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FINAL PROJECT IN ROBOTICS AND AUTOMATION

Portable Gas Stove Safety Device

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Portable Gas Stove Safety Device

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***Abstract* - The prevalence of portable gas stove usage, particularly in culinary businesses such as Samgyupsal or Hotpot establishments and household settings, underscores the importance of safety measures to mitigate potential hazards, notably gas leaks. As a solution, this research paper introduces a Portable Gas Stove Safety Device designed to enhance safety standards for users reliant on butane-powered gas stoves. The technology comprises two integrated components: a gas leak detection device and an automatic shut-off mechanism. Employing advanced sensors and wireless communication capabilities, the device swiftly detects gas leaks and initiates automatic shut-off procedures, thus preempting potential safety incidents. This study elucidates the technology's design, implementation, and functional efficacy, highlighting its potential to significantly improve safety outcomes in portable gas stove usage scenarios.**

***Keywords:* Gas Leak, Detection, Portable, Gas Stoves, Sensor, Automatic**

I. INTRODUCTION

A. Problem Statement

The use of portable gas stoves are widely used for businesses or for outdoor cooking and camping, yet their safety often falls short, leading to potential gas leaks and safety hazards. This research aims to address the effective detection and prevention systems by proposing an IoT device equipped with sensors capable of autonomously detecting gas leaks and shutting off the gas supply.

B. Project Overview

This paper provides an overview of a portable safety gas device. Consisting of two interconnected devices, this technology integrates gas leak detection and shut-off mechanisms to mitigate potential hazards. The first device, positioned at the back of the stove, employs fans and sensors to detect gas leaks and trigger alerts via Bluetooth communication. Meanwhile, the second device, located at the front, facilitates automatic shut-off upon receiving signals from the first device, effectively preventing further gas flow in hazardous situations.

C. Objectives

The general objective of this project is to evaluate the effectiveness of a two-device system, specifically aiming to enhance safety measures for users reliant on portable gas stoves:

a. Develop a gas leak detection system using advanced sensors capable of accurately detecting and quantifying gas leaks in the vicinity of the portable gas stove.

b. Implement an automatic shut-off mechanism that activates promptly upon detection of a gas leak by the gas leak detection system. This mechanism will be designed to swiftly and effectively cut off the gas supply to the portable gas stove, thereby preventing the escalation of potential safety hazards posed by gas leaks.

c. Establishing reliable communication between two HC-05 modules - ensuring dependable communication between two HC-05 modules and securing for strong and smooth communication.

II. METHODOLOGY

This chapter discusses the primary design aspects, data flow across the system, and power management strategies. It aims to develop and evaluate the effectiveness of the two-device system, focusing on accurate gas leak detection and reliable communication between components.

