EK210 A6 H8 Prototype - Room Occupancy Monitor

Allen Fraiman, James Conlon, Phyliss Darko, Hayden Robinson

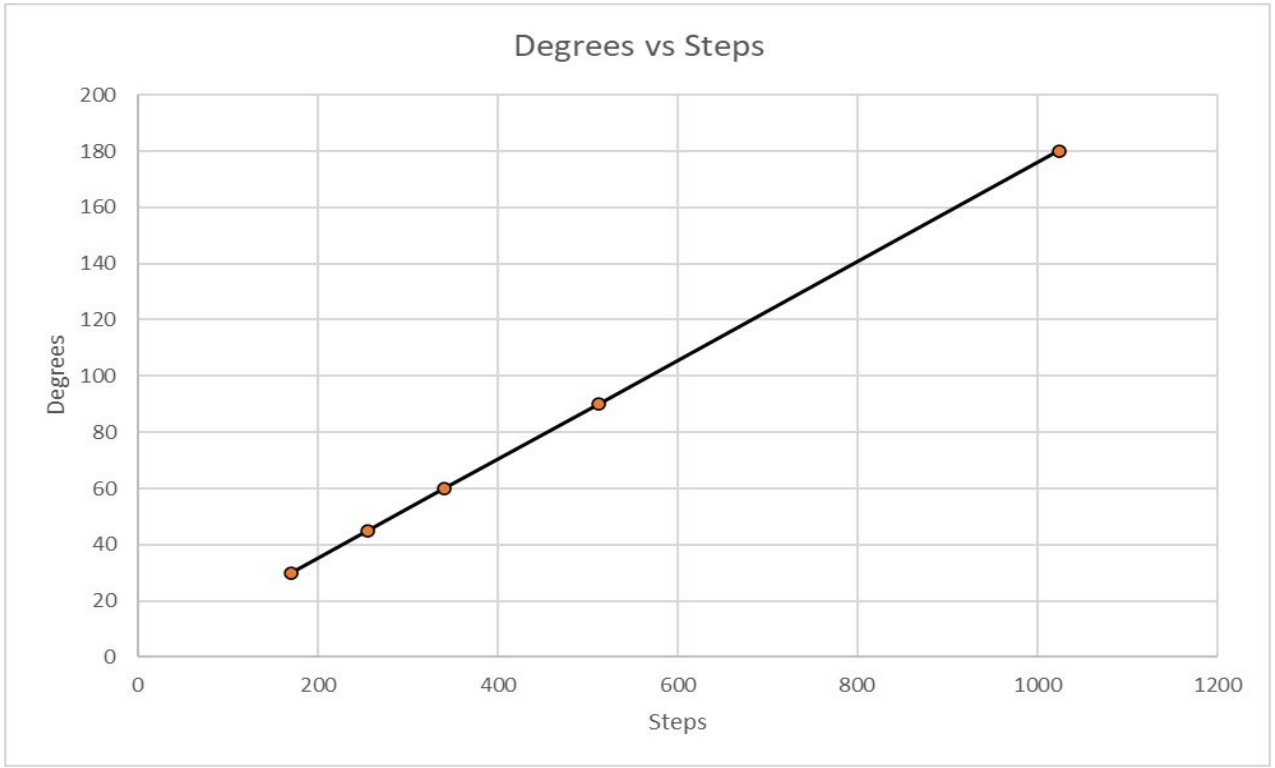
Problem Statement

- Design a device for administrators to monitor and control classroom occupancy, preventing overcrowding for health, safety, and compliance with fire and disease spread regulations.

