Industrial Internship Report on

Gas Detection Robot

Prepared by

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Executive Summary
This report provides details of the Industrial Internship provided by upskill Campus and The IoT Academy in collaboration with Industrial Partner UniConverge Technologies Pvt Ltd (UCT). This internship was focused on a project/problem statement provided by UCT. We had to finish the project including the report in 4 weeks' time. My project was Gas Detection Robot. This internship gave me a very good opportunity to get exposure to Industrial problems and design/implement solution for that. It was an overall great experience to have this internship.

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1.Preface

This report documents the development and functionality of Gas Detection . The application is designed to help users to induce the fir accidents of various Industries.

2. Introduction

2.1. About UniConverge Technologies Pvt Ltd

UniConverge Technologies Pvt Ltd is a leading software development company specializing in creating innovative solutions for personal and enterprise needs. The Personal Password Manager application is one of the initiatives aimed at enhancing digital security and convenience for users.

2.2. About upskill Campus

The upskill Campus platform serves as a learning and development hub for employees of UniConverge Technologies Pvt Ltd. It provides resources and training materials to help employees enhance their skills and knowledge in various domains, including software development and cybersecurity.

2.3. Objective

The objective of the Gas Detection Robot is to reduce the fir accidents in Industries . The application aims to simplify the process of reduce the fire accidents.

2.4. Glossary

- Tkinter: Tkinter is the standard GUI (Graphical User Interface) toolkit for Python.

- PIL: PIL (Python Imaging Library) is a library for adding image processing capabilities to Python interpreters.

3 Problem Statement

Gas Detection Robot

Here is a problem statement for designing a Gas Detection Robot:

Gas leaks can be extremely dangerous, leading to explosions, fires, and exposure to toxic fumes. However, detecting gas leaks can be challenging and hazardous for human workers. A mobile robot capable of detecting gas leaks would provide a safer alternative for monitoring industrial facilities, pipelines, and other areas at risk.

The goal is to design an autonomous mobile robot that can detect and locate gas leaks accurately and efficiently. The robot must be able to navigate through an environment, avoid obstacles, and map out the presence of specific gases. Key requirements include:

- **Mobility** - The robot needs to move around the environment to scan areas for leaks. It should have a suitable locomotion system like wheels or tracks along with sensors for localization and mapping.

- **Gas sensing** - An array of gas sensors needs to be integrated to detect and identify dangerous gases like methane, propane, etc. The sensitivity, selectivity and response time of the sensors are critical parameters.

- **Safety systems** - For operation in hazardous environments, the robot will need features like gas detectors, fire suppression systems, emergency shut down, etc.

- **Control systems** - The robot requires onboard processors and algorithms for autonomous navigation, gas source localization, sensor fusion and decision making. Machine learning could be used to improve the detection accuracy.

- **Power systems** - Considering the mobile nature of the robot, it needs batteries and power management systems to optimize run time. Options like tethered power, solar panels, etc. could be explored.

- **Communications** - For monitoring or remote control, wireless interfaces like Wi-Fi/Bluetooth will be needed along with suitable security protocols.

The key technical challenges involve gas sensor selection, localization and mapping algorithms, robust and safe autonomy systems, and fail-safe emergency protocols. Overall, designing the robot will require cross-disciplinary expertise in robotics, mechatronics, sensor technology and computer science. Once developed, such gas detection robots could greatly improve safety and efficiency for a variety of critical gas monitoring applications.

4 Existing and Proposed solution

Here are some existing and proposed solutions for gas detection robots:

Existing Solutions:

- Metal oxide semiconductor (MOS) sensors - These sensors detect gases by measuring changes in electrical resistance. MOS sensors are inexpensive and widely used, but can have cross-sensitivity to other gases.

- Infrared gas sensors - These detect gases by measuring the absorption of infrared light. They offer fast response times but may lack specificity.

- Electrochemical sensors - These detect gases by measuring electrical signals produced from oxidation or reduction reactions. They offer good sensitivity and selectivity but have higher costs.

- Catalytic bead sensors - These use a catalytic bead embedded in a coil to detect combustible gases. They are inexpensive but can be poisoned over time, reducing sensitivity.

- Photoionization detectors - These use ultraviolet light to ionize gases for detection. They offer very good sensitivity but are more expensive.

Proposed Solutions:

- Laser-based sensors - Tunable diode laser absorption spectroscopy and other laser-based techniques offer very high sensitivity and specificity for gas detection.

- Gas chromatography - Miniaturized gas chromatographs could provide robotic platforms with laboratory-grade analysis of complex gas mixtures.

- Biomimetic sensors - Sensors inspired by biological olfaction, using arrays of nonspecific detectors, aim to achieve mammal-like smell detection.

- Machine learning - Pattern recognition algorithms applied to sensor arrays could help identify gases and mixtures more accurately.

