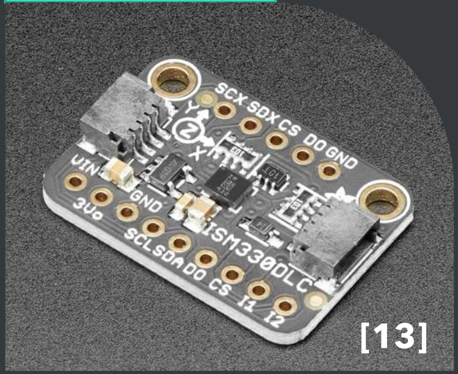
FUNCTIONAL DIAGRAM



ASSEMBLY DIAGRAM

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

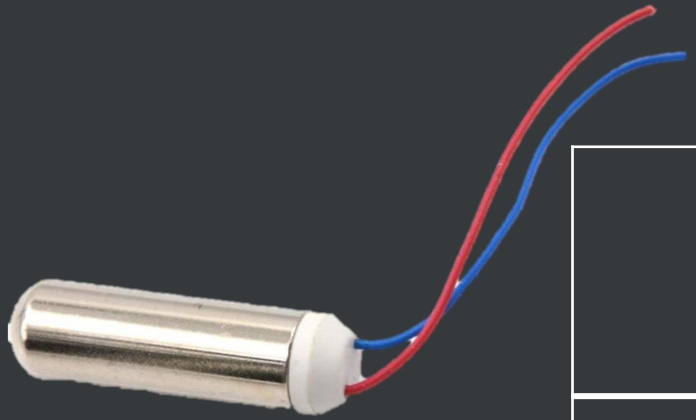
[24]

[24]

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

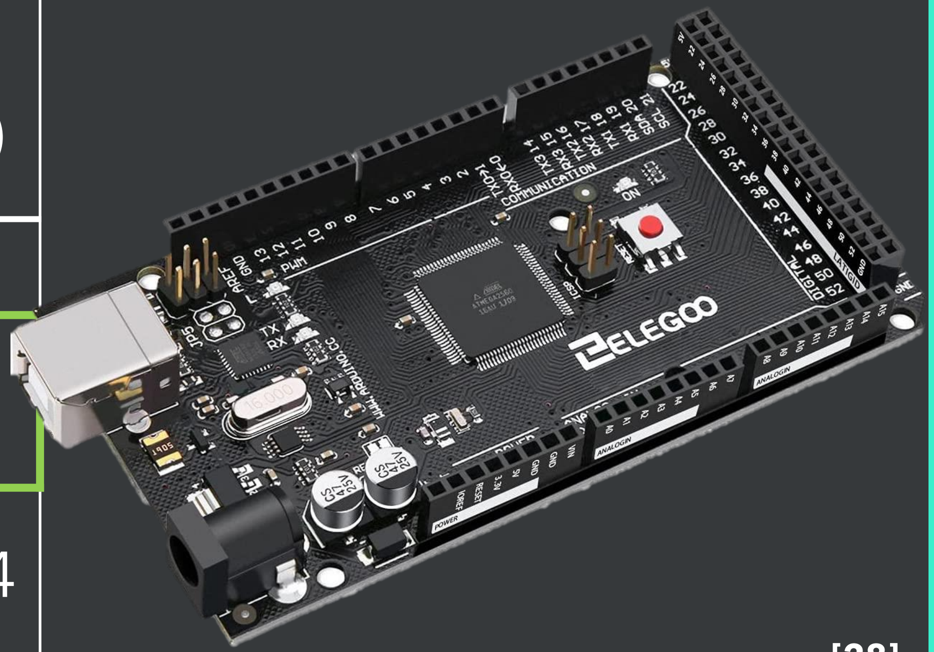
RUMBLE MOTOR


[25]

