ScentBot

DESIGN REVIEW | SS23 ECE Capstone

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Use Case

- A mobile scent classification system that can **map** and **locate the source** of odor to help prevent hazards.

- Current scent detection systems are **immobile**, extremely **expensive**, and **inaccessible** to consumers, like people suffering from **anosmia**.

- ECE Areas: Signals & Systems, Software Systems

Design Requirements

#01 Accurately classify different scents	#02 Collision-free navigation and location detection	#03 Accessibility
Classification Accuracy (TPR): > 95%	Computation time < 1.5s per step for data collection, routing and inference	Cost effective scent module (< $150)
False negative rate: < 1%	Robot can detect scent from > 0.5m radial distance	I2C compatible sensors for easy interfacing
Collect training data in at least 3 different indoor temperature and humidity environments	Prediction confidence threshold for detecting a scent > 90%	

Solution
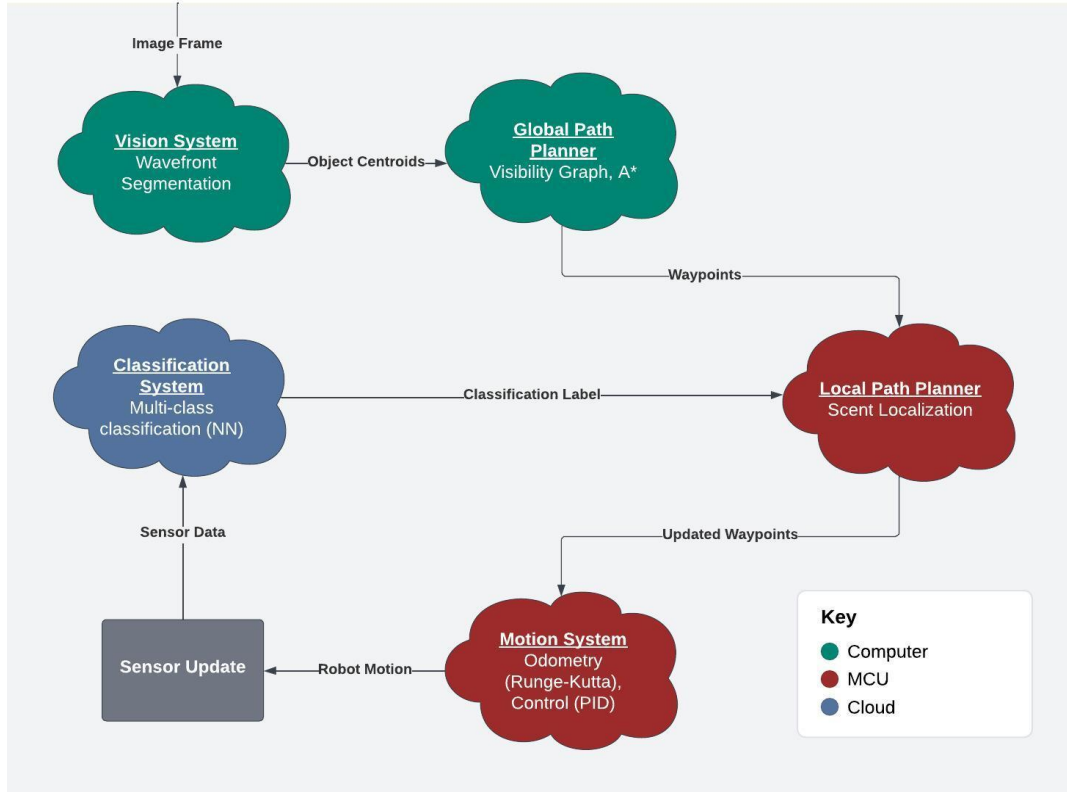
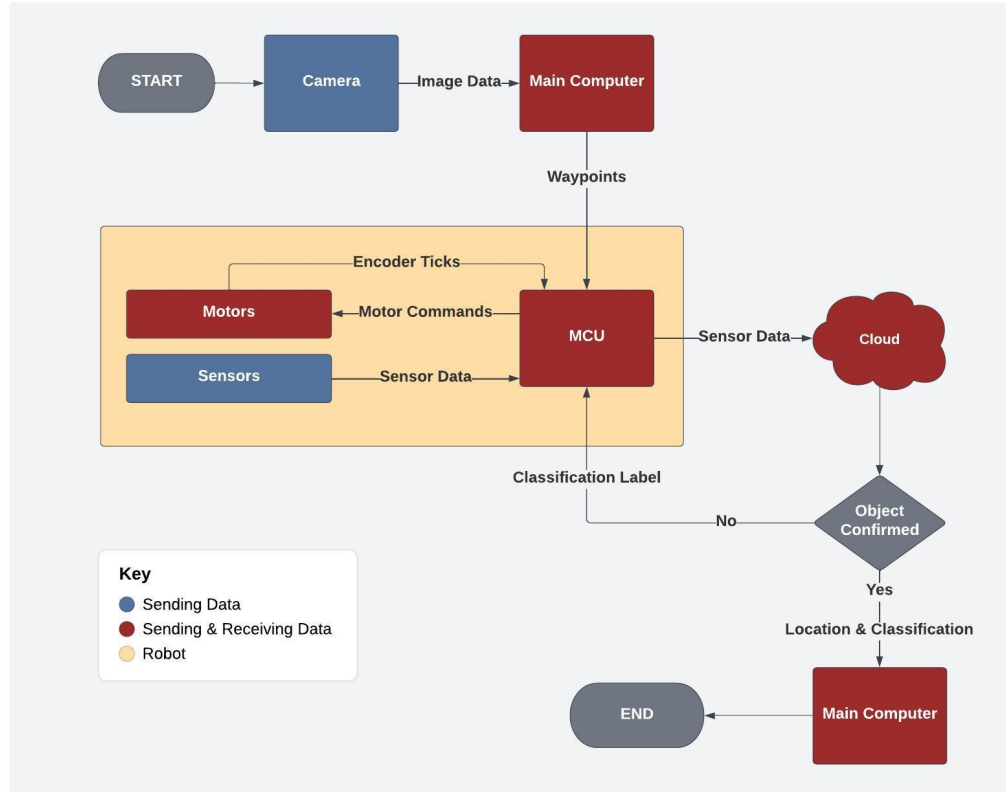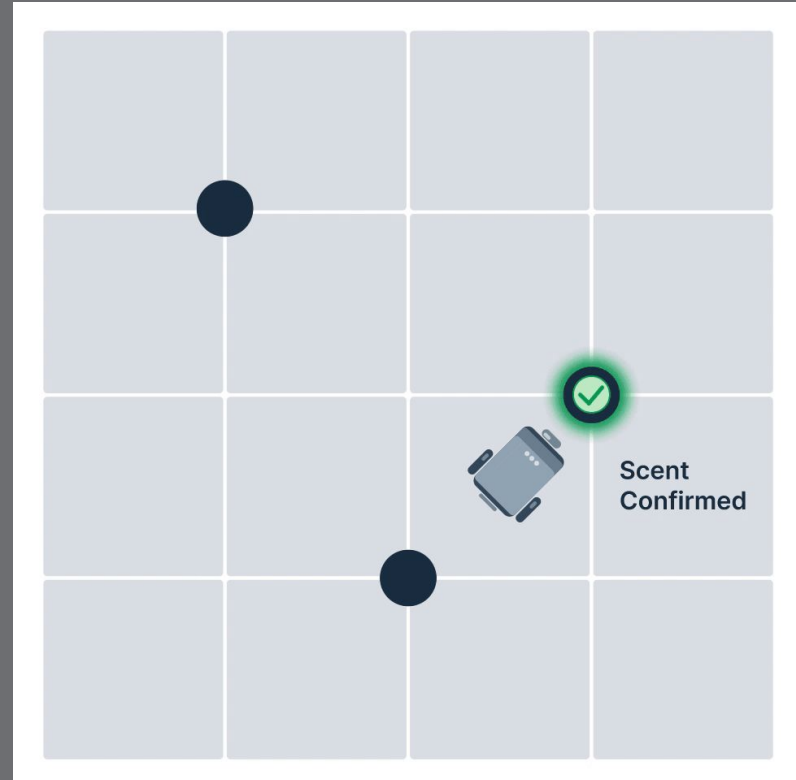# Data Flow