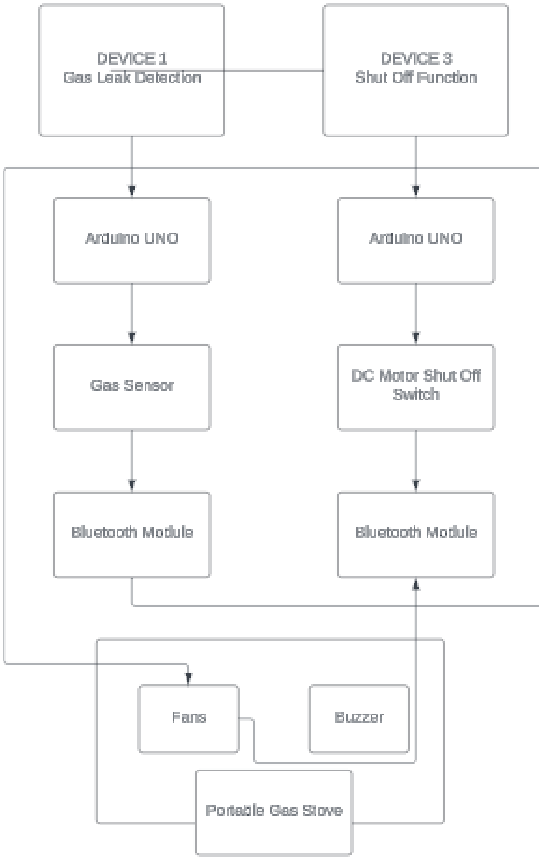

Figure 1.1 Block Diagram

A. Hardware Design

The hardware design of this paper aimed at enhancing safety for users of butane-powered gas stoves. The device comprises two interconnected components, a gas leak detection unit and an automatic shut-off mechanism. The gas leak detection unit, positioned at the back of the stove, utilizes fans and sensors for precise detection of gas leaks, triggering alerts through Bluetooth communication.

Meanwhile, the automatic shut-off mechanism, located at the front, swiftly cuts off the gas supply upon receiving signals from the detection unit, thereby preventing potential safety hazards.

1.) Electronics Systems

The electronic systems will be created on TinkerCAD. It will reflect the actual components to detect gas leaks accurately.

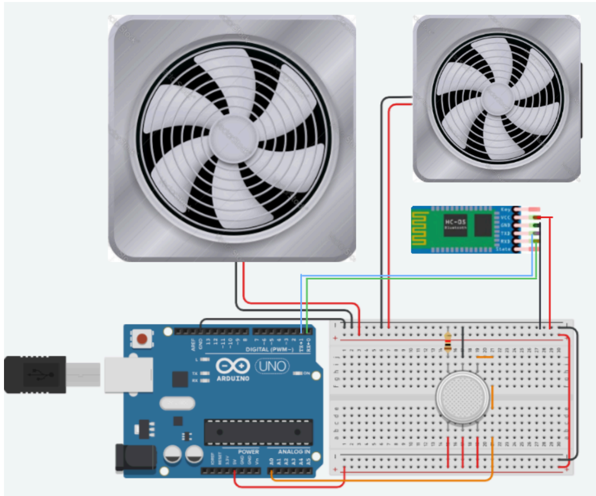

Figure 1.2 Circuit Design of Device 1

Figure 1.2 illustrates the electronic connections of device 1 used for the gas leak detection. It is composed of two (2) exhaust fans, one (1) bluetooth module, one (1) Arduino UNO R3, one (1) 9V battery and one (1) gas sensor. The fans are wired to the Arduino to create airflow for gas detection and exhaust purposes. The gas sensor is connected to the Arduino to monitor gas levels in the surrounding environment. Additionally, the bluetooth module enables wireless communication between device 1 and device 2, facilitating alarms and coordination with the automatic shut-off function.

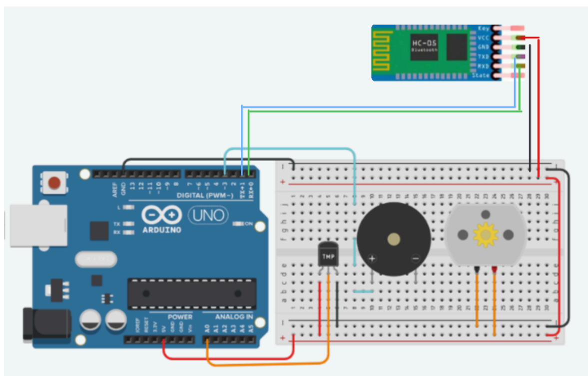

Figure 1.3 Circuit Design of Device 2

Figure 1.3 illustrates the electronic connections of device 2, the automatic shut-off function. It incorporates essential components, including one (1) temperature sensor, one (1) Bluetooth module, one (1) Arduino UNO R3, one (1) buzzer, and one (1) DC motor. The temperature sensor is interfaced with the Arduino UNO R3 to monitor temperature levels of the stove. The buzzer is wired to the Arduino UNO R3 to produce alarms in the event of gas leaks. In addition, the DC motor is connected to a makeshift switch designed to flick off the switch of the portable gas stove upon receiving an alert signal. The bluetooth module enables wireless communication between device 2 and device 1.

