PROJECT REPORT

on

Gas Leakage Detecting Robot with Automatic Obstacle Avoidance

Submitted by

Shwetha Iyer (Div. A1 - 1032211195)

Vishvaksen Pendyala (Div. A1 - 1032210472)

Reet Shinde (Div. A1 - 1032211433)

Under the Guidance of

Dr. Vinaya Gohokar

School of Electronics & Communication Engineering

Dr. Vishwanath Karad
MIT WORLD PEACE UNIVERSITY, PUNE.

Dr. Vishwanath Karad
MIT WORLD PEACE UNIVERSITY | PUNE
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS

SCHOOL OF
ELECTRONICS & COMMUNICATION ENGINEERING

Academic Year 2022-2023

CERTIFICATE

This is to certify that **Shwetha Iyer**, PRN No. **1032211195** has successfully completed his/her PBL activity entitled "**Gas Leakage Detecting Robot with Automatic Obstacle Avoidance**" and submitted the same during the academic year 2022-2023 as a requirement for completion of continuous assessment component under subject *Sensors & Actuators*.

Batch Coordinator	Head of School Dr. Vinaya Gohokar

Date: 16-05-2023

Place: Pune

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to HOD and subject teacher, *Dr. Vinaya Gohokar*, for providing us the wonderful opportunity of working on a hands-on project. Her constant encouragement, support and feedback has made this a motivating and insightful learning experience for us.

We would also like to thank MIT World Peace University for their laboratory facilities, which gave us the tools and environment required to perform this project.

In addition, we would also like to acknowledge the endless moral and material assistance given by our friends and family, without which this project would not have been completed.

Table of Contents

ABSTRACT

This paper demonstrates the development of a microcontroller-based mobile gas-sensing robot that can determine the source location of an LPG gas leakage. The autonomous robot is constructed using an Arduino Uno microcontroller and equipped with LPG gas sensors. This project is proposed to reduce the workload for the inspection and management of LPG pipelines. LPG leak detection can be challenging as it is an odourless and highly flammable gas. The system is also equipped with an ultrasonic sensor to detect obstacles and automatically avoid them without any human intervention.

1. INTRODUCTION

1.1 Motivation

LPG, or Liquefied Petroleum Gas, is a mixture of hydrocarbon gases, mainly propane and butane in different compositions. It is a commonly used fuel for domestic, commercial and industrial purposes due to its calorific value and portability, but it is colourless and odourless, making it hard to detect in case of leaks.

LPG being an igneous gas can cause hazards like explosions that may serve as a potential risk to humans, assets or nature. Hence, there is a demand for the development of a microcontroller-based LPG gas detecting and warning system which can work automatically without the need for human interference. Such robots are intended to avoid factoring humans in difficult or unsafe jobs and in remote location applications.

1.2 Aim and Objective of this Project

The foremost objective of developing an obstacle-avoiding gas leakage locator is to improve safety and reduce the risk of exposing humans to dangerous environments. The robot would be capable of properly detecting even low levels of LPG so as to properly identify a gas leakage and locate its source by following the gas trail.

Another important goal is ensuring that the robot can navigate through its surroundings while autonomously avoiding any obstacles in its path. For this, the robot must be equipped with distance sensors such as ultrasonic or infrared.

2. PROJECT DEVELOPMENT

2.1 Block Diagram

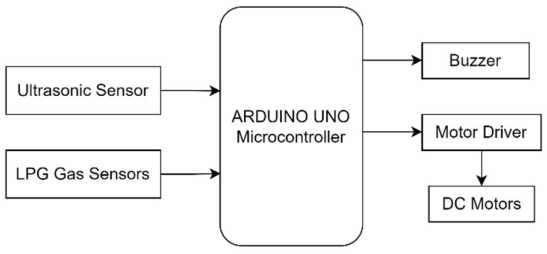

Fig. 1: System Architecture of an LPG Gas Detecting Robot having Autonomous Navigation

2.2 Component Specifications

a. Arduino Uno R3:

Arduino Uno is an open-source development board that works on the ATMega328P microcontroller developed by Atmel. It has an 8-bit RISC based processing core and up to 32 kB of flash memory. It has 14 digital I/O pins, of which 6 are PWM pins, and 6 analog I/O pins.