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

DETECTION MICROCONTROLLER

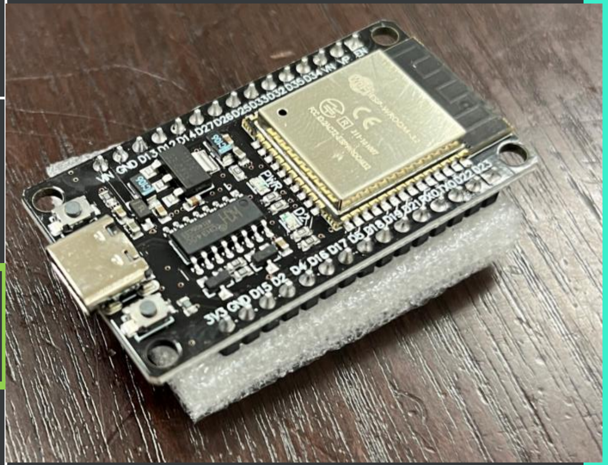
Product	Input Voltage (V)	Clock Speed (MHz)	Analog GPIO Pins	Cost (USD)
Requirements	**N/A**	**≥ 16**	**≥ 16**	**N/A**
Elegoo Mega [28]	7 – 12	16	16	21.00
Shield Buddy [29]	7 – 12	300	16	129.94
Arduino Mega [30]	7 – 12	16	16	48.20



[28]

BLUETOOTH TRANSMITTER

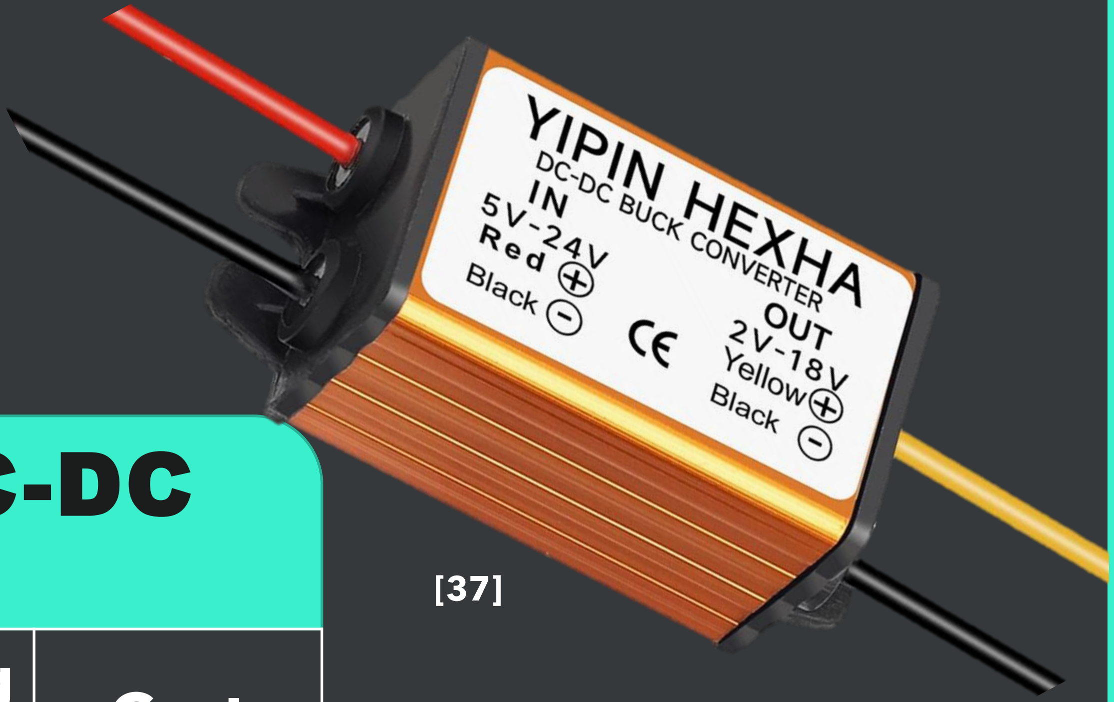
Product	Working Voltage (V)	Working Current (mA)	Connectivity	Cost (USD)
Requirements	**≤ 5**	**≤ 500**	**Bluetooth**	**≤ 30.00**
DSD Tech HM-10 BT Module[31]	3.6 – 6	50	Bluetooth 4.0 BLE	10.99
ESP32 [17]	2.3 – 3.6	500	Bluetooth 4.2	6.67
Adafruit Feather nRF52840 Express [32]	3.7	500	Bluetooth LE	24.95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