2.) Physical Systems

The physical system focuses on designing a compact and durable in the actual portable gas stove to accommodate integrated gas sensors and components effectively. It will also create a space-efficient enclosure for microcontrollers and circuits.

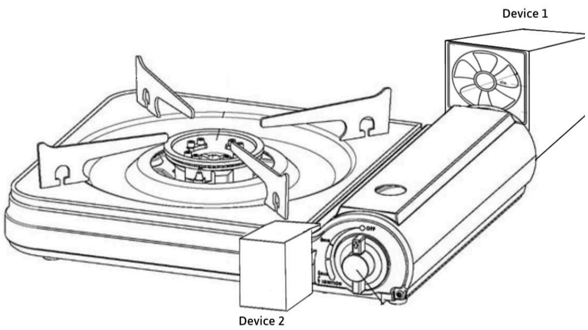

Figure 2.1 Engineering Drawing

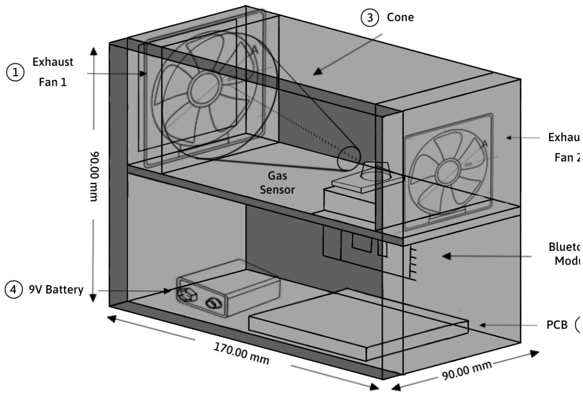

Figure 2.2 Engineering Drawing of Device I

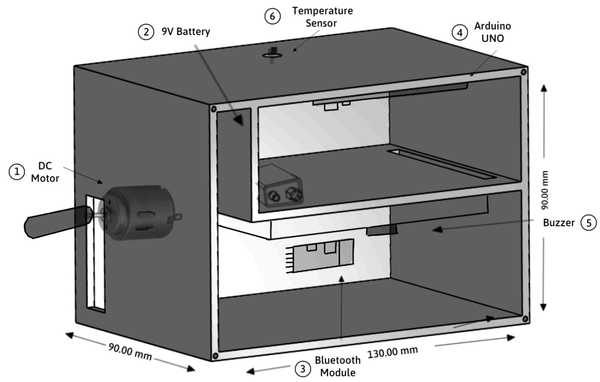

Figure 2.3. Engineering Drawing of Device 2

3.) Power Management

The device uses two 9V batteries: one for Device 1, powering the Arduino, two fans and an LED indicator if the device in on or off; and one for Device 2, powering the Arduino, the motor for the automatic shut-off and also an LED indicator that will show if the device is on of off.

B. Software Design

The software design used is the Arduino IDE that involves implementing our two main functionalities which are gas leak detection and automatic shut-off. This involves writing code to interface with a gas sensor for detecting gas leaks, processing sensor data, and triggering alerts and shut-off mechanisms based on predefined thresholds and conditions.

1.) Embedded Software

The embedded software code in Arduino IDE implements a gas leak detection that continuously reads sensor data and compares it against predefined thresholds to detect potential leaks.

```
int index = 0;
const int FS = 10;
int led1 = 3;
int SenVal[FS];
int Filtered(int Data);
void setup() {
  // put your setup code here,
to run once:
  pinMode(A0, INPUT);
  Serial.begin(9600);
  digitalWrite(led1, HIGH);
```

```
}

void loop() {
  // put your main code here,
to run repeatedly:
  int RawData = analogRead(A0);
  int Filtered =
Filter(RawData);
  //Serial.println(RawData);
  //Serial.print("\t");
  Serial.println(Filtered);
  Serial.write(Filtered);
  delay(100);
}
int Filter(int Data){
  SenVal[index] = Data;
  index = (index + 1) % FS;
  int Sum = 0;

  for(int i = 0; i < FS; i++){
    Sum += SenVal[i];
    }
  return Sum / FS;
  }
```