Setup

- Test Arena 2m x 2m

- White Foam Core Boards

- Arena divided into 4 x 4 grid

- Overhead Camera

- Multiple objects on corners - only one scented

Scent Confirmed

The Robot

- Arduino Uno Microcontroller

- ESP8266 Wi-Fi Module for relaying data

- Sensor array for collecting gas data

- DC motors with magnetic encoders

- Exhaust fan to ensure continuous air flow

- L298N motor driver

- HC-SR04 Ultrasonic Sensor

- 2 x 6V power supplies
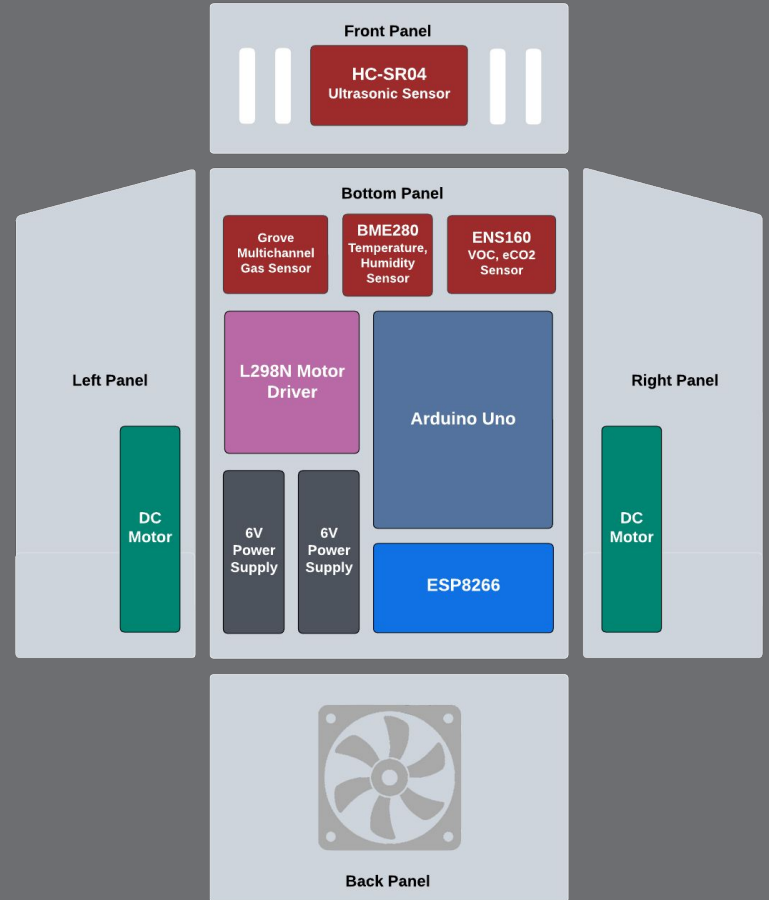
Verification & Metrics

Requirements	Testing	Metrics
Accurately classify different scents	Inference testing of algorithm on individual scents & testing with various unscented objects	Accuracy (TPR): > 95% False negative rate: < 1%
Collision-free navigation	Correct path planning around various configurations	Robot can navigate to within 5 cm of each waypoint
Low latency	Time taken to send classification label in test setup	Latency of detection, routing, and classification: < 1.5s
Record location of different scents	Robot deviation from path once a scent is detected	Robot can detect scent from > 0.5m radial distance
Accessibility	Cost of sensor module	Estimated budget for sensor module: < $150

Alternative Approach: Random Exploration

- High dependence on sensor sensitivity for our project

- Test the working distance of our sensors to determine the need for path planning

- Test setup: **one** object, scent diffuser to create increasing density for scent detection

- Robot will randomly explore the space and follow the increasing scent probability to the object

