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LPG Gas Leakage Detection System with Auto Cutoff Regulator using Arduino

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Abstract: *The problem of gas leakage and fire is often encountered in our day-to-day life. LPG, Liquified Petroleum Gas, is highly flammable gas used as fuel in heating appliances. Leakage of this gas raises the risk of building fire, suffocation or an explosion. Most of the fire-breakouts in industries are due to gas leaks. These cause dreadful damage to the equipment, human life leading to injuries, deaths, and environment. The mentioned problem can be solved with the development of reliable techniques to detect gas leakage. We proposed a system to detect gas leakage automatically with the help of gas sensor and Arduino microcontroller and alerts the person if there is gas leakage by buzzer alarm and auto cutoff regulator.*

Keywords: gas leakage

I. INTRODUCTION

Internet of things endeavour towards making life simpler and faster by automating the entire small tasks associated with the life of human. Today, everything is getting smart due to the technological progress such as of IOT. As IOT is very beneficial for automating the tasks, the advantage of IOT can also be comprehensive for enhancing the convenient safety methods.

Security plays a significant role while constructing home, buildings, industries as well as towns. The enlarged focus of certain gases in the environment can be exceptionally unsafe, in recent time, everyone needs a facility which reduces time and effort and expect their work to be as easy as possible. One such area where man prefers to get the work faster and easier is cooking. Most commonly LPG is used for cooking purpose.

LPG is one of the household needs in daily life. It acts as an alternative to petroleum, which continues to decrease. With this transition, there are several problems caused by gas leak that may cause accidents.

We proposed a system in order to prevent these accidents caused by gas leakage. The proposed system will detect gas leakage with the help of gas sensor and Arduino microcontroller. It alerts the person by buzzer alarm and the gas regulator is turned off automatically using servo motor.

In recent years, concerns regarding the safety of domestic and industrial environments have escalated due to the hazardous nature of liquefied petroleum gas (LPG). LPG, being highly combustible, poses significant risks if there's a leakage in its containment system.

To mitigate these risks and ensure the safety of lives and property, the development of efficient and reliable gas leakage detection systems has become imperative. In response to this need, engineers and innovators have turned to cutting-edge technologies like Arduino microcontrollers to design Automatic LPG Gas Leakage Detection Systems with Auto Cutoff Regulators.

1.1 What is Arduino?

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring),

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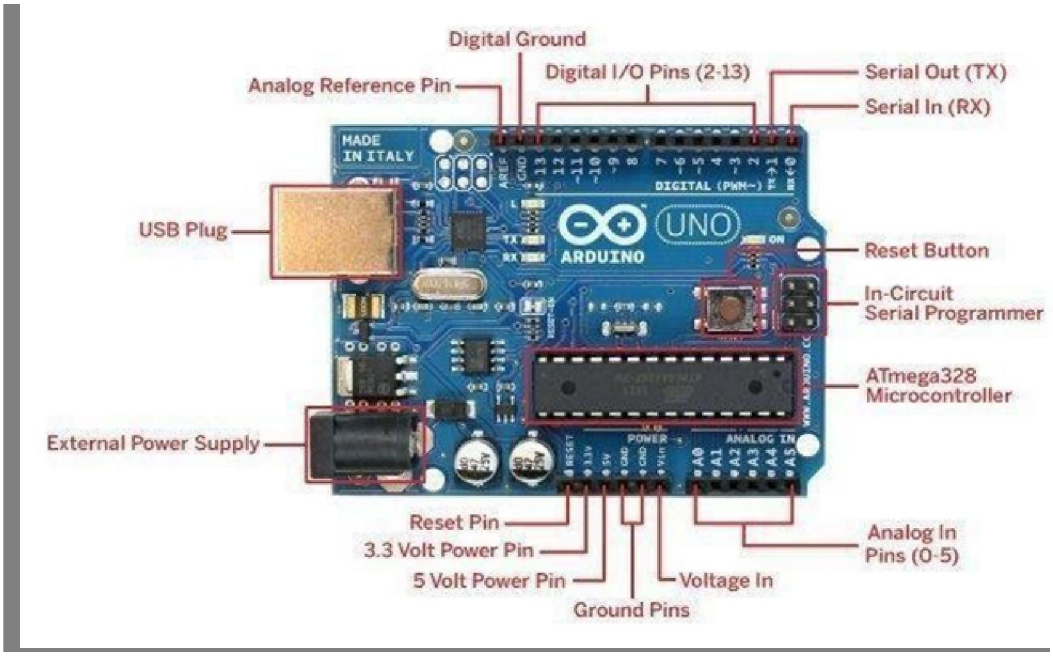
and the Arduino Software (IDE), based on processing. Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory.