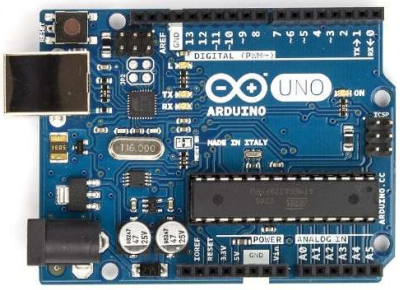

Fig. 2: Arduino Uno board configuration

b. L298N Motor Driver:

An L298N is provided to control the motor by the Arduino. It is a dual H-Bridge motor driver IC designed to drive inductive loads such as DC, stepping motors, relays and solenoids. It can control motors that can operate between 5 to 35V and up to 2A. Two enable inputs are provided to activate or deactivate the device independently of the input signals. To control the speed of the motor you apply a PWM signal to the enable line.

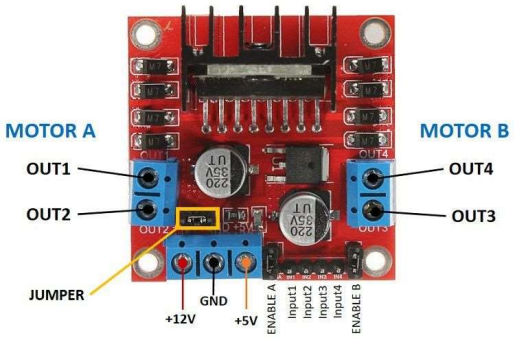

Fig. 3: L298N Motor Driver

c. HC-SR04 Ultrasonic Sensor:

This device uses ultrasonic sound waves to measure the distance of a target object. The time taken between the wave's transmission and reception is calculated against the speed of sound to determine the distance travelled. The HC- SR04 ultrasonic sensor has a range of 2 cm to 400 cm with an angle of 15 degrees.

Fig. 4: HC-SR04 Ultrasonic Sensor

d. MQ-6 Gas Sensor:

The MQ-6 module is a gas sensor suitable for detecting LPG, iso-butane, propane and LNG. Whenever these gases come into contact with the sensing element, its resistivity changes. This change is then measured to get the concentration of the gases present. The MQ-6 can detect gas concentrations anywhere from 200 to

10000 ppm. The sensor has a high sensitivity and fast response time.

Fig. 5: MQ-6 Gas Sensor

e. *DC Gear Motors*

This project utilizes two single-shaft plastic gear motors of the BO series. They rotate at a maximum speed of 150 rpm and can operate within an input range of 3V to 12V. These motors are cost-effective, lightweight and shock-absorbent.

Fig. 6: DC Motor

f. *CC1212A Buzzer*

This is a two-pin ceramic piezo-buzzer that emits a continuous tone of frequency up to 2.3kHz. In this project, the buzzer acts as a sound alert that goes off when the location of the gas leakage has been identified.

Fig. 7: Buzzer

2.3 Working of the System

The working of the robot is designed to be simple and user-friendly. Once the microcontroller is powered on, the motors will run normally and the robot will move forward. If the ultrasonic sensor perceives an obstacle at a distance of less than 20 cm, the robot stops, moves in reverse, and turns either left or right depending on a random choice.

The gas sensors mounted on the left and right sides of the robot will take readings continuously from the surroundings. The output voltage from the gas sensor increases as the concentration of gas increases. If the concentration detected on the left side is more than that on the right side, the robot turns left. Similarly, if the concentration detected on the right side is more than that on the left side, the robot turns right. If the concentration level of both sides is similar (<100 ppm difference), the robot continues to move forward.

If at any point, the concentration on either side is more than 10000 ppm, the robot stops and the buzzer begins to sound, indicating that a leak has been found.

2.4 Flowchart and Circuit Diagram

Figure 8 illustrates the detailed task of the robot, explaining the step-by-step procedure of how the system works.