Figure 2.4 Master Code: Gas Leak Detection

The code utilizes analog pin A0 to read data from a gas sensor to capture gas level readings. The raw data from the sensor is then processed using a moving average filter for stable readings. Additionally, digital pin 3 is assigned to an LED and set to a high state in the setup function indicating that the device is working or is ON mode.

```
int tempt = A0;
int index = 0;
int led2 = 3;
const int FS = 10;
int SenVal[FS];
void setup() {
  // put your setup code here, to
run once:
  Serial.begin(9600);
  pinMode(7, OUTPUT);
  pinMode(6, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(4, OUTPUT);
  pinMode(tempt, INPUT);
  digitalWrite(7, LOW);
  digitalWrite(led2, HIGH);
}

void loop() {
  // put your main code here, to run
repeatedly:
  if(Serial.available() > 0){
    int state = Serial.parseInt();
    Serial.print(state);
    Serial.print("\t");
    if(state > 87){
      digitalWrite(7, HIGH);
      delay(100);
      digitalWrite(7, LOW);
      delay(100);
      digitalWrite(6, HIGH);
      digitalWrite(5, LOW);
      analogWrite(4, 255);
      }else{
       digitalWrite(7, LOW);
       digitalWrite(6, LOW);
       digitalWrite(5, LOW);
     }
   }
    float rawtempt =
analogRead(tempt);
    float Filtered =
Filter(rawtempt);
    float temp = (Filtered * 500) /
1023;
    Serial.println(temp);
    delay(50);
    if(temp > 60.00){
      digitalWrite(7, HIGH);
    }else{
      digitalWrite(7, LOW);
    }
}
float Filter(float Data){
  SenVal[index] = Data;
  index = (index + 1) % FS;
  float Sum = 0;

  for(int i = 0; i < FS; i++){
    Sum += SenVal[i];
    }
  return Sum / FS;
  }
```

Figure 2.5 Slave Code: Automatic Shut Off

This code controls the device 2, the automatic shut-off mechanism. It reads temperature data, processes it through a moving average filter, and sends the filtered data to the serial monitor. If the temperature exceeds 60 degrees Celsius or a specific state value is received via serial input, the system activates outputs to trigger the shut-off mechanism. The system uses several output pins to control different aspects of the shut-off process.

2.) Application Software

The application software developed in Arduino IDE facilitates user interaction and system configuration for the devices. It provides a user-friendly interface via Bluetooth communication, allowing users to monitor gas leak alerts and manually activate the shut-off mechanism if required, enhancing overall safety convenience**.**

C. Data Engineering

The data engineering for the portable gas stove device involves managing and processing sensor data from the gas leak detection unit to accurately detect and quantify gas leaks.

1.) Data Description

The data description for the Portable Gas Stove Safety Device encompasses various parameters, including gas concentration levels, temperature, and humidity readings, important for detecting potential gas leaks and monitoring environmental conditions. These data are collected by advanced sensors integrated into the device and transmitted wirelessly using Bluetooth communication, facilitating real-time analysis and decision-making to enhance safety measures for users.

2.) Algorithms Used

The two devices used a moving average filter algorithm to smooth sensor data, reducing noise and improving the reliability of detected values. Device 1 uses this filtered data to detect gas leaks, while Device 2 combines serial communication with temperature monitoring to control a shut-off mechanism based on predefined thresholds. These algorithms ensure the devices operate accurately and respond appropriately to hazardous conditions.

