Can U Cardio?

A Gym Occupancy Tracking System

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Use Case

- Students at CMU may find themselves wanting to use the cardio machines at the UC Fitness Center
- With Can U Cardio, users can go online and see which machines are in use.

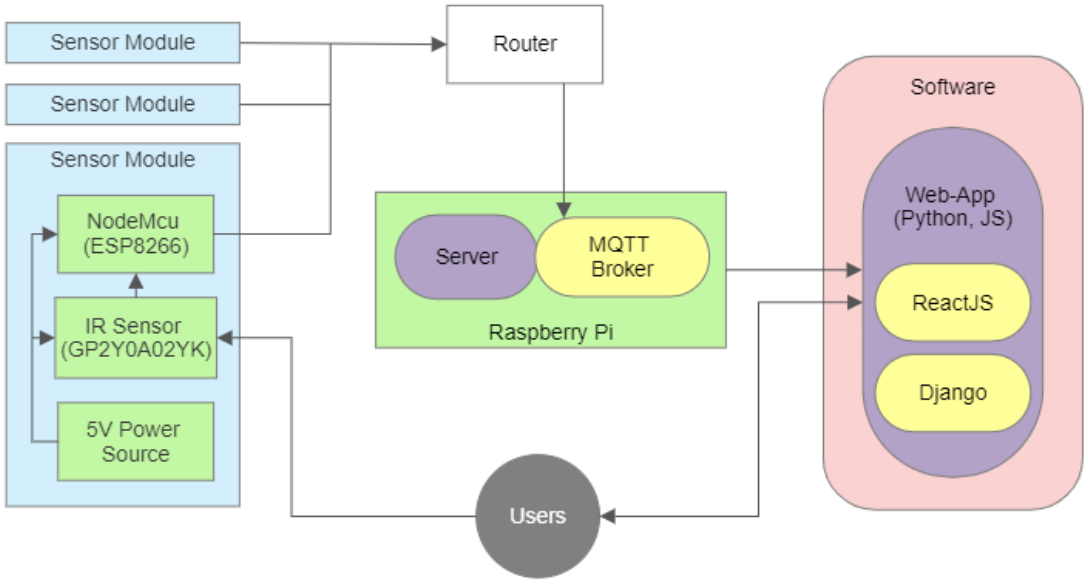
Quantitative Use Case Requirements

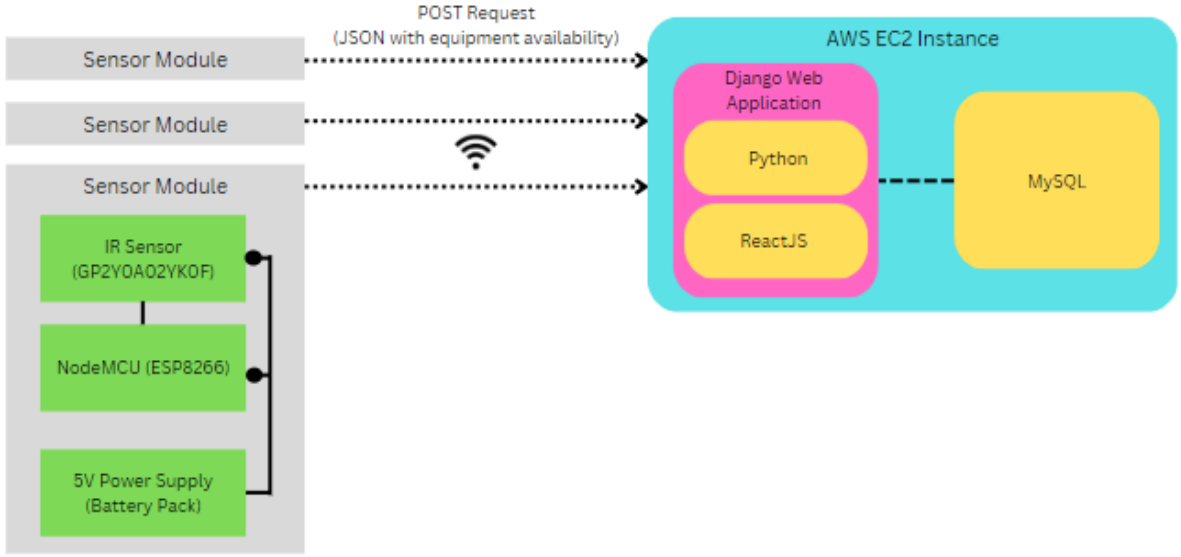
Detection Delay	≤ 30 sec	Real-time feedback and updates are imperative to attract users to our platform.
Detection Range	0.5ft-5ft (15cm-152cm)	The longest usable length of the gym equipment is 5ft in the case of the treadmill.
Detection Accuracy per Machine	≥ 90%	Each machine's occupancy needs to be reflected accurately so our system needs to work on an individual machine level
Detection Mapping Accuracy	≥ 90%	We want to ensure that the proper machine is being identified as occupied according to the gym layout to avoid conflicts between users.
Usage Time	≥ 16.5h	UC Gym is open from 6:30 AM to 11 PM on weekdays.