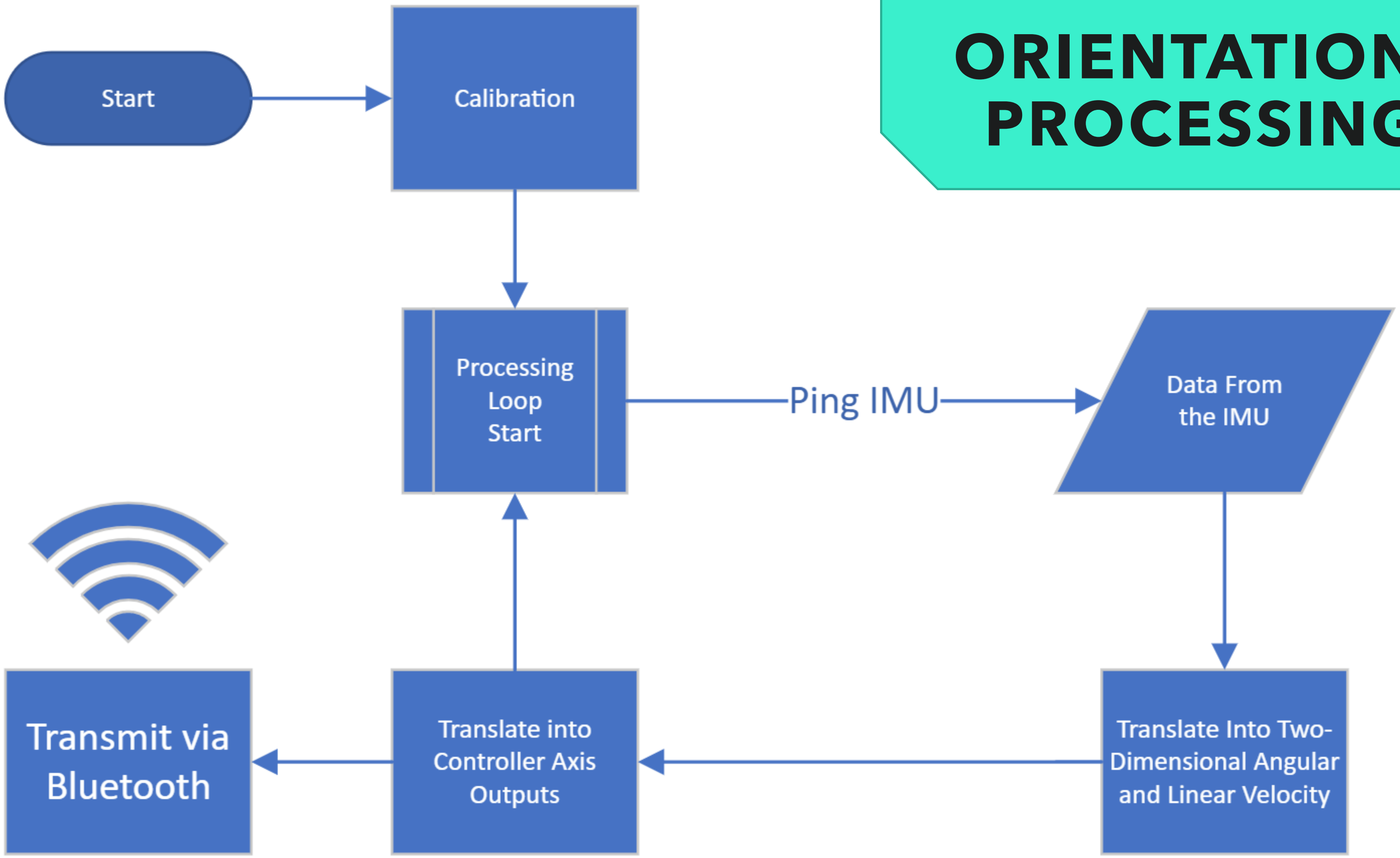
SOFTWARE

Meta [48]