III. TESTING PROCEDURES AND RESULTS

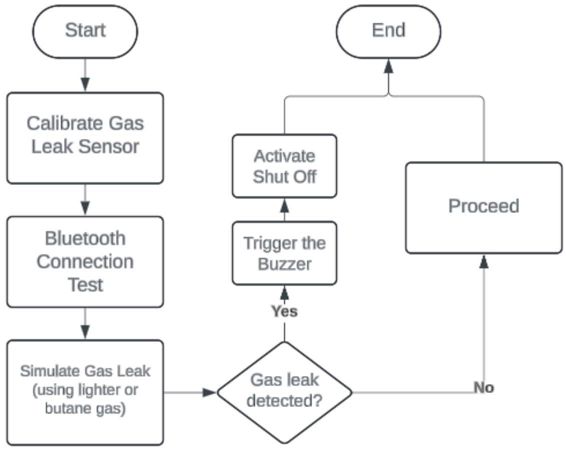

Figure 3 Test Procedure Flow Chart

A. Testing Configuration / Setup

1. Environment:

- Testing conducted in a controlled indoor environment to simulate typical usage conditions.

2. Equipments:

- Two (2) Arduino UNO R3
- Gas Sensor (MQ-2)
- Temperature Sensor (LM35)
- Two (2) Bluetooth Modules (HC-05)
- Two (2) Exhaust Fans
- DC motor
- 9V battery
- Laptop with Arduino IDE

3. Test Configuration

- Gas sensor threshold set to 200.
- Temperature sensor threshold set to 60°C.
- Bluetooth communication baud rate set to 9600.

4. Testing Setup

B. Testing Results

Test No.	Test Load	Duration	Remarks	Value
1	Lighter	7 secs	Alarm	89
2	Lighter	4 secs	Alarm	94
3	Lighter	4 secs	Alarm	89
4	Lighter	6 secs	Alarm	97
5	Lighter	7 secs	Alarm	97

Test No.	Test Load	Duration	Remarks	Value
1	Butane Gas Scan	18 secs	Alarm	150
2	Butane Gas Scan	16 secs	Alarm	250
3	Butane Gas Scan	10 secs	Alarm	104
4	Butane Gas Scan	6 secs	Alarm	94
5	Butane Gas Scan	0 secs	Didn't Alarm	83

Test No.	Test Load	Duration	Remarks	Highest Value
1	Direct to the sun	10 minutes	Didn't Alarm	49°c
2	Direct to the sun	10 minutes	Alarm	94°c
3	Direct to the sun	10 minutes	Didn't Alarm	55°c
4	Direct to the sun	10 minutes	Alarm	97°c
5	Direct to the sun	10 minutes	Alarm	80°c

Test No.	Test Load	Duration	Remarks	Highest Value
1	Not Direct to the sun	10 minutes	Didn't Alarm	40°c
2	Not Direct to the sun	10 minutes	Didn't Alarm	49°c
3	Not Direct to the sun	10 minutes	Didn't Alarm	45°c
4	Not Direct to the sun	10 minutes	Alarm	69°c
5	Not Direct to the sun	10 minutes	Didn't Alarm	47°c

IV. ANALYSIS OF TESTING RESULTS

The Lighter load test resulted in a consistency that the device was able to detect the gas in the lighter and the alarm go off on about an average of 5.6 seconds while having an average of 93 of detection value.

V. CONCLUSIONS

- The researchers have successfully developed a gas leak detection system utilizing advanced sensors, enhancing safety measures for users reliant on portable gas stoves. The system accurately detects and quantifies gas leaks in the stove, addressing a safety concern in culinary businesses and household settings.

- The implementation of an automatic shut-off mechanism ensures prompt action upon gas leak detection, effectively preventing the escalation of potential safety hazards. This mechanism swiftly cuts off the gas supply to the stove, mitigating risks and ensuring users from potential accidents or injuries.

- The establishment of reliable communication between the HC-05 modules ensures the operation and communication framework enhances the overall efficacy of the safety device, reinforcing its ability to improve safety outcomes and mitigate hazards associated with portable gas stove usage.

VI. REFERENCES

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