- Metric: 3 minutes to convergence
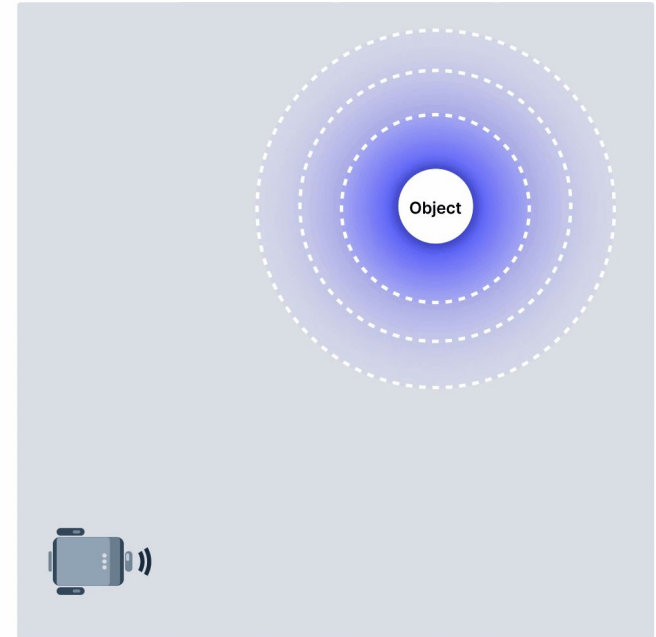
Progress So Far

- Wavefront Segmentation implementation

- Robot CAD progress
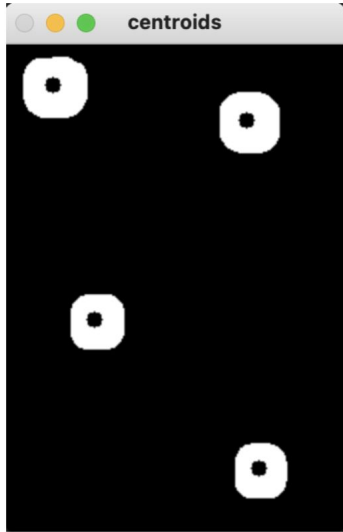
Schedule

Task No.	Task Title	Owner	Progress	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7		Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Finals Week
				1/30 - 2/5	2/6 - 2/12	2/13 - 2/19	2/20 - 2/26	2/27 - 3/5	3/6 - 3/12		3/13 - 3/19	3/20 - 3/26	3/27 - 4/2	4/3 - 4/9	4/10 - 4/16	4/17 - 4/23	4/24 - 4/30	5/1 - 5/7
1	**Deliverables**																	
i	Project Abstract	All	Done															
ii	Project Proposal	All	Done															
iii	Website Setup	All	Done															
iv	Proposal Presentation	Caroline	Done															
v	Design Review	All	In progress															
vi	Design Review Presentation	Aditti	In progress															
vii	Design Review Report	All	Not started															
viii	Ethics Assignment	All	Not started															
ix	Interim Demo	All	Not started															
x	Final Presentation	Eshita	Not started															
xi	Final Report	All	Not started							S									
xii	Final Demo	All	Not started							P									
2	**Sensing System**									R									
i	Research Sensors and Microcontrollers	All	Done							I									
ii	Ordering Sensors & Parts	All	Done							N									
iii	Sensor System Assembly	Eshita & Caroline	In progress							G									
iv	Data Routing (ioT)	Eshita	Not started															
v	Dataset Generation	Eshita & Caroline	Not started															
vi	Classification Algorithm	Eshita	Not started															
vii	Testing	All	Not started															
3	**Robot Navigation & Control**																		
i	Research Commercial Mobile Robots	All	Done							B									
ii	Ordering Parts	All	Done							R									
iii	Robot Assembly	Aditti & Caroline	In progress							E									
iv	Computer Vision Segmentation	Aditti	Done							A									
v	Odometry	Aditti	Not started							K									
vi	Path Planning (Scented)	Caroline	Not started															
vii	Path Planning (Unscented)	Aditti	Not started															
viii	Testing	All	Not started															
5	**System Integration & Verification**																		
i	Field Design & Construction	All	In progress															
ii	Hardware Integration	All	Not started															
iii	Software Pipeline Integration	All	Not started															
iv	Testing with 1 Scented Object	All	Not started															
v	Testing with Multiple Scented Objects	All	Not started															
6	**Slack**																		

Conclusion

- Overall purpose

  - A mobile scent classification system that can **map** and **locate** the source of odor to help prevent hazards, working toward considerations of public safety.

- Key changes

  - Random exploration approach

- Key challenges moving forward

  - Sensor sensitivity and determining need for path planning

  - Robot motor calibration