Electronic Airborne Chemical Detection (SNOUT)

Project Lead: Anirudh Subramanian
Members: Zhengye Chen, Odalys Garay, Srikar Kotha, Mason Nguyen
Seth Powell, Aiden Skillman, Caleb Snider

TEXAS A&M UNIVERSITY Engineering

TEXAS A&M UNIVERSITY
ROBOTICS TEAM & LEADERSHIP EXPERIENCE

Intro & Problem Definition

Smell

- Our least digitized sense
- Remains one of the hardest for machines to replicate
- Current chemical detection relies heavily on trained animals, particularly dogs
  - Explosive and narcotics detection
  - Search-and-rescue operations
  - Medical scent detection (disease biomarkers)
  - Identifying hazardous industrial chemicals.
- Electronic chemical detection systems exist, but most are expensive, slow, or require laboratory conditions.

Our goal is to develop **SNOUT**, a compact robotic sensor that mimics biological smell detection by identifying chemicals through unique signatures.

Working Principle

SNOUT detects chemicals using **Fluorescence Spectroscopy**, a technique where molecules emit light after being excited by UV energy, and **Metal Oxide Detection**, where molecules change the electrical resistivity of a substance.

Fluorescence Process

1. UV light excites electrons inside the molecule.
2. The electrons jump to higher energy states.
3. As they relax back down, the molecule emits lower-energy visible photons—fluorescence.

Metal Oxide Detection

1. Sensor picks up Current Readings
2. Presence of Particles generates electrical resistance
3. The greater the resistance, the greater number of particles in the area

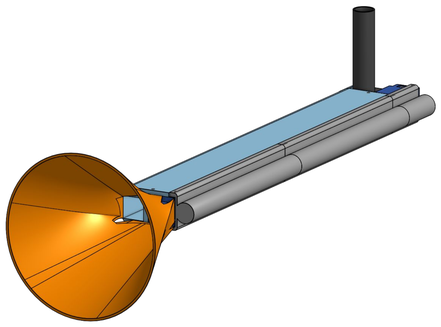

Figure 1: *Mockup of SNOUT system*

Design Approach

Mechanical Design

- 3 horizontal column design ensures controlled airflow through the UV chamber.
- A small intake fan pulls ambient air or sample air into the chamber.
- Optional filters can be added to isolate specific excitation wavelengths.

Design

- Two UV sources:
  - **254 nm** for inorganic and mineral-based signatures
  - **365 nm** for organic molecules, amino acids, and hydrocarbons

Wavelength Detectors pick up particles in the air (aerosols) that affect air quality - funnels designed to get air to the layers of filters - and flouresce

9 different MO Sensors for various gasses that cannot be detected by fluorescence

Electronics & Sensors

- **AS7134 spectral sensor** measures intensity at multiple wavelengths.
- **MO Detectors** detect gas concentrations
- Internal cables are shielded to reduce electrical interference from the UV LED drivers.

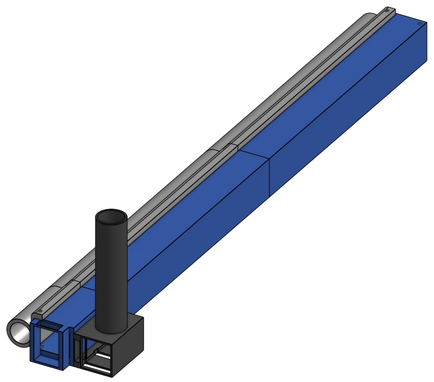

Figure 2: *Interior of SNOUT device*

Software

The AI model used is a Random Forest Model. Random Forest is an AI based on decision trees, where an ensemble machine learning method that combines the output of multiple individual decision trees to produce a single, more accurate, and stable prediction. This was picked to allow the Raspberry Pi to run the program easier.

- Low memory requirements
- Quick to run
- Low Power

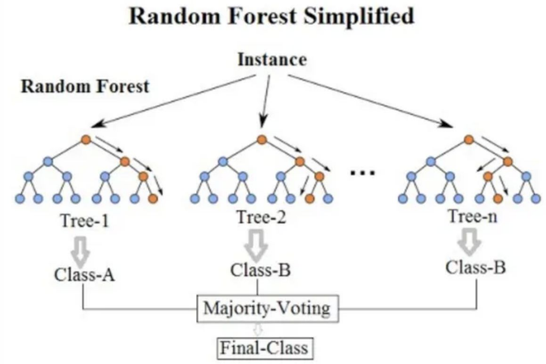

Figure 3: *Random Forest Model*

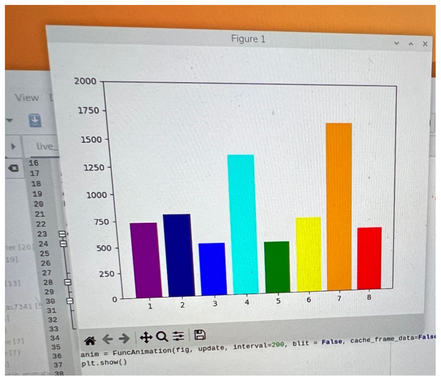

Figure 4: *A*

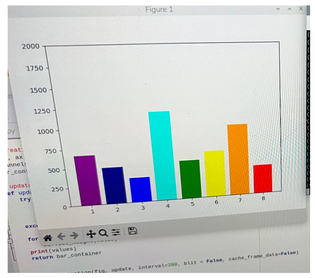

Figure 5: *B*

Figure 6: *C*

Figure 4-6: *A: Control, B: Tonic Water, C: Marker Shavings*

What We Accomplished

- Designed and printed the first airflow-controlled sensor chamber
- Calibrated the AS7134 sensor under both UV wavelengths
- Implemented a working Random Forest pipeline for early classification tests

Next Steps

- Finish Metal Oxide branch of detector
- Increase dataset size with more chemical categories
- Integrate humidity and temperature sensing for environmental compensation

Last Notes

SNOUT is a step toward digitizing one of humans' least understood senses. By combining fluorescence spectroscopy and Metal Oxide Detection with machine learning and robotic design, our system aims to create a low-cost, portable, and reliable chemical detection platform capable of performing tasks typically handled by highly trained scent-detection animals.