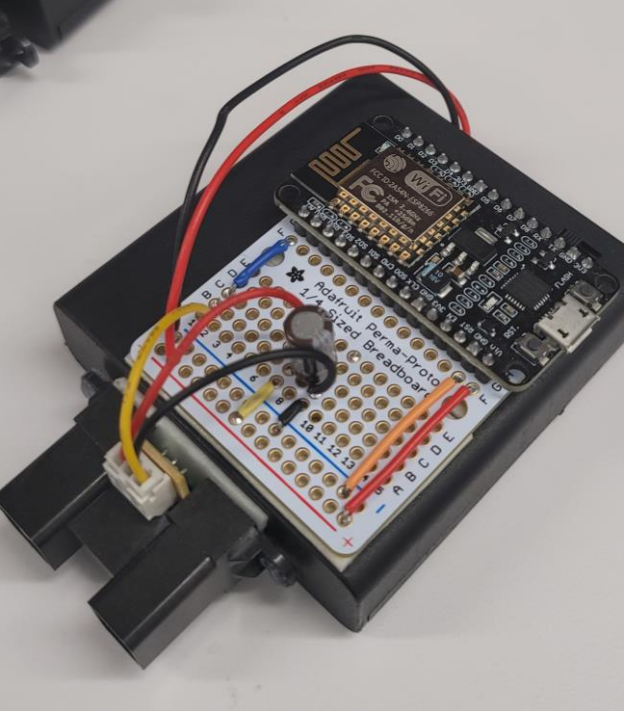
Solution Approach

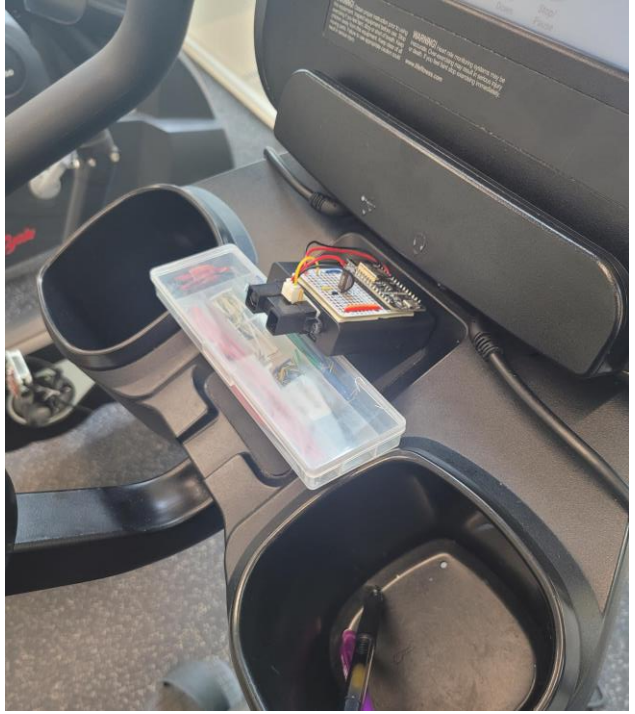
- Proximity based monitoring system
- Physical sensor modules attached to gym equipment’s dashboards
- Wirelessly sends occupancy data to a web-app accessible to gym members and staff.