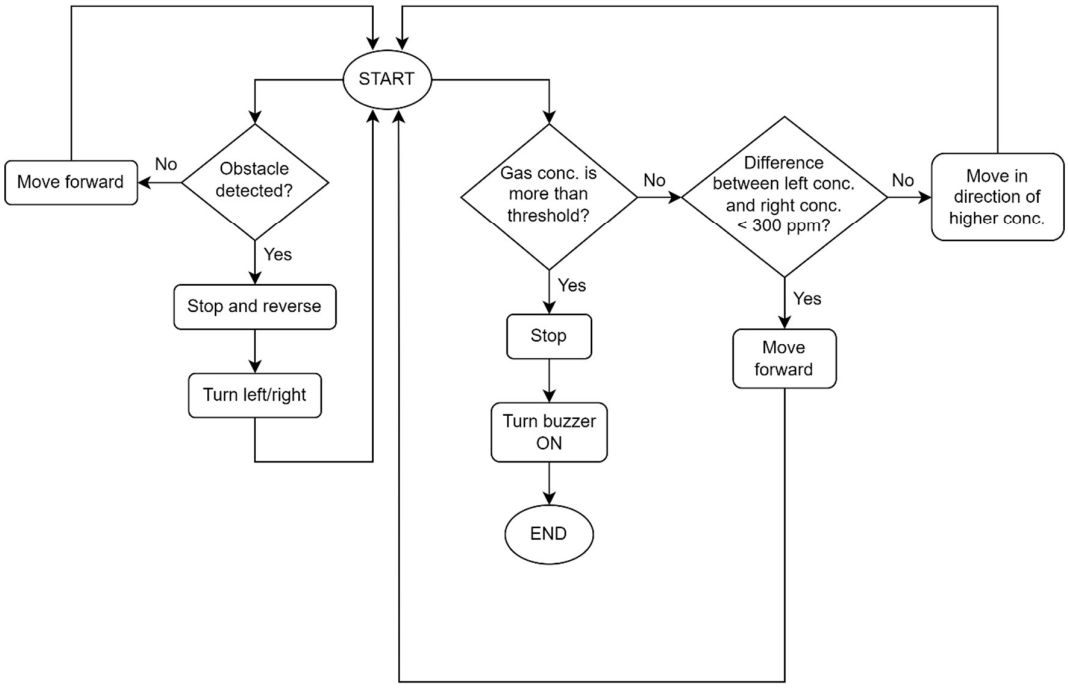

Fig. 8: Flowchart of an LPG Gas Detecting Robot having Autonomous Navigation

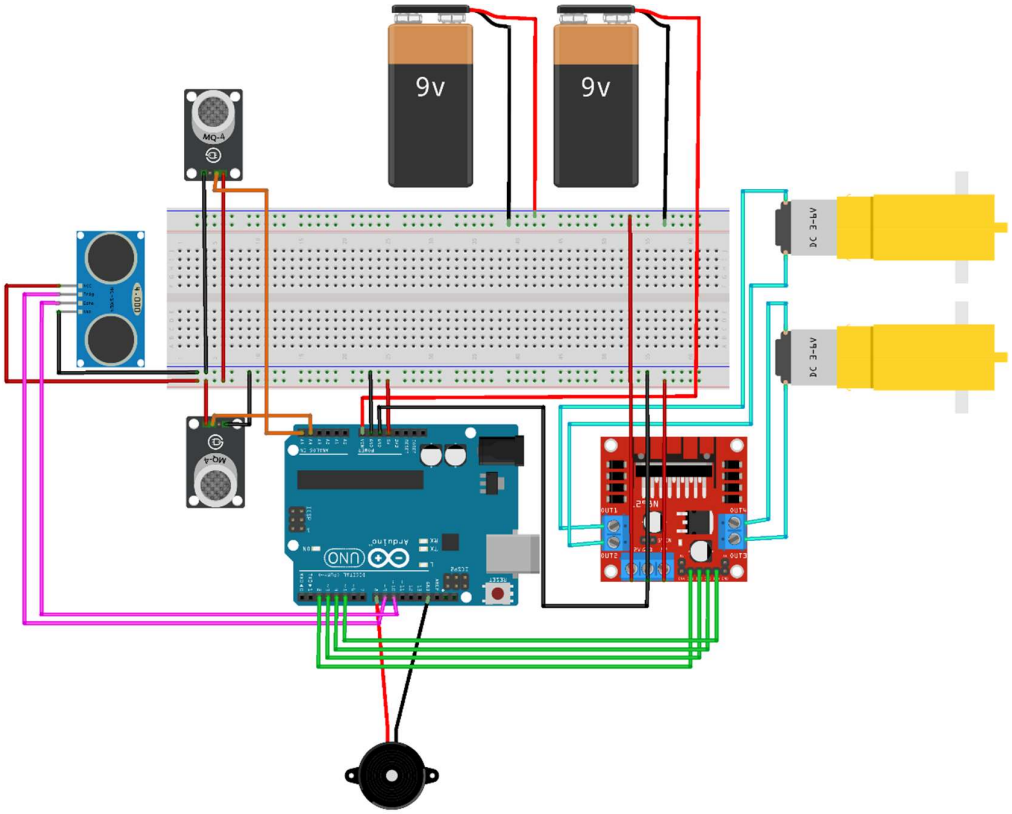

Fig. 9: Circuit Diagram

3. RESULTS

3.1 Results of the Implementation

The microprocessor-based gas sensing mobile robot has been successfully implemented. The result is a combination of the planned hardware and software, to obtain the complete proposed system. Experimental tests were done and the desired outputs were obtained based on objectives. The system was seen to satisfy its functional requirements of automatic obstacle avoidance and accurate localization of the LPG gas source.

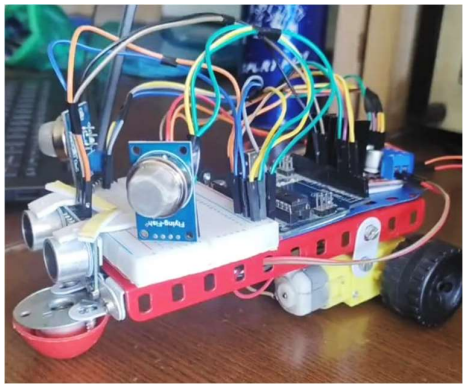

Fig. 10: Result of Implementation

3.2 Challenges Faced

This project brought on some unforeseen challenges. Firstly, the power requirement for the Arduino Uno, sensors and motor driver collectively turned out to be quite high. So, different options need to be explored for improving the power efficiency of the system.

Additionally, since it is difficult to simulate an LPG gas leak event in a safe and controlled manner, all the scenarios that the system might encounter could not be tested.

Lastly, the expenditure of all the circuit components came out to be more than expected, especially the cost incurred from the battery purchases.

4. CONCLUSION

This report presents the details of the design and implementation of an automated gas-leak detecting robot. This robot, built with specific sensors and machinery, aims to reduce the risk of any hazards caused by the leakage of toxic gases like LPG. The goal of this model is to ensure safety and security through the early identification of toxic gas leaks in both domestic and industrial settings. This will help to reduce the number of preventable gas-related tragedies.