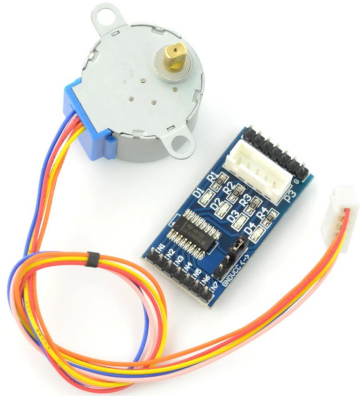
Key Objectives

Objectives	Metrics/Specification
Count occupants entering & exiting without interference.	- Accuracy rate >90%, less than 1% undercount or overcount. - Operational range of 0-1m. - Able to process over 50 individuals per day.
Measure occupants precisely	- Counting precision with max deviation of +-1 person.
Complete count quickly	- Time from switch press to system occupancy indication should be less than 5 sec. - Should process counts within 1 sec of passing.
Determine occupancy status	- Real time occupancy update with lag time less than 5 sec. - Unmistakable indication of occupancy value/count.
Prevents overcrowding (mechanical preventer)	- Mechanical bar deploys within 2 sec after reaching maximum occupancy.
Easy to use/portable	- System setup/takedown time under 5mins. Total weight under 5kg.
Does not obstruct entry/exit	- Door closes and opens freely (even when arm is deployed). - No reduction in entry/exit flow rate under normal operation.

Key Means - 28BYJ-48 Stepper Motor with ULN2003 Driver



- Step Angle: 11.25°
- Gear Reduction: 64:1
- 360° Turn: 2048 Steps
- 90° Turn: 512 Steps



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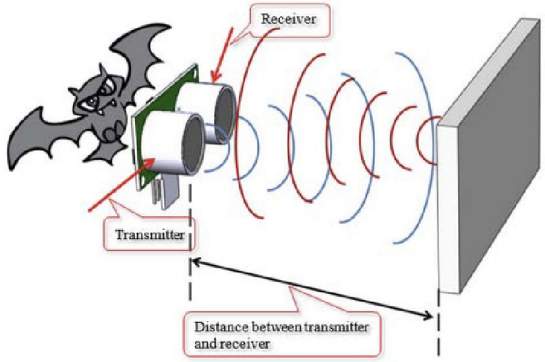
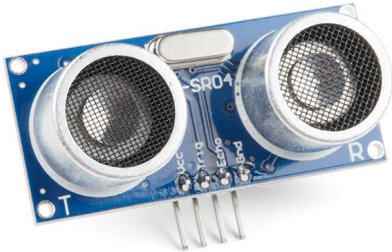
Key Means - Ultrasonic sensor - HC-SR04



- Datasheet: range: 0.2m - 4m; 15° measuring angle.
- Chose to use two sensors for directionality of entry/exit
- Problem: Which way did they come from?
- Problem: Preventing parallel sensors from double counting one person



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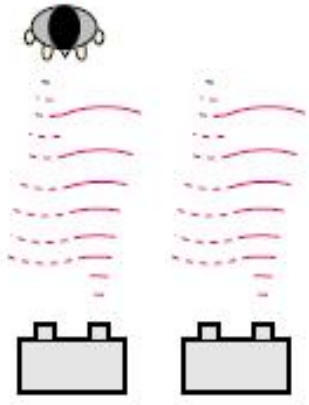

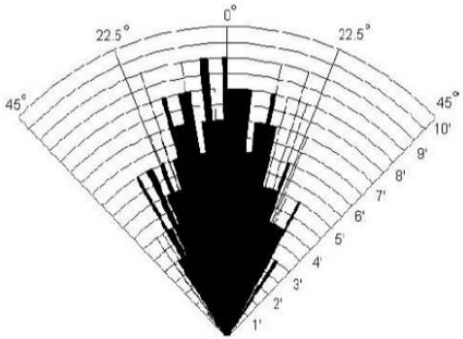

Practical test of performance,
Best in 30 degree angle

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Ultrasonic Sensor - Design Iteration

- Solution: Ensure the sensing areas don’t cross, alternate sensing cycles
- → “Best Effort” algorithm is not going to be perfect
- → Many considerations and testing
- → Debouncer improvements
- → Power considerations

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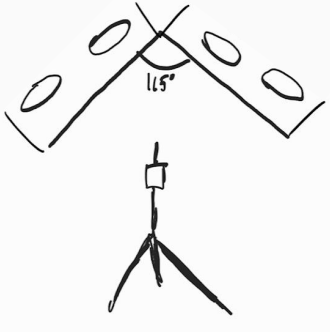

User Group Considerations

- System and sensors secured around chest level to ensure detection of all people.
  - Variable-height tripod.
- Piezoelectric buzzer to enhance auditory cues.
- LEDs for extra visual communication.

