

# ScentBöt

PROJECT PROPOSAL | SS23 ECE Capstone

---

Caroline Pang, Aditti Ramsisaria, Eshita Shrawan

# 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



## Requirement #01

# Accurately classify different scents

### Motivation

Users should be informed of the type of scent in order to effectively formulate a plan to handle the hazard.

### Sub-requirements

- Detect 3 types of scents: paints, ammonia, and spirits
- Classification accuracy ( > 95%)
- Classification is adaptive to the local environment

## Requirement #02

# Collision-free navigation and location detection

### Motivation

The robot should be able to safely navigate around environments, quickly detect any potential hazards, and communicate them to the user.

### Sub-requirements

- Obstacle avoidance
- Computation time < 1.5s for data collection, routing and inference
- LEDs to indicate which scent is detected
- Scented object location and class recorded on main computer

## Requirement #03

# Accessibility

### Motivation

Current scent-detection methods like Ion Mobility Spectrometry (IMS) are expensive, inaccessible to most consumers, and require specialized knowledge to use.

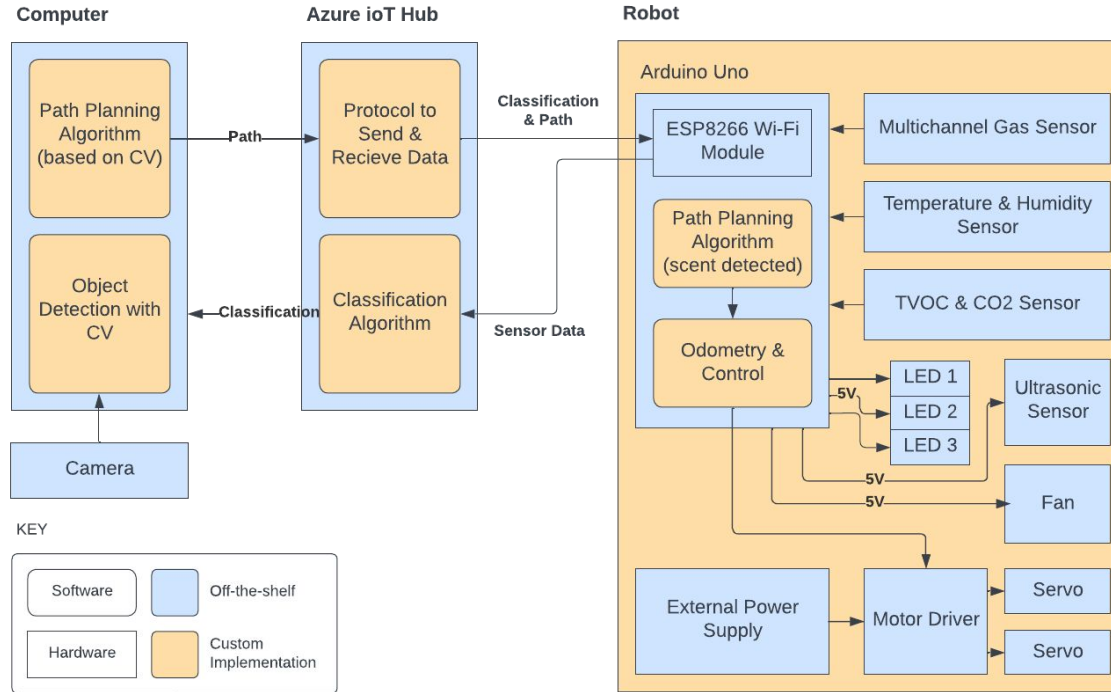
### Sub-requirements

- Cost effective scent module (< \$150)
- Replaceable sensor setup with easy to follow instructions