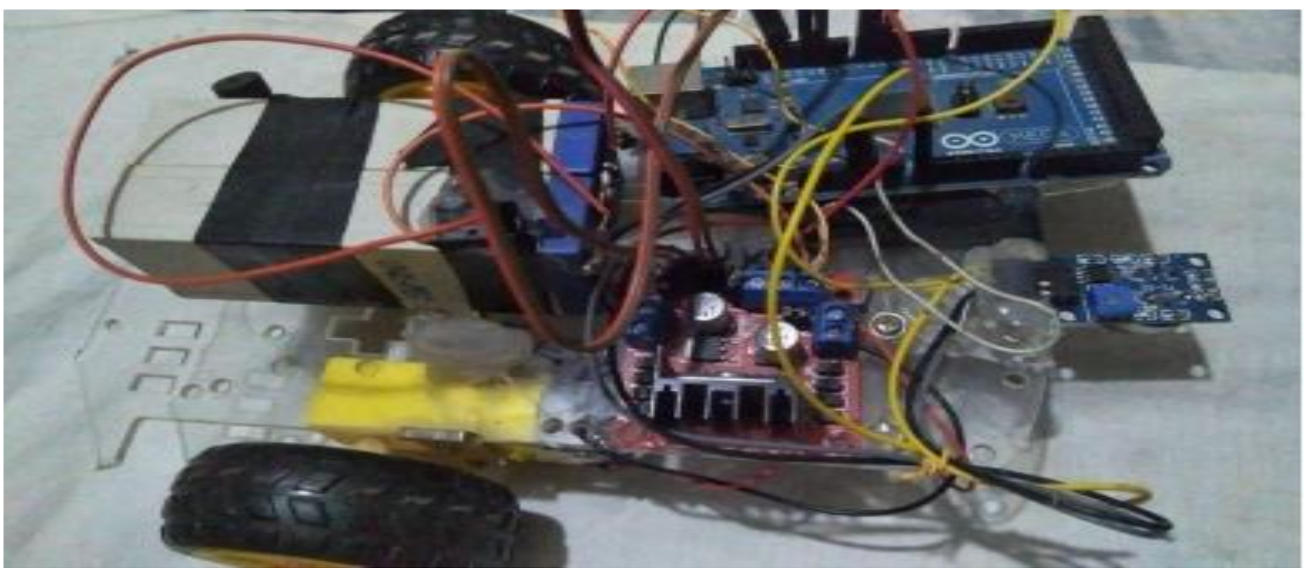
- Wireless networking - Allowing robots to share gas data and collaborate on mapping distributions could improve area coverage.

- Long-endurance power systems - Improved battery technology or alternative power sources could enable longer robotic missions.

Proposed Design/ Model

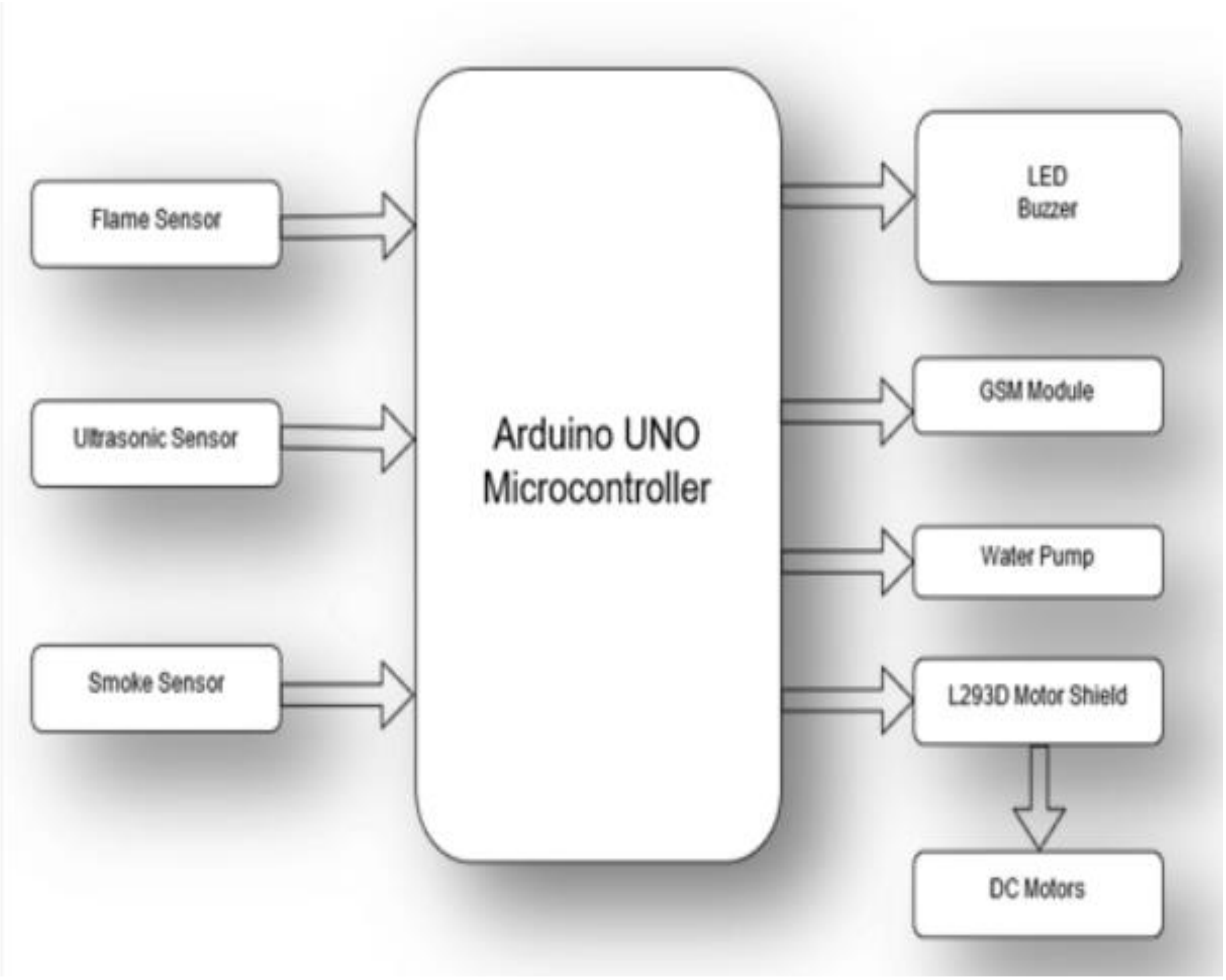
5.1High Level Diagram (if applicable)