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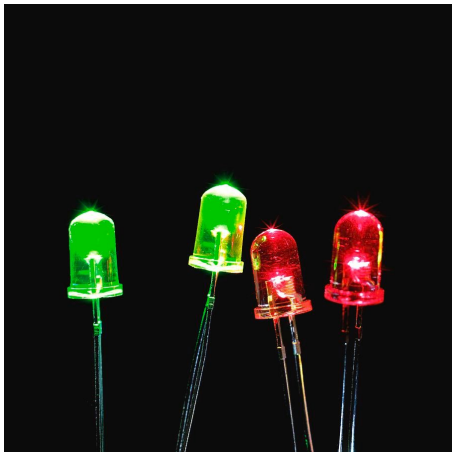

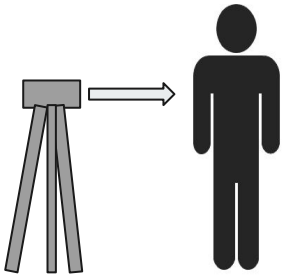

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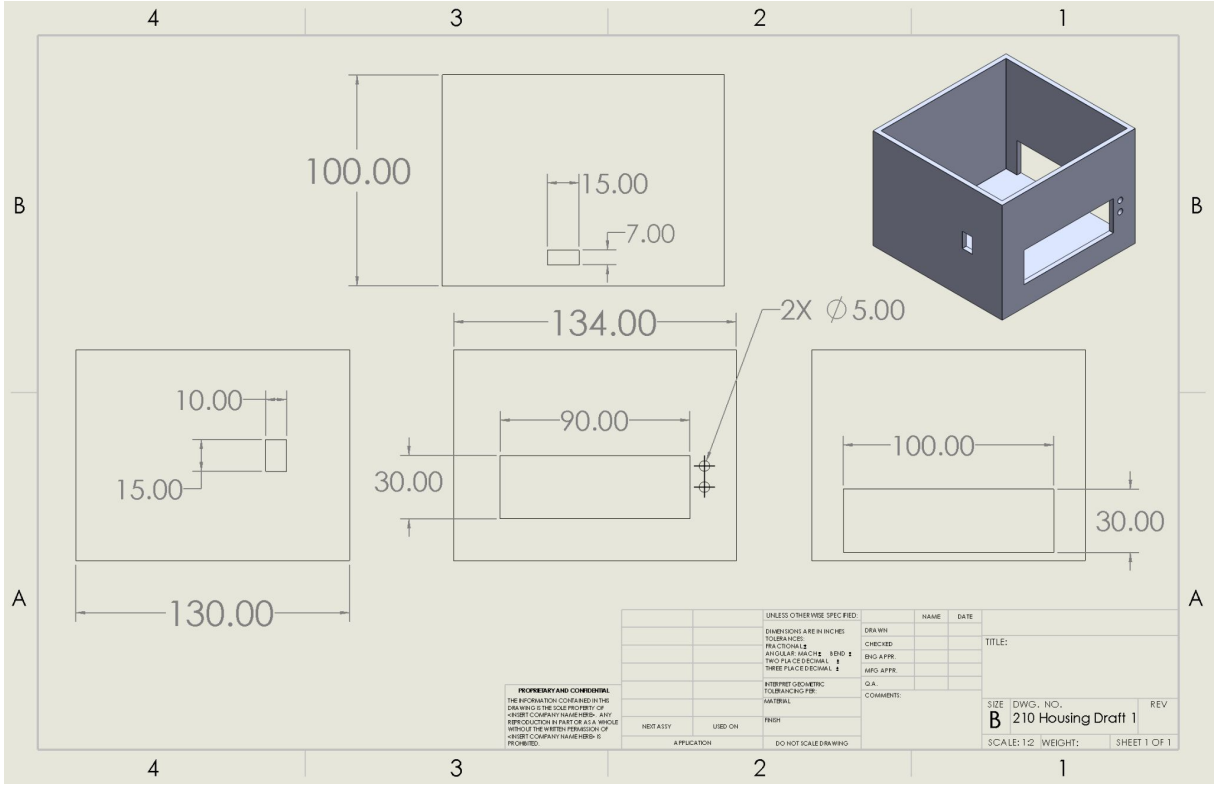
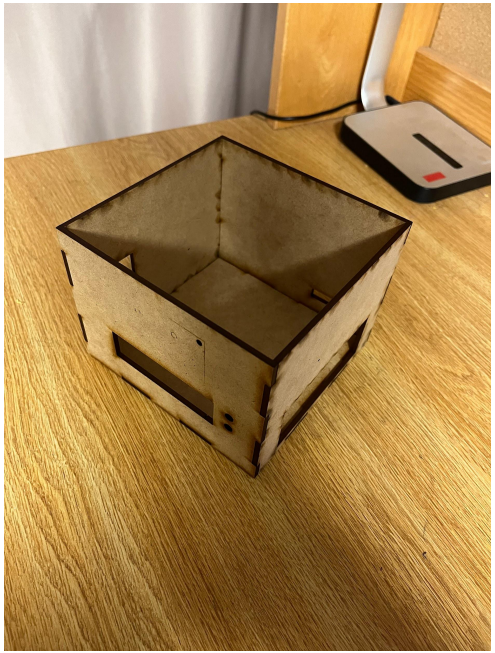
Housing