5. FUTURE SCOPE

There is scope for attaching an IoT-based device so that in the event of a gas leak, the authorities can be notified in time and preventative measures can be taken. IoT devices can link many objects like smartphones, sensors, actuators, etc. to the Internet so that they can communicate with people or between themselves. For example, a GSM module can be used to establish an SMS alert system for all the connected devices in the area.

REFERENCES

1. Arain, M. A., Trincavelli, M., Cirillo, M., Schaffernicht, E., & Lilienthal, A. J. (2015, March 20). *Global Coverage Measurement Planning Strategies for Mobile Robots Equipped with a Remote Gas Sensor*. MDPI. https://doi.org/10.3390/s150306845
2. Younas, T., Mukhi, D. K., Saifuddin, M., Faiz Hassan Zaidi, S. M., Fayyaz, M. M., & Khan, H. A. (2020, June 9). *LPG Gas Detecting Robot Based on IOT | E3S Web of Conferences*. LPG Gas Detecting Robot Based on IOT | E3S Web of Conferences. https://doi.org/10.1051/e3sconf/202017301006
3. Science, R. (2022, December 16). *Gas Detection Robot: A guide on Smart Gas Leakage Detector Bot - Robots Science*. Robots Science. https://www.robotsscience.com/autonomous/gas-detection-robot/
4. Ghazali, M. Z., Noor, N. M., Ramly, N., & Putit, S. (2012). Development of Microcontroller Based Mobile Gas Sensing Robot. *Procedia Engineering*, *41*, 1190–1196. https://doi.org/10.1016/j.proeng.2012.07.300