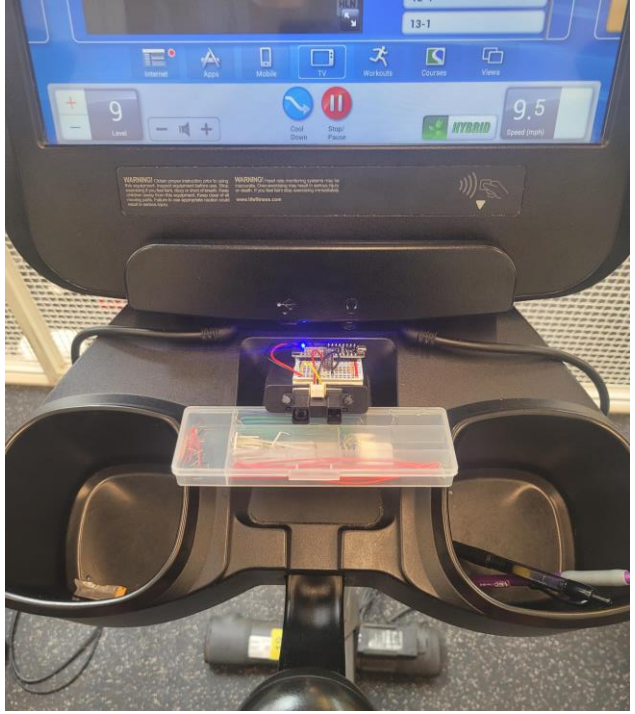
Old Vs New System Specs/Block Diagram

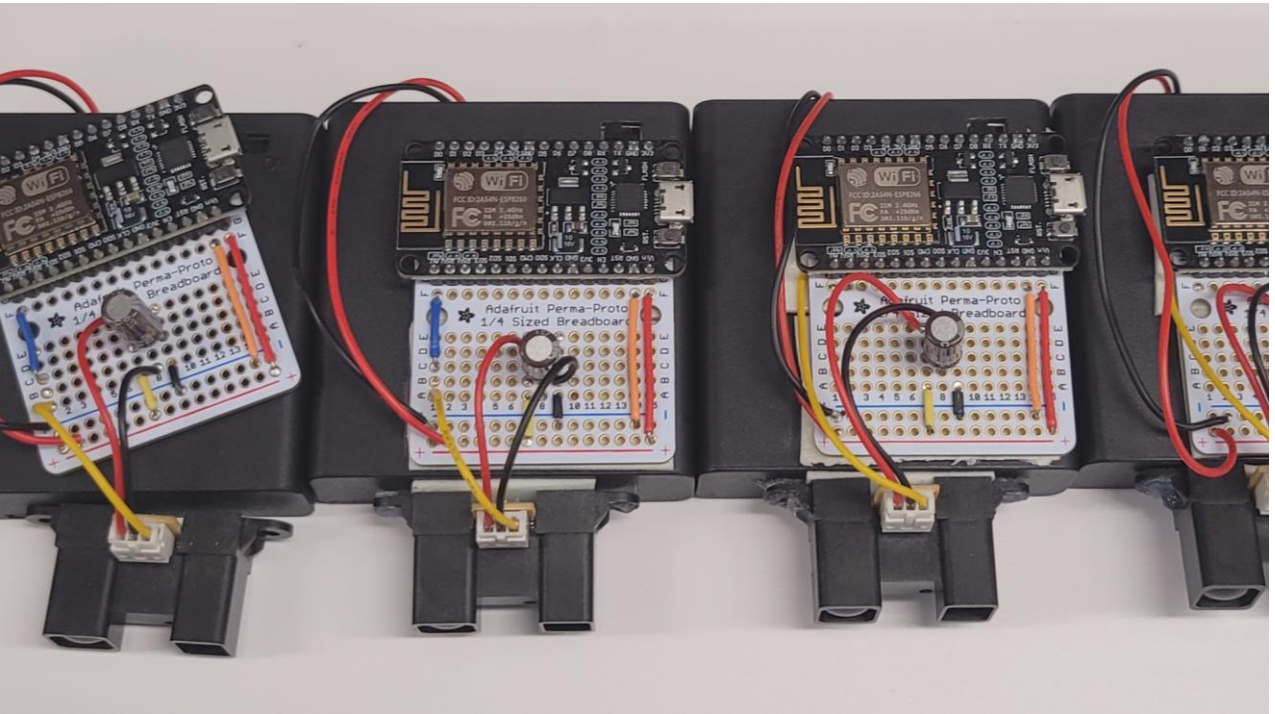








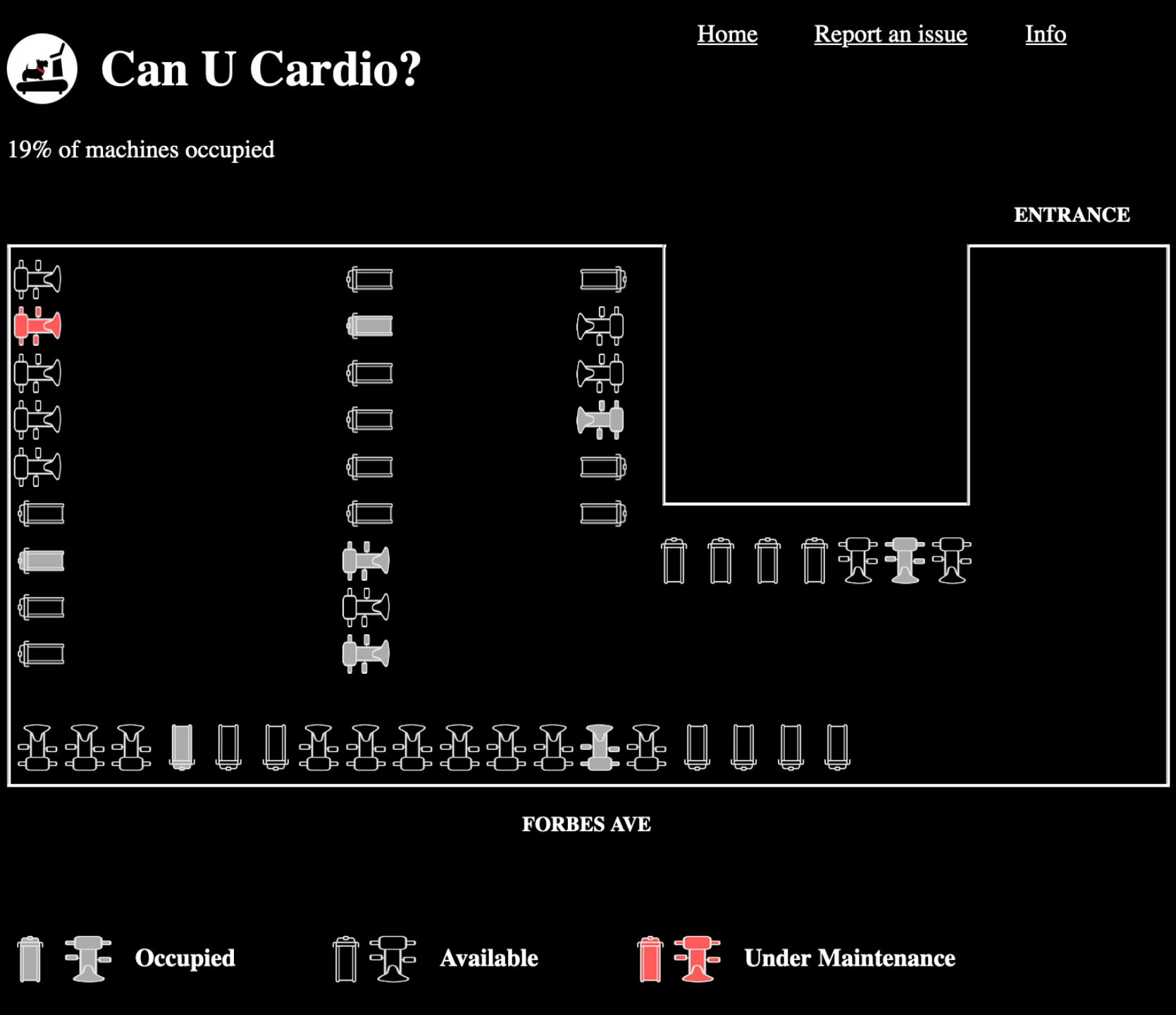