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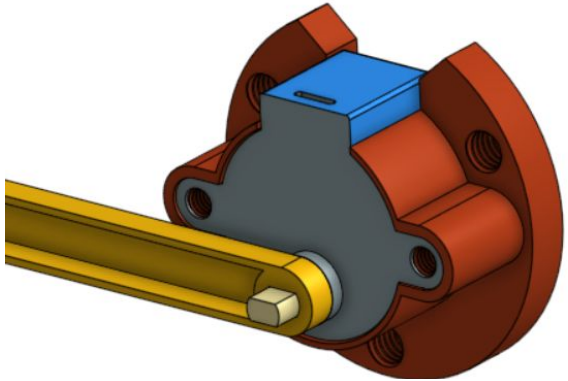
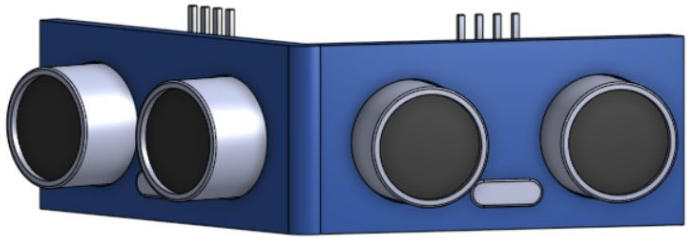
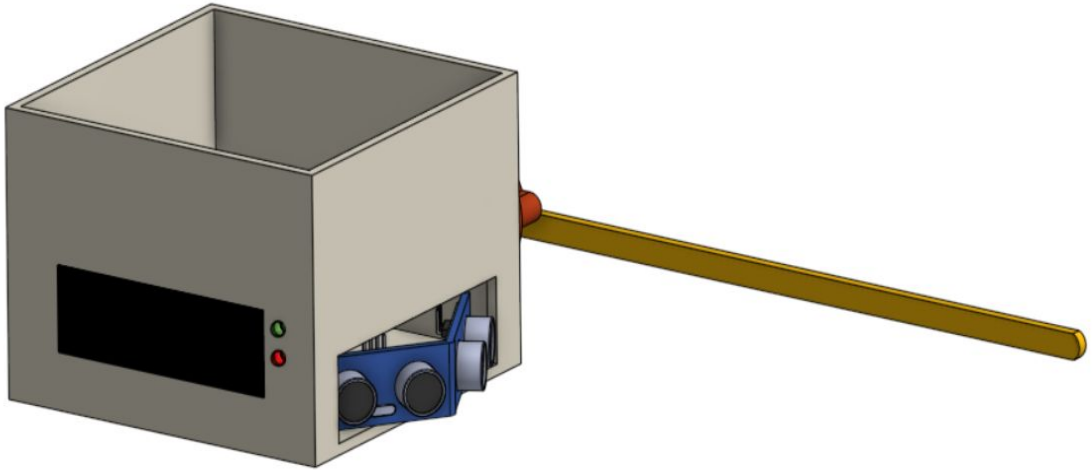
Mounting Components