The default bootloader of the Arduino UNO is the option-boot bootloader. Boards are loaded with program code via a serial connection to another computer. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Other variants, such as the Arduino Mini and the unofficial Board Arduino, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods. When used with traditional microcontroller tools, instead of the Arduino IDE, standard AVR in-system programming (ISP) programming is used.

1.2 Problem Statement

The widespread use of liquefied petroleum gas (LPG) in domestic and industrial settings has led to an increased risk of accidents due to gas leakage. Traditional methods of detecting LPG leaks rely heavily on human intervention, which can be slow and often ineffective. In light of this, there is a pressing need for an Automatic LPG Gas Leakage Detection System with Auto Cutoff Regulator that can swiftly detect leaks and take preventive actions without human intervention.

The primary objective of this project is to design and implement a reliable, cost-effective, and user-friendly system that ensures the safety of occupants and property in environments where LPG is used. The system should be capable of:

1. Detecting LPG gas leaks promptly and accurately, even at low concentrations, to prevent potential hazards such as fire or explosion.
2. Automatically shutting off the gas supply upon detecting a leak, minimizing the risk of ignition and escalation.
3. Providing real-time feedback to occupants about the status of the gas detection system and any detected leaks.
4. Offering a user-friendly interface for easy operation and maintenance, including provisions for adjusting detection thresholds and alarm settings.
5. Ensuring robustness and reliability in various environmental conditions, with minimal false alarms and downtime.
6. Utilizing cost-effective components and technologies, with a focus on accessibility and affordability for both domestic and industrial users.
7. Adhering to relevant safety standards and regulations governing LPG usage and gas detection systems.

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The successful development and implementation of this Automatic LPG Gas Leakage Detection System with Auto Cutoff Regulator using Arduino will significantly enhance safety measures in environments where LPG is employed, providing peace of mind to occupants and mitigating the risks associated with gas leaks.

II. OBJECTIVES

- **Gas Leak Detection:** The primary objective is to detect LPG gas leaks promptly and accurately. The system should be sensitive enough to detect even minor leaks that might go unnoticed but still pose a danger.
- **Rapid Response:** Ensure that the system can respond quickly to a detected gas leak, minimizing the time between detection and action. This includes activating the auto cutoff mechanism in milliseconds to prevent further gas leakage.
- **Safety Assurance:** Guarantee the safety of residents or users by effectively shutting off the gas supply when a leak is detected. The auto cutoff regulator should work reliably and consistently.
- **Remote Monitoring:** Enable remote monitoring of the system's status and gas levels, allowing users to check on their property's safety even when they are not on-site.
- **Energy Efficiency:** Design the system with energy-efficient components and modes to minimize power consumption, especially in the case of battery-operated systems.
- **Sensor Accuracy:** Ensure that gas sensors used in the system are accurate and have minimal false positives or false negatives. Calibrate sensors as needed.
- **Emergency Protocols:** Implement emergency protocols, such as a manual override or backup power source, in case the system encounters issues or failures.

Gas leakage is detected with the help of gas sensor and Arduino microcontroller.
The system will alert the person by buzzer alarm and the gas regulator is turned off automatically using servo motor.

III. LITERATURE SURVEY

- **Sensor Technologies:** Most research focuses on using various gas sensors to detect LPG leaks. Common sensor types include MQ series gas sensors, semiconductor sensors, and electrochemical sensors. Researchers often compare and evaluate the performance of different sensors in terms of sensitivity, response time, and reliability.
- **Arduino-Based Control:** Arduino microcontrollers are commonly used for data processing, decision-making, and control in these systems due to their accessibility and versatility. Researchers often develop code to interface with gas sensors, process sensor data, and activate the auto cutoff regulator when a gas leak is detected.
- **Communication:** Some studies explore methods for remote monitoring and control. This involves integrating GSM or Wi-Fi modules with Arduino to send alerts or notifications to users' smartphones or central monitoring systems when a gas leak is detected.
- **Auto Cutoff Mechanism:** Designing an efficient auto cutoff mechanism is a crucial aspect of these systems. Research often focuses on the reliability and safety of the cutoff mechanism, ensuring it quickly and effectively shuts off the gas supply in case of a leak.
- **Power Management:** Efficient power management is essential, especially if the system is intended for long-term use. Research may cover techniques for optimizing power consumption in the Arduino and associated components.
- **Safety Regulations:** Compliance with safety standards and regulations for gas detection and control systems is an important consideration. Some research may focus on meeting these standards to ensure the system's safety and reliability.