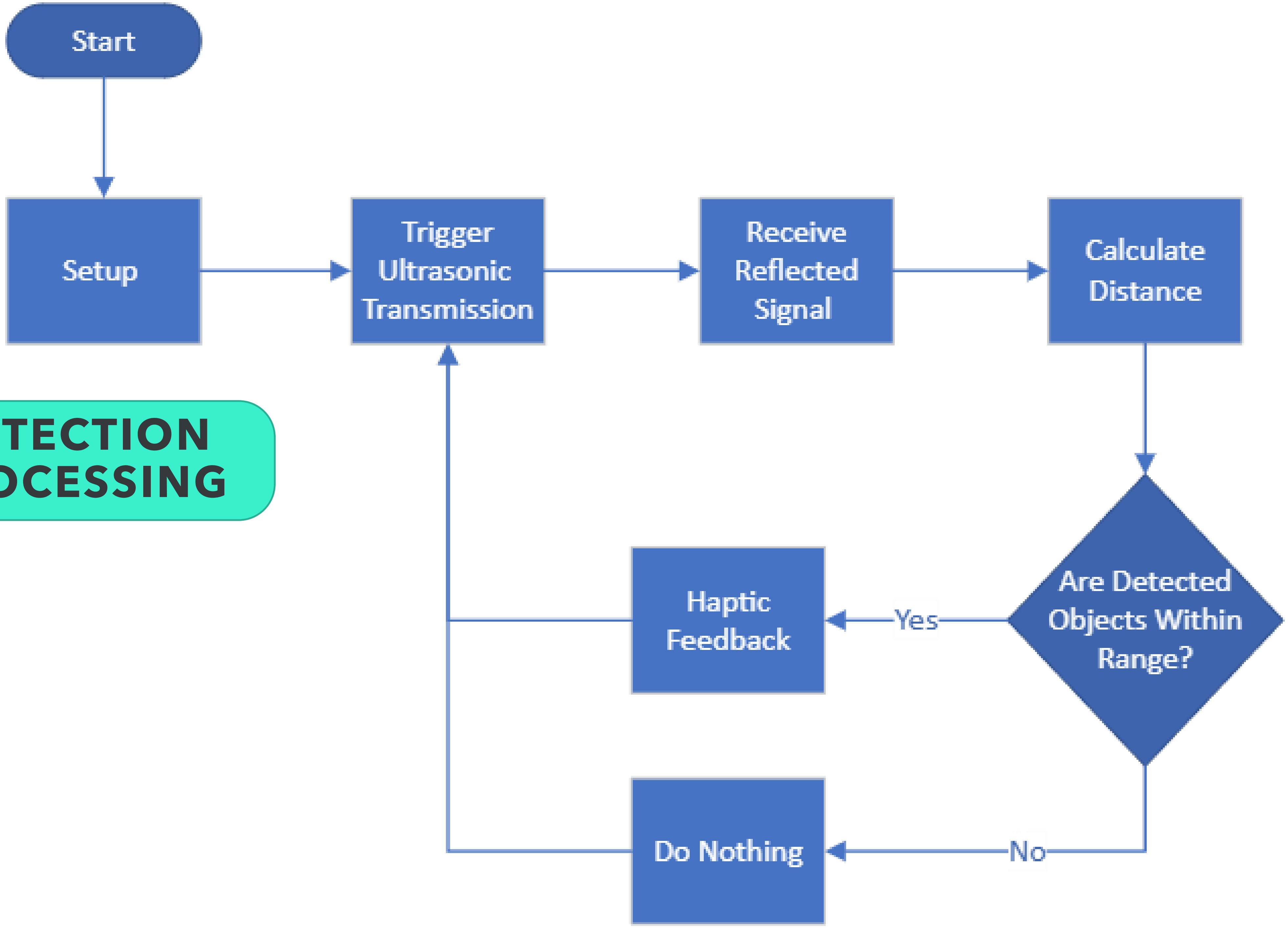
ARDUINO™ [50]

UNREAL ENGINE [49]