Complete Solution

Sensor Module

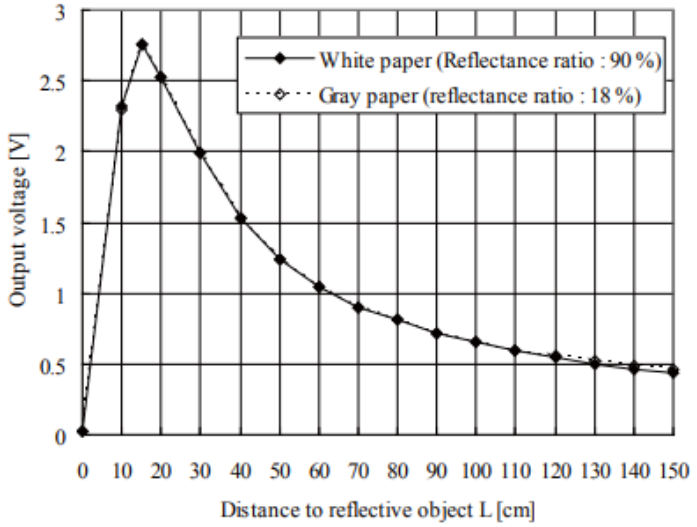
- Sharp IR Sensor (GP2Y0A02YK0F)
- NodeMcu (ESP8266)
- Battery Pack of 4 Rechargeable AA Batteries