IV. RELATED WORK

V. Suma, R. R. Shekar and K. A. Akshay: This paper thus put forth a new proposed system which is microcontroller-based application of gas booking and gas detection systems using IOT. The sensor used in this model can sense and

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detect the leakage of the gas, and the user gets notification regarding to remaining percentage of gas in the cylinder as well certain action can be taken to pre-book the new cylinder without any barrier. This unit can be easily integrated into an alarm unit, or a visual indication of the LPG awareness for further benefits. This proposed system can be useful in marketing sectors like hotels, shop etc. The main intention of this work is to ensure safe and easier way of gas booking and gas leakage detection to avoid disasters that may occur due to negligence.

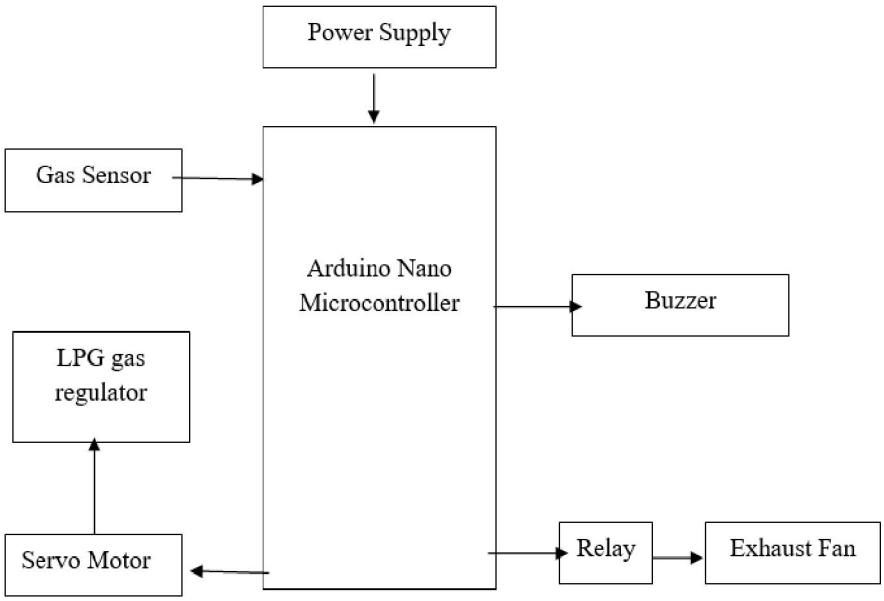
S. Adsul, A. K. Sharma and R. G. Mevekari: This paper presents a wireless leakage detection system using various sensors and microcontroller which makes system portable and Non-Destructive techniques (NDT). In this system the parameters like humidity, temperature, pressure, sound detection and gas detection around leakage areas are detected using sensors and Arduino microcontroller.

M. Santi Putri and M. Tio: This paper aims to provide a solution to this problem by building a device that utilizing sensors connected to Node MCU. The device performs area monitoring continuously. Using this device, users will be able to prevent accidents that occur due to gas leaks so that accidents can be avoid.

A. Varma, Prabhakar S and K. Jayavel: The proposed gas leakage detector is promising in the field of safety. The attempt while making this prototype has been to bring a revolution in the field of safety against the leakage of harmful and toxic gases to minimize and hence nullify any major or minor hazard being caused due to them.

J. Vijayalakshmi, G. Puthilibhai and S. R. L. Siddarth: In this work," Ammonia Gas Monitoring System Using Ammonia Sensor Technology" the leakage analysis is done. Ammonia gas is a major factor that affects human being health. The ammonia sensor technology system is used to detect the ammonia gas leakage, using this system human being's health is protected from ammonia gas. The system will the ammonia gas level that exceeds its threshold level and provide a comparison on a graphical representation based on the present gas level and historical data in the final report.