ORIENTATION PROCESSING



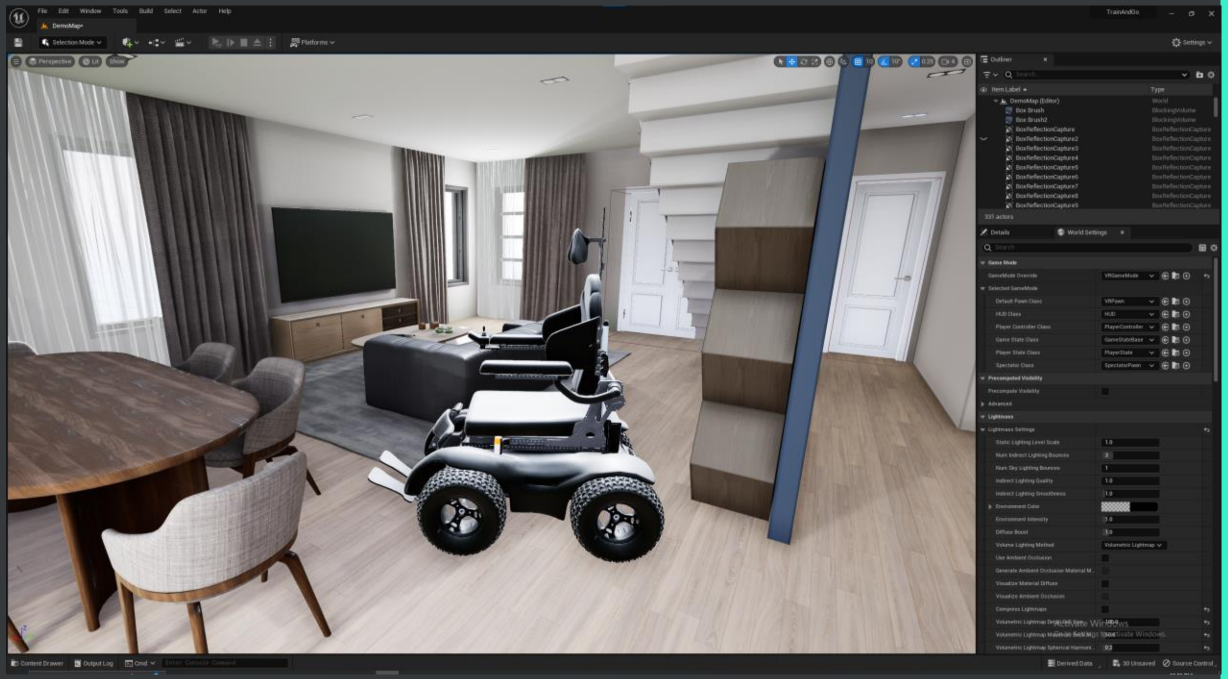
DETECTION PROCESSING



PROGRESS