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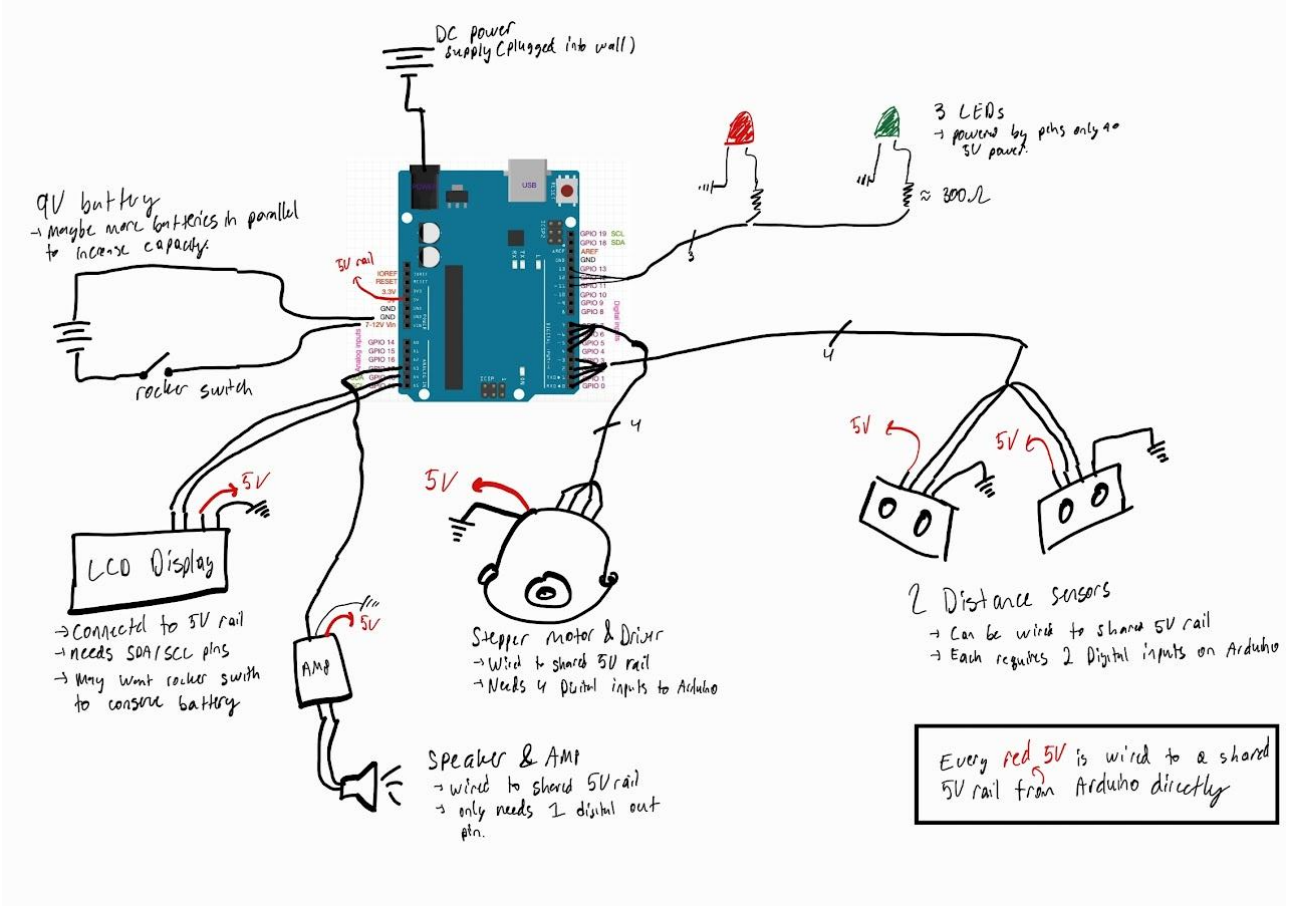
Circuit Diagram