V. BLOCK DIAGRAM



This is our proposed block diagram for automatic gas leakage detection. We are using Arduino nano microcontroller as controller. We are providing power supply to the controller through 9V DC battery. As the controller, and sensor requires 5V we are using 7805 voltage regulator which gives 5V output voltage and this regulated supply we are using as power supply. The gas sensor MQ-2 is used to detect gas leakage and it checks for gas leakage continuously and sends data to the controller. The controller analyses the data received by the sensor and takes appropriate decisions. The buzzer is connected to the Arduino as output. If there is a gas leakage controller will turn on the buzzer to alert the person.

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VI. COMPONENTS REQUIREMENTS

HARDWARE COMPONENTS:

1. Arduino UNO
2. Gas Sensor (MQ-2)
3. Power Supply (9V DC Battery and Cap)
4. Servo motor
5. Buzzer
6. Jumper cables
7. Bread Board (800 Points)
8. LPG gas regulator
9. Exhaust fan

SOFTWARE COMPONENTS:

1. Embedded C
2. Arduino IDE

VII. COMPONENTS EXPLANATION:

HARDWARE COMPONENTS:

Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

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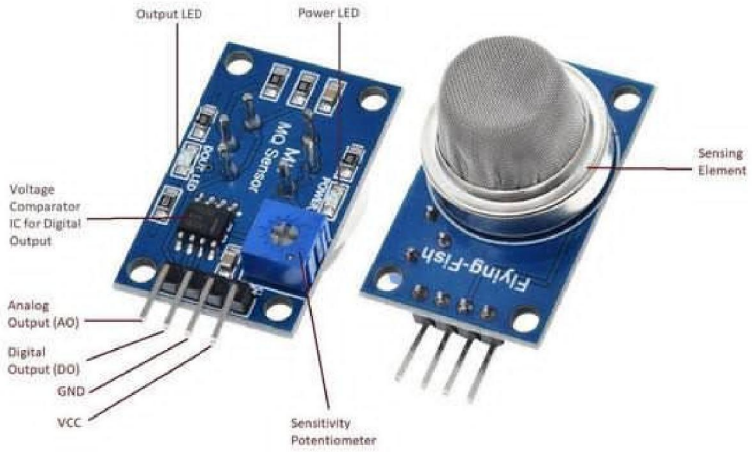
Technical Specifications:

Microcontroller	ATmega328
Architecture	AVR
Operating Voltage	5 V
Flash Memory	32 KB of which 2 KB used by bootloader
SRAM	2 KB
Clock Speed	16 MHz
Analog I/O Pins	8
EEPROM	1 KB
DC Current per I/O Pins	40 mA (I/O Pins)
Input Voltage	7-12 V
Digital I/O Pins	22
PWM Output	6
Power Consumption	19 mA
PCB Size	18 x 45 mm
Weight	7 g
Product Code	A000005

Applications

- Prototyping of Electronics Products and Systems
- Multiple DIY Projects.
- Easy to use for beginner level DIYers and makers.
- Projects requiring Multiple I/O interfaces and communications.

MQ-2 Gas Sensor



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MQ-2 Methane LPG Liquid Propane Gas Sensor Module is widely used in gas leakage detecting pieces of equipment in family and industry, are suitable for detecting of LPG, natural gas, town gas, avoid the noise of alcohol and cooking fumes and cigarette smoke. The sensitivity can be adjusted by the potentiometer. Sensitive material of MQ-2 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exists, the sensor's conductivity is higher along with the gas concentration rising. Please use simple electro circuit, convert change of conductivity to the corresponding output signal of gas concentration.MQ-5 gas sensor has high sensitivity to Methane, Propane, and Butane, and could be used to detect both Methane and Propane. The sensor could be used to detect different combustible gas especially Methane, it is with low cost and suitable for different application

Buzzer:

This is a Small PCB Mountable 3V Active Electromagnetic Buzzer. It is great to add Audio Alert to your electronic designs. It operates on 3V supply, uses a coil element to generate an audible tone.

Specifications:

- Input Voltage (Max): 3V
- Resistance: 30 Ω
- Resonance Frequency: 2048 Hz
- Sound pressure(dB(A)/10cm) min.: 80
- Body Size: 12 x 9.5mm
- Pin Pitch: 6mm
- External Material: Plastic;
- Colour: Black

Jumper Wires

Jumper wires are used for making connections between items on your breadboard and your Arduino's header pins. Use them to wire up all circuits.