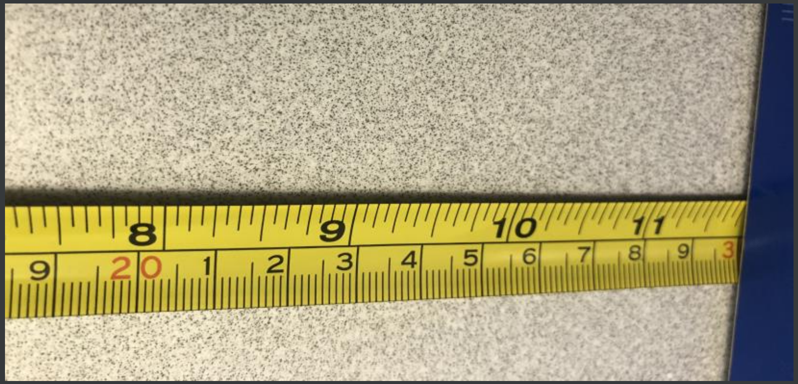
VR ENVIRONMENT

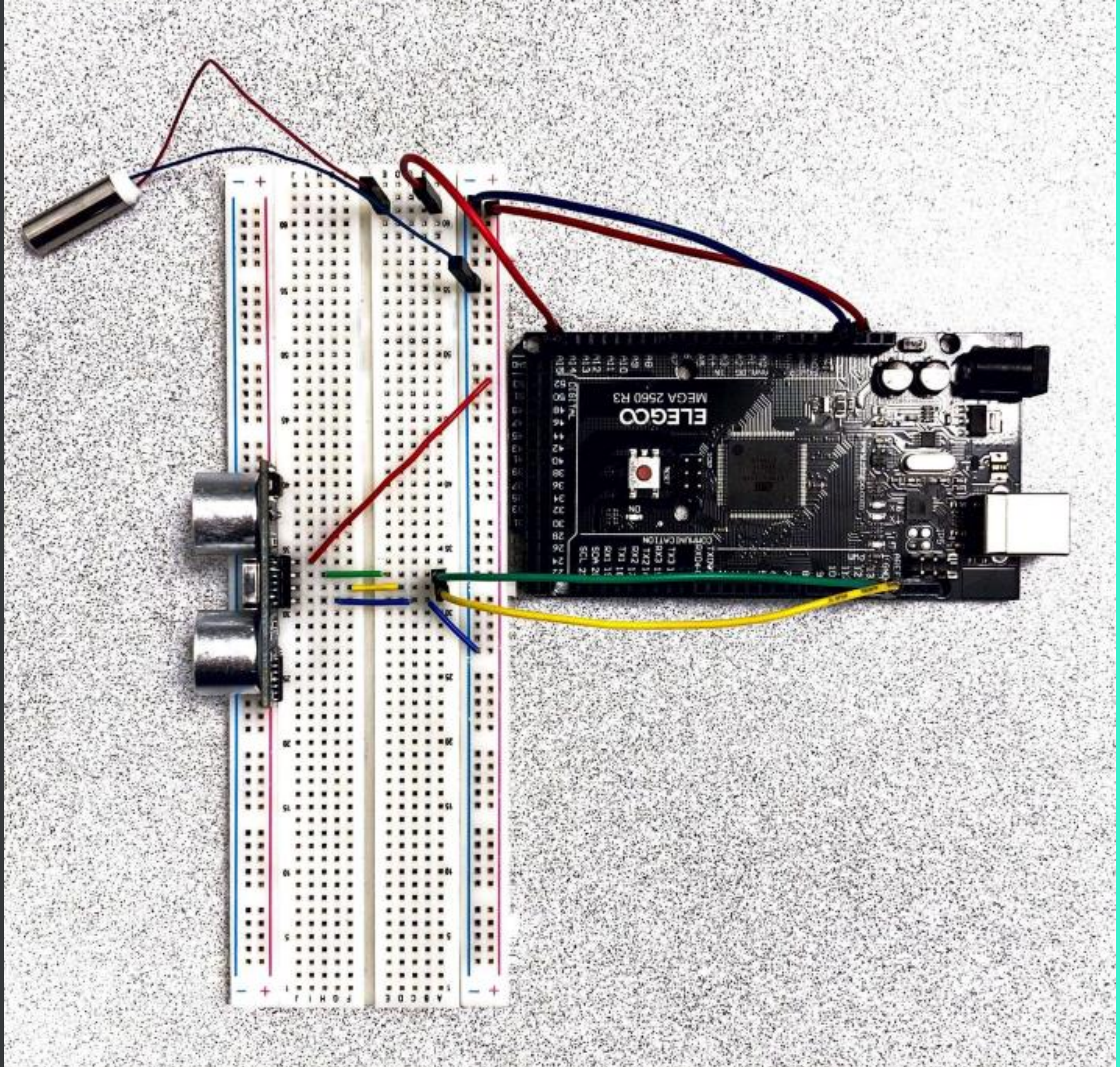
UNREAL ENGINE [49]