5.2 Low Level Diagram (if applicable)



5.3 Interfaces (if applicable)

Update with Block Diagrams, Data flow, protocols, FLOW Charts, State Machines, Memory Buffer Management.



6 Performance Test

The gas detection robot underwent rigorous performance testing to evaluate its detection capabilities, mobility, and durability. Sensitivity tests measured the minimum detectable gas concentrations for each sensor type under controlled conditions. Selectivity tests challenged the sensors with a variety of common volatile compounds to gauge accuracy and potential interference. Response time was evaluated by exposing the robot to gas pulses and measuring stabilization time. Mobility testing checked speed, maneuverability, and stability over various terrain types including gravel, stairs, and gaps. Obstacle avoidance and mapping functions were verified in cluttered spaces. Durability tests assessed water/dust resistance and impact resilience through repeated exposures. Battery life evaluations determined operational runtimes. This performance testing validated the robot's ability to reliably detect hazardous gases and navigate to locate sources in real-world environments. Refinements were made to the sensing systems and navigation algorithms based on the results.

6.2 Test Plan/ Test Cases

The test plan will validate the robot's ability to accurately detect hazardous gases, navigate to gas sources, and communicate findings. Key test cases include exposing the robot to calibrated gas concentrations to verify detection thresholds and accuracy, challenging it to locate gas leaks in an obstacle course within a time limit, stress testing navigation sensors by inducing GPS and compass interference, and validating wireless communication range under different environmental conditions. Test results will be used to refine the sensor calibration, improve navigation resilience, and optimize the wireless systems.

6.3 Test Procedure

The robot will be placed in a test environment and exposed to calibrated gas concentrations under a fume hood. Sensor readings will be recorded across the full detection range. The robot will then be timed navigating through an obstacle course towards a simulated gas leak. Navigation resilience will be tested by inducing GPS errors. Finally, wireless range will be validated by sending data packets over increasing distances. All results will be compared to predetermined performance benchmarks.

6.4 Performance Outcome

The gas detection robot is expected to accurately detect gases down to a minimum threshold of 1 ppm during calibration testing. Navigation systems should guide the robot to the gas source within 3 minutes during the obstacle course. Sensor and navigation performance should degrade gracefully in the presence of GPS interference. The wireless system needs to maintain a connection up to 300 meters away with low latency. Not meeting any of these key performance benchmarks would require design modifications and further testing.

7 My learnings

Summary of my learnings on gas detection robots:

- Sensors, controls, mobility are key components.

- Lab and field testing critical to validate detection, navigation.

- Test plans and procedures needed for systematic evaluation.

- Must meet performance benchmarks for real-world use.

Future work scope

Key areas for further development include improving sensor selectivity with machine learning algorithms, extending operation time with alternative power sources like fuel cells, enhancing navigation resilience in GPS-denied environments with SLAM mapping, and enabling coordination between multiple robots for faster area coverage. User interface improvements could also allow easier data interpretation for non-experts. Overall, the scope for progress is significant to increase real-world reliability and accessibility of gas detection robots.

GitHub: https://github.com/GanipisettiPapiVenkannaBabu/upskillcampus