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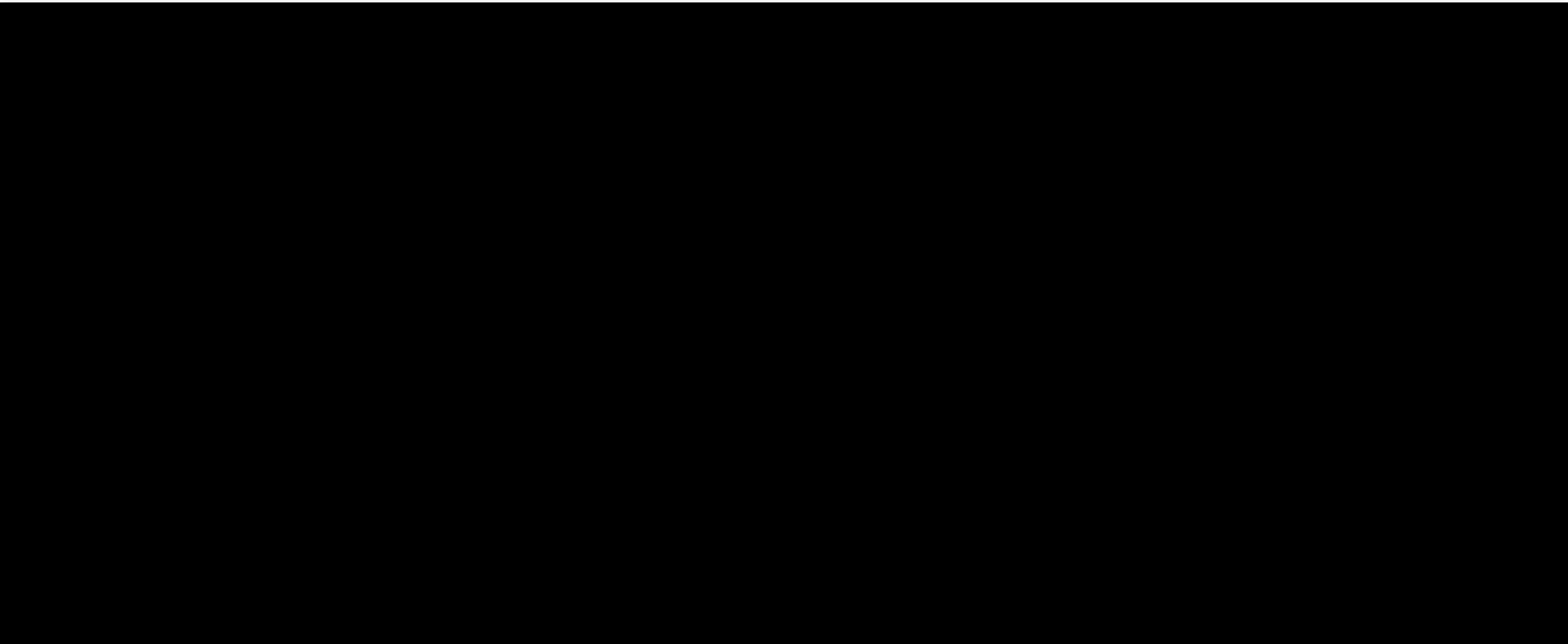
Prototype Video