# Technical Challenges

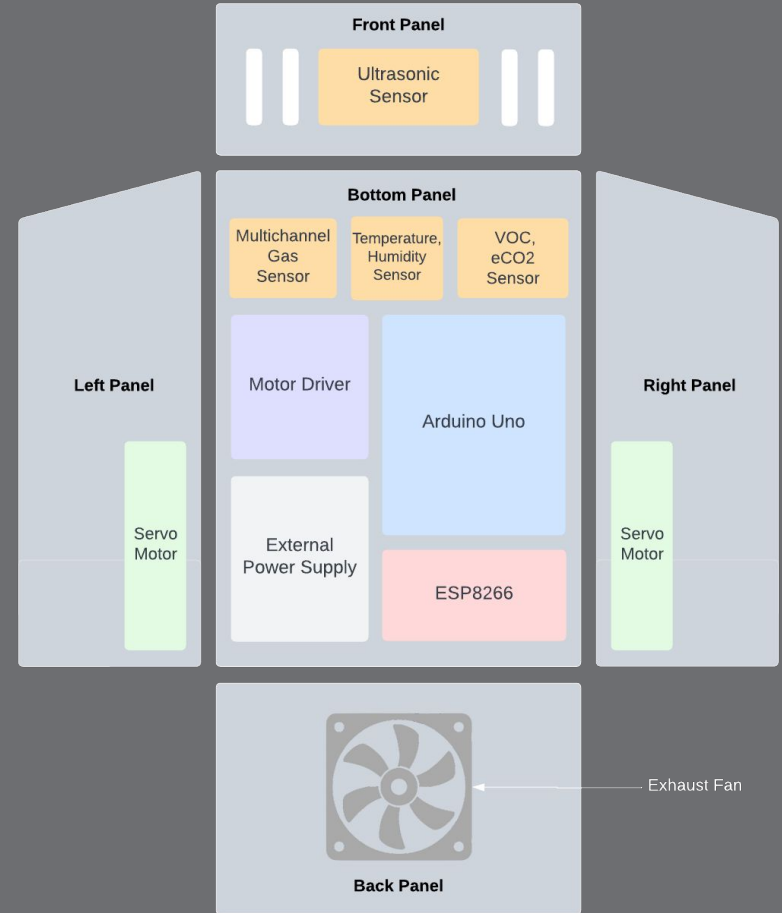
- Accurate scent detection and classification across **varying temperature and humidity environments**
- Optimized **path planning** to efficiently direct the robot throughout the environment
- Detecting scents **from a distance** and **system calibration** to ignore ambient scents
- **Efficiently reorienting** towards the direction of highest probability of a scented object

# Solution Approach



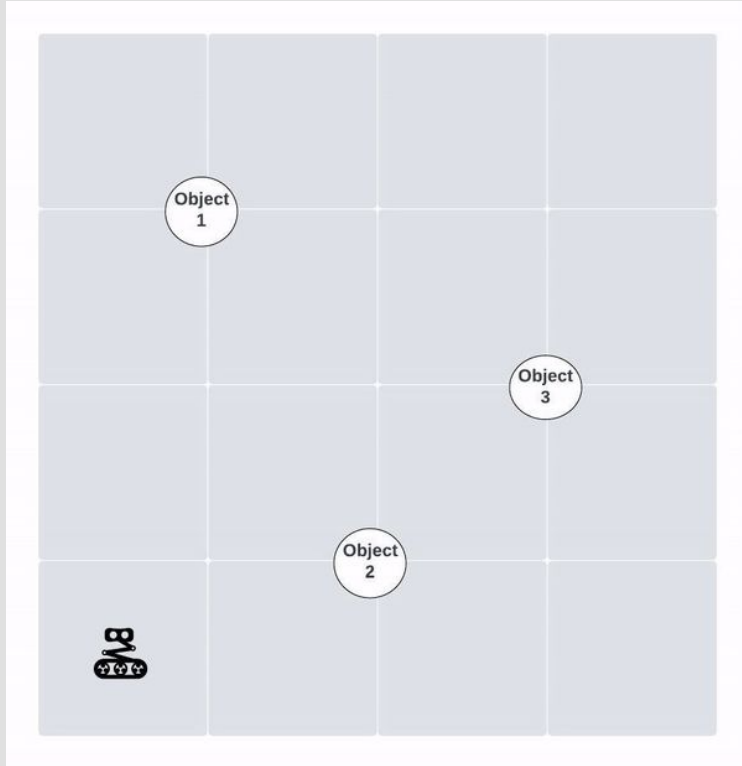
# The Robot

- Arduino Uno Microcontroller
- ESP8266 + Wi-Fi for relaying data
- Sensor array for collecting gas data
- Servo motors with quadrature encoders
- Exhaust fan to ensure continuous air flow





# Testing & Verification



- **Algorithm inference tests:** to test scent classification and calculation of optimal path from various configurations.
- **Arena testing:** one scented object and various unscented objects for correct **identification** and **classification**.