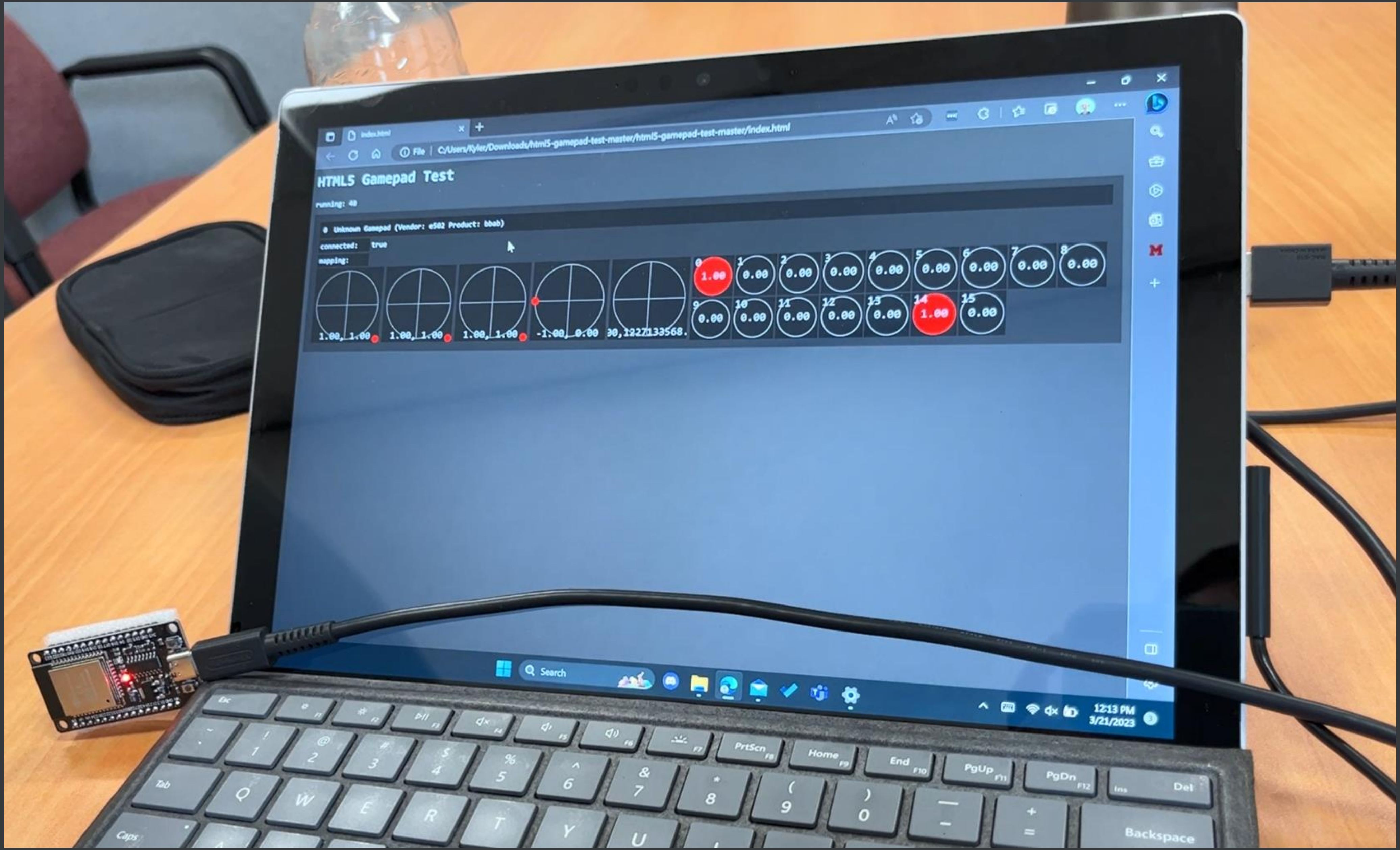
```
 Sensor1:
30
 rumblePin:
1
 Sensor1:
30
 rumblePin:
1
 Sensor1:
30
 rumblePin:
1
```