Features:

- Compatible with 2.54mm spacing pin headers
- High quality and in good working condition
- Durable and reusable
- Easy to install and use
- A popular choice for construction or repair
- Be used for the electronic project and Genuine Arduino product
- Flexible Breadboard Jumper Cable Wire allows you to plug and unplug easily for prototyping.
- There are mainly three types male-male, female-female and male-female jumper wires.

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Bread Board (840 Points):

- A breadboard is used to make up temporary circuits for testing or to try out an idea.
- No soldering is required so it is easy to change connections and replace components.
- Parts will not be damaged so they will be available for re-use afterward.
- Practical and useful Solderless breadboard with 840 points Completely reusable and have a self-adhesive back Easy component placement.

9V DC Battery:

This is General purpose 9V Original HW marked Non-Rechargeable Battery for all your project and application needs. Its Universal 9V battery size and connecting points; it is useful in many DIY projects as well as household applications and they can easily be replaced and installed.

Features:

- Constant 9V Output till lasts
- Metal Jacket Body
- Good Built Quality and hence Leakproof
- Easy to install and Replace
- Corrosion-free Connector Point for long-term use
- 0% Mercury and Cadmium. Environment-friendly
- OEM Compatible.

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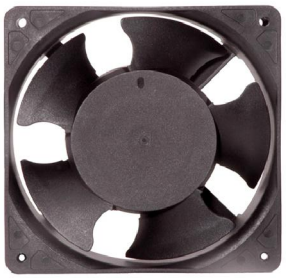
7. Exhaust Fan (5V CPU Fan):



- Exhaust fans can be installed on the window, wall or ceiling.
- They are available in the following types: Wall-mounted exhaust fans are incorporated within a cut-out in the external wall or can be integrated within the design of the window.
- These exhaust fans are very effective as they expel stale air directly outdoors.
- The exhaust fan is used exhaust the leaked gas from closed room to outside air.

LPG Gas Regulator

- A gas regulator is used to maintain a uniform gas supply pressure to an appliance.
- They ensure the appliance is not over or under pressurized, and they can normally be adjusted to provide a specific pressure.
- Each appliance has a gas pressure set by the manufacturer needed to ensure safe and correct operations.

Servo Motor:

- A servo motor is a rotary actuator or linear actuator that is a combination of a motor coupled to a sensor for position feedback and a controller.
- It allows for precise control of angular or linear position, velocity, and acceleration.
- Servo motors have a rotational sensor (encoder) which makes them more accurate.
- The most common type of servo motor is the positional rotation servo.
- The output shaft of a positional rotation servo motor can rotate in about half of a circle, or 180 degrees.
- The degree of rotation can be controlled by applying an electrical pulse of the proper width to its control pin.
- The servo checks the pulse in every 20 milliseconds.
- A pulse of 1 millisecond (ms) width rotates the servo to 0 degrees, 1.5ms rotates to 90 degrees (neutral position), and 2 ms rotates it to 180 degrees.

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SOFTWARE REQUIREMENTS:

1. Embedded C

The embedded c programming language is used in the microcontrollers. The embedded c language is a general-purpose programming language that provides code efficiency, elements of structured programming and a rich set of operators. Embedded c is not a big language and is not designed for any one particular area of application. It's generally combined with its absence of restriction, makes embedded c a convenient and effective programming solution for a wide variety of software tasks. Many applications can be solved more easily and efficiently with embedded c than with other more specialized languages. The embedded c language on its own is not capable of performing operations (such as input and output) that would normally require intervention from the operating system. Instead, these capabilities are provided as a part of standard library. Because these functions are separated from the language itself, embedded c is especially suited for producing code that is portable across wide platforms.