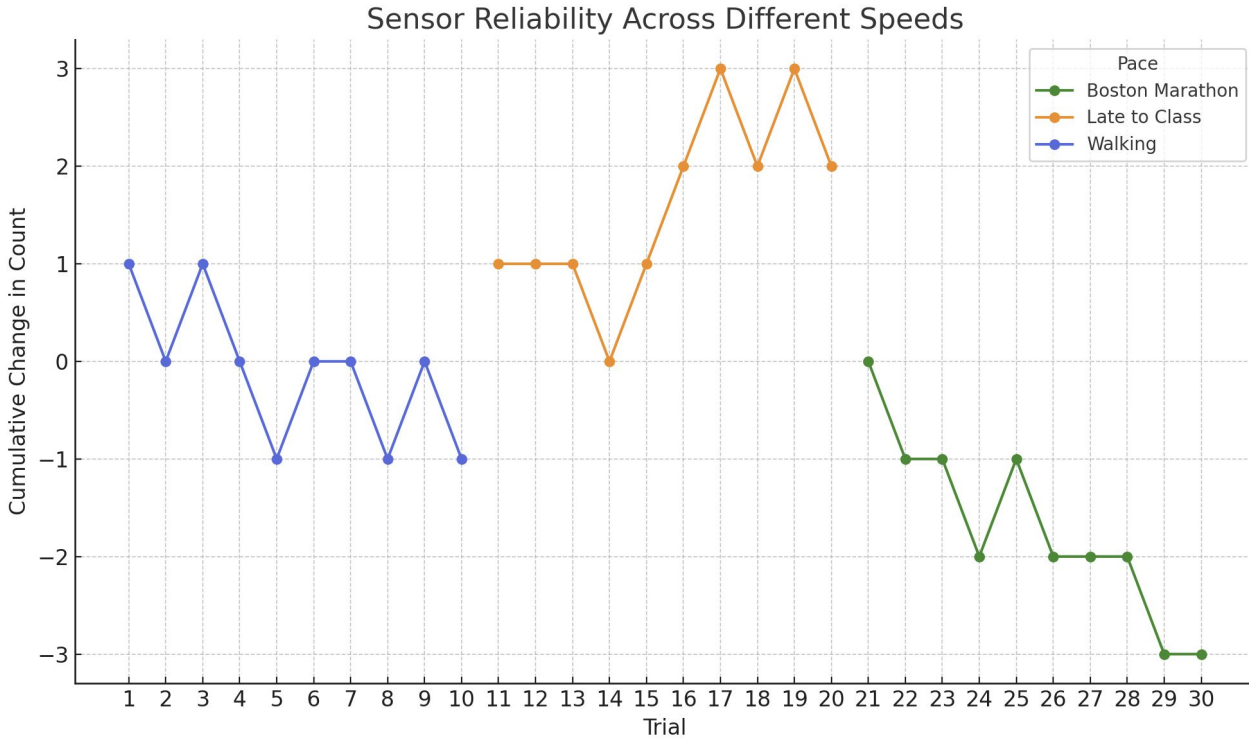


Initial Sensor/Code Testing

Max Occupant Value	# of People Walking Through	Count (In)	Did Bar Deploy?	Green LED Off?	Red LED On?
3	3	3	Yes	Yes	Yes
4	5	5	Yes	Yes	Yes
5	6	5	Yes	Yes	Yes
6	6	5	No	No	No
7	8	8	Yes	Yes	Yes
8	8	8	Yes	Yes	Yes

Different Speed Testing

- We did 10 trials for each speed alternating in/out.
- So the final result should be close to zero for all 3 speeds
- notice that the blue (walking) is the closest to 0
- straight line is “missed detection” ie no change



Looking Ahead

- Enhancing Box Design
  - Lid design and fabrication
  - Paint outside surfaces
  - Hole resizing
- Interfacing with tripod
- Buzzer implementation
- Test sensor configuration inside housing
- Algorithm improvements and reliability
- Battery life (rechargeable)

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