ULTRASONIC SENSOR

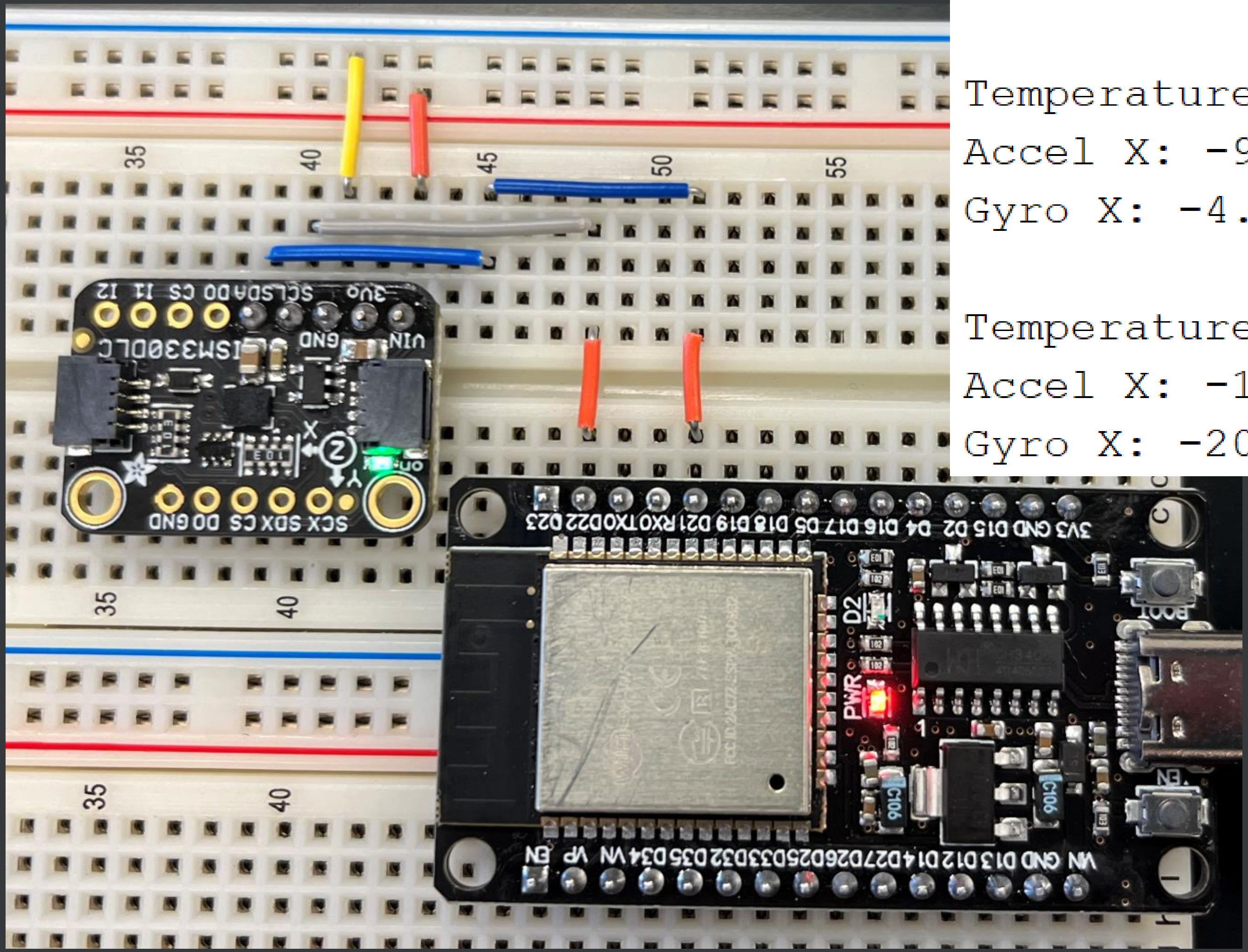




BLUETOOTH GAMEPAD



IMU READINGS

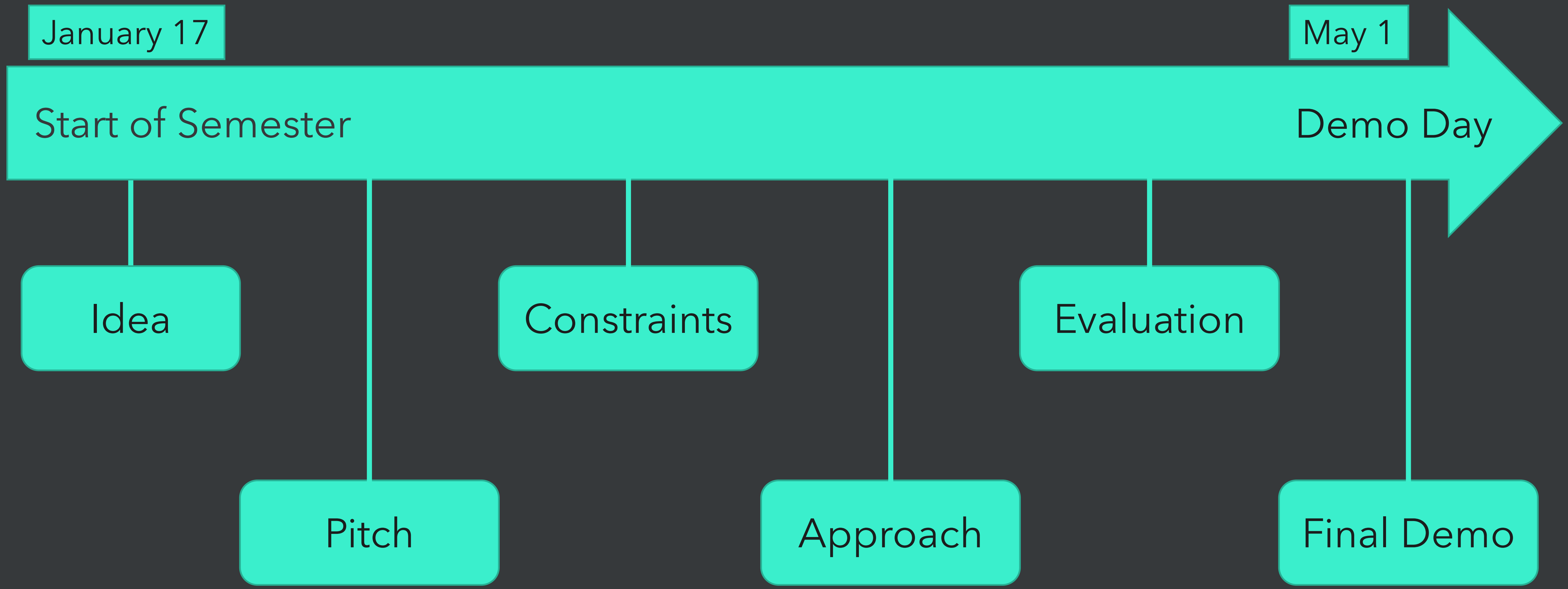


```
Temperature 17.86 deg C
Accel X: -4.16   Y: -2.58          Z: 1.83 m/s^2
Gyro X: 7.18     Y: 2.94           Z: -1.00 radians/s

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
```

TIMELINE


January 17
May 1
Start of Semester
Demo Day
Idea
Pitch
Constraints
Approach
Evaluation
Final Demo

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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