# Testing & Verification

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 1 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 > 2ft radial distance
Accessibility	Cost of sensor module	Estimated budget for sensor module: < \$150

# Task Distribution

- **Robot navigation and control** (Aditti)
- **Data routing** (Eshita)
- **Path planning** (Caroline)
- **Robot Assembly** (Aditti & Caroline)
- **Classification Algorithm** (Caroline & Eshita)
- **Hardware Integration** (All members)
- **Software Integration** (All members)
- **Field Construction** (All members)
- **Scenario Design & Testing** (All members)

# 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	
<b>1 Deliverables</b>																			
i	Project Abstract	All	<input checked="" type="checkbox"/> Done																
ii	Project Proposal	All	<input type="checkbox"/> In progress																
iii	Website Setup	All	<input checked="" type="checkbox"/> Done																
iv	Proposal Presentation	Caroline	<input type="checkbox"/> In progress																
v	Design Review	All	<input type="checkbox"/> Not started																
vi	Design Review Presentation	Aditti	<input type="checkbox"/> Not started																
vii	Design Review Report	All	<input type="checkbox"/> Not started																
viii	Ethics Assignment	All	<input type="checkbox"/> Not started																
ix	Interim Demo	All	<input type="checkbox"/> Not started																
x	Final Presentation	Eshita	<input type="checkbox"/> Not started																
xi	Final Report	All	<input type="checkbox"/> Not started																
xii	Final Demo	All	<input type="checkbox"/> Not started																
										<b>S</b>									
										<b>P</b>									
										<b>R</b>									
<b>2 Sensing System</b>																			
i	Research Sensors and Microcontrollers	All	<input type="checkbox"/> In progress																
ii	Ordering Sensors & Parts	All	<input type="checkbox"/> Not started																
iii	Sensor System Assembly	Eshita & Carolin	<input type="checkbox"/> Not started																
iv	Data Routing (IoT)	Eshita	<input type="checkbox"/> Not started																
v	Dataset Generation	Eshita & Carolin	<input type="checkbox"/> Not started																
vi	Classification Algorithm	Eshita	<input type="checkbox"/> Not started																
vii	Testing	All	<input type="checkbox"/> Not started																
										<b>G</b>									
<b>3 Robot Navigation &amp; Control</b>																			
i	Research Commercial Mobile Robots	All	<input type="checkbox"/> In progress																
ii	Ordering Parts	All	<input type="checkbox"/> Not started																
iii	Robot Assembly	Aditti & Caroline	<input type="checkbox"/> Not started																
iv	Computer Vision Segmentation	Aditti	<input type="checkbox"/> Not started																
v	Path Planning (Unscented)	Aditti	<input type="checkbox"/> Not started																
vi	Path Planning (Scented)	Caroline	<input type="checkbox"/> Not started																
vii	Odometry	Aditti	<input type="checkbox"/> Not started																
viii	Testing	All	<input type="checkbox"/> Not started																
										<b>B</b>									
										<b>R</b>									
										<b>E</b>									
										<b>A</b>									
										<b>K</b>									
<b>5 System Integration &amp; Verification</b>																			
i	Field Design & Construction	All	<input type="checkbox"/> In progress																
ii	Hardware Integration	All	<input type="checkbox"/> Not started																
iii	Software Pipeline Integration	All	<input type="checkbox"/> Not started																
iv	Testing with 1 Scented Object	All	<input type="checkbox"/> Not started																
v	Testing with Multiple Scented Objects	All	<input type="checkbox"/> Not started																
<b>6 Slack</b>																			