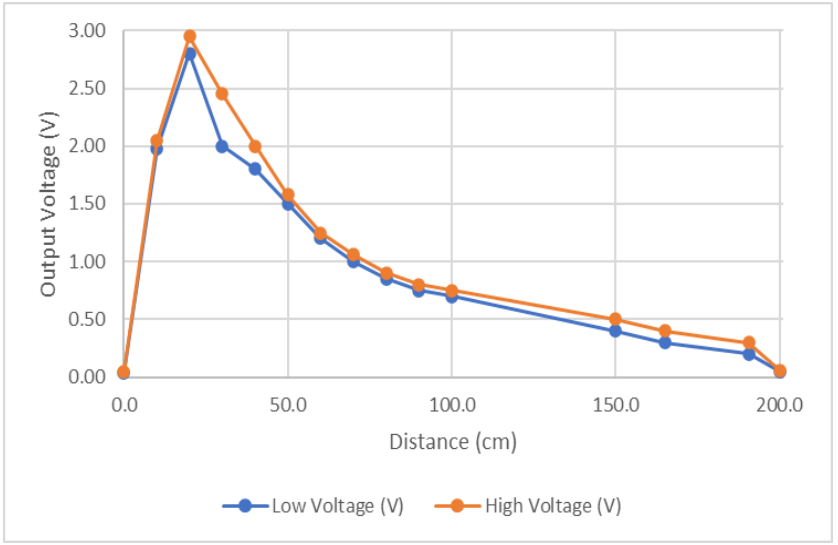


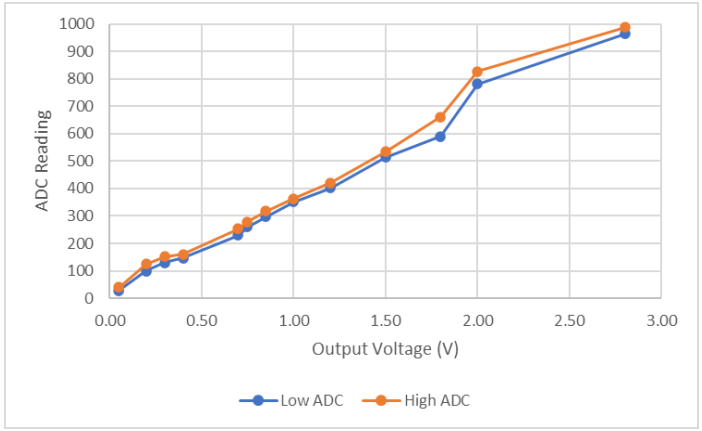
Complete Solution

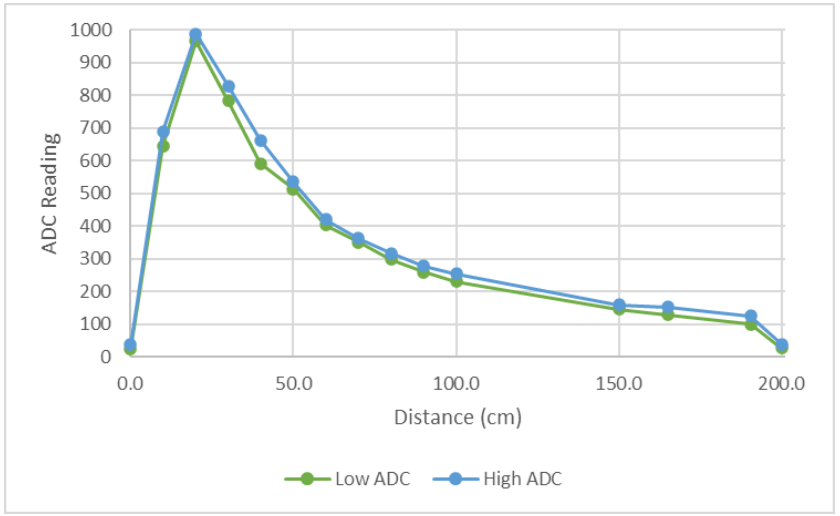
Web app

- Web app displays the gym occupancy with each machine being displayed as “free” or “busy”
- Display an overall % of machines used
- Option to report a machine as faulty, which updates the map accordingly
- Admin page so gym owners can set up system









Testing

IR Sensor/NodeMcu

- Verification of the relationship between distance and output voltage of the sensor.
- Correlations between voltage and ADC (analog to digital converter) readings were established.