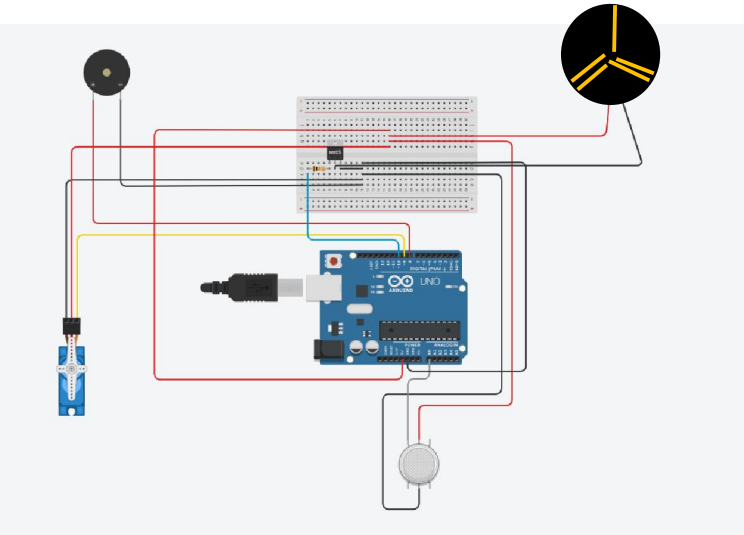
2. Arduino IDE

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

VIII. METHODOLOGY

- The gas sensor will check for gas leak continuously.
- Whenever it detects any gas leakage it will sends the data to the Arduino microcontroller.
- Microcontroller analyzes the data collected by the gas sensor.
- If there is gas leak detected the controller will turn on the buzzer alarm in order to alert the person to know that there is a gas leakage.
- The system will also turnoff the gas regulator automatically using servo motor.

IX. CIRCUIT DIAGRAM



X. PROGRAM

```
#include <Servo.h>
#define gas_sensor  A0
#define buzzer      8
```

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```
#define fan        10
int sensor_value;
Servo servo;
void setup() {
//Serial.begin(9600);
pinMode(buzzer, OUTPUT);
pinMode(fan, OUTPUT);
servo.attach(9); //servo motor signal pin attached to Arduino pin 9
servo.write(2); //regulator on
}
void loop()
{
sensor_value = analogRead(gas_sensor);
Serial.println(sensor_value);
if (sensor_value > 250) // change this value according to sensitivity of gas
{
digitalWrite(buzzer, HIGH);
digitalWrite(fan, HIGH);
servo.write(130);
}
else
{
digitalWrite(buzzer, LOW);
digitalWrite(fan, LOW);
servo.write(5);
}
delay(500);
}
```

XI. APPLICATIONS

- Domestic gas leakage detection.
- Industrial gas leakage detection.
- food and beverage to chemical production and wastewater treatment.
- Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion.
- Residential Buildings.
- Commercial Kitchens.
- Industrial Facilities.
- Laboratories.
- Hotels and Hospitality.
- Mobile Homes and RVs.
- Warehouses and Storage Facilities.
- Public Transport Vehicles.

XII. CONCLUSION

In conclusion gas leakage and fire is often encountered in our day-to-day life. LPG, Liquified Petroleum Gas, is highly flammable gas used as fuel in heating appliances. Leakage of this gas raises the risk of building fire, suffocation or an explosion. In order to prevent the gas leakage, we proposed a system for automatic gas detection. The gas leakage is

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detected with the help of gas sensor and Arduino microcontroller. The system will alert the person by buzzer alarm and the system will alert the person by buzzer alarm and the gas regulator is turned off automatically using servo motor.

the Automatic LPG Gas Leakage Detection System with Auto Cutoff Regulator using Arduino represents a significant advancement in safety technology, offering a proactive solution to mitigate the risks associated with LPG usage in various environments. By leveraging the power of Arduino microcontrollers and sophisticated sensors, this system provides prompt and reliable detection of gas leaks, coupled with automatic cutoff of the gas supply to prevent potential hazards such as fire or explosion.

The development and implementation of this system offer several key benefits, including enhanced safety for occupants and property, peace of mind for users, and compliance with safety standards and regulations governing LPG usage. Whether deployed in residential buildings, commercial kitchens, industrial facilities, or other settings where LPG is utilized, the system offers a robust and cost-effective solution to ensure a safe environment for all stakeholders.

Furthermore, the flexibility and scalability of the system allow for customization to meet specific user requirements, including adjustments to detection thresholds, alarm settings, and interface options. This ensures ease of operation and maintenance, as well as compatibility with various applications across different sectors.

In summary, the Automatic LPG Gas Leakage Detection System with Auto Cutoff Regulator using Arduino represents a proactive approach to safety management, offering advanced capabilities to detect and mitigate gas leaks effectively. As technology continues to evolve, further enhancements and refinements to this system promise even greater levels of safety and reliability, contributing to a safer and more secure future for communities worldwide.

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