Verification m

Integrated Testing Fixed Parameters

- Sensor module analog reading and post request send delay: **1 second**
- Web-app refresh rate: **5 seconds**
- ADC reading distance cutoff: **210** (corresponds to ≈ 3.67ft ≈ 111.9cm)
- Treadmill running surface length: **60” = 5ft ≈ 152.4cm**
- Total bike length**: 41.5” ≈ 3.46ft ≈ 105.4cm**

	# of successful trials out of 10			
Sensor Module #	**On-range stand-in**	**Out-of-range stand-in**	**Pass-by**	**Surroundings (wide angle)**
1 (treadmill)	10	10	10	10
2 (treadmill)	10	10	10	10
3 (bike)	10	9	10	10
4 (bike)	10	9	10	10

	Avg detection delays out of 10 trials (s)		
Sensor Module #	**Free to Busy**	**Busy to Free**	**Overall (avg of BF and FB)**
1	2.37	4.77	3.57
2	4.30	2.93	3.62
3	1.61	3.46	2.55
4	3.92	2.12	3.02

Validation

Detection Delay	≤ 30 sec	The max average detection delay for one sensor was 3.62 seconds . The max single delay recorded by one of the sensors was 6.75 seconds
Detection Range	0.5ft-5ft (15cm-152cm)	The lowest and longest distances that we were able to measure accurately were 3.9” ≈ 0.3ft ≈ 10cm and 65” ≈ 5.42ft ≈ 165.1cm respectively.
Detection Accuracy per Machine	≥ 90%	The lowest detection accuracy for one sensor module was 95%
Detection Mapping Accuracy	≥ 90%	No sensor was detected as another thus this turned out to be 100% accurate
Usage Time	≥ 16.5h	The continuous battery life of our sensor module is estimated to be a bit more than 4 days.

Specs and Performance

Spec/Performance Metric	Value
Operating Voltage	4.5-5.1V
Typical Operating Current	107mA
Battery Capacity	11,200mAh
Battery Life	4d:8hrs:40min (continuous use) 6d:3hrs:46min (interrupted use)
Average Detection Delay	3.19 seconds
Average Detection Accuracy	98.8%
Sensor Module Dimensions	91mm x 66mm x 39mm

Design Changes and Trade-offs

Web-app

- Initially planned on using RPi to host web application
  - RPi is lower cost due to no recurring AWS fees
- Switched to Apache Web Server on an EC2 instance
  - Provides more security for web app
  - Far less likely to be physically damaged thus it’s more reliable
  - More scalable than the RPi
- SQLite vs MySQL:
  - SQLite is the default Django database
  - MySQL requires more setup/is not as “out of the box”
  - MySQL is more scalable and provides more robustness in comparison to SQLite

Project Management

Can U Cardio

Weeks	Week 7	Spring Break	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Finals Week
Start Dates	26-Feb	5-Mar	12-Mar	19-Mar	26-Mar	2-Apr	9-Apr	16-Apr	23-Apr	30-Apr
Software										
Create EC2 Instance										
Create Django web app										
Get AWS web server running										
Receive data from microcontroller										
Update web app (backend) with data										
Work on front end										
Implement Sockets from software side										
Work on average time spent on machine										
Fix bugs with report action, etc.										
Hardware										
Order ESP8266										
Develop prototype code for microcontroller										
Develop code for microcontroller										
Develop code to send via W-Fi										
Receive and integrate sensor data into microcontroller										
Implement Sockets from microcontroller side										
Develop/Modify code to process IR Sensor Data										
Signals/Sensors										
Order and receive IR Sensors										
Analog circuit setup and testing										
NodeMCU & Arduino IDE setup										
Preliminary Arduino code to measure distance										
Connecting sensor to microcontroller and run code										
Order and receive wireless power components										
Sensor module mounting mechanism										
Fully functional sensor modules (4 modules)										
Testing & Integration										
Slack										
Deliverables										
Design Slides (19-Feb)										
Design Report (3-Mar)										
Ethics Assignment (15-Mar)										
Interim Demo (3-Apr)										
Final Presentation Slides (23-Apr)										
Final Poster (3-May)										
Final Report (5-May)										
Final Video (6-May)										
Public Demo (8-May)										

Key
Ian B.
Nat
Ian F.
Team
Break