GAS LEAK DETECTION SYSTEM

1. Introduction

Objective:

Design and build a gas leak detection system using an Arduino UNO microcontroller. The system should be able to detect the presence of gas (such as methane, propane, or natural gas) in the environment and provide an alert when gas levels exceed a safe threshold. The gas leak detector should be reliable, cost-effective, and suitable for both residential and industrial applications.

Project Description:

This project aims to create a reliable and cost-effective system that can detect the presence of harmful gases (such as methane, propane, or natural gas) in the environment. By utilizing an Arduino UNO microcontroller and gas sensors, this project provides an early warning system to prevent accidents, protect lives, and safeguard property.

Key Features:

- Gas Sensing: The gas sensor (e.g., MQ-2 or MQ-5) detects gas concentrations and converts them into electrical signals.
- Threshold Setting: Adjustable thresholds are defined for safe gas levels. When gas concentrations exceed these thresholds, an alert is triggered.
- Visual and Audible Alerts: LEDs or a buzzer provide immediate visual and audible warnings.
- Real-time Monitoring: The system continuously monitors gas levels and responds promptly.
- User-friendly Interface: Optionally, an LCD display can show real-time gas concentration data.
- Safety Measures: The system can shut off gas valves or activate ventilation systems in case of high gas levels.
- Compact Design: All components are housed in a protective enclosure for easy installation.

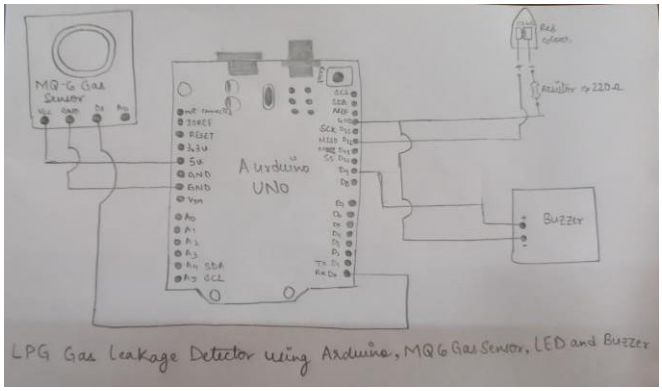
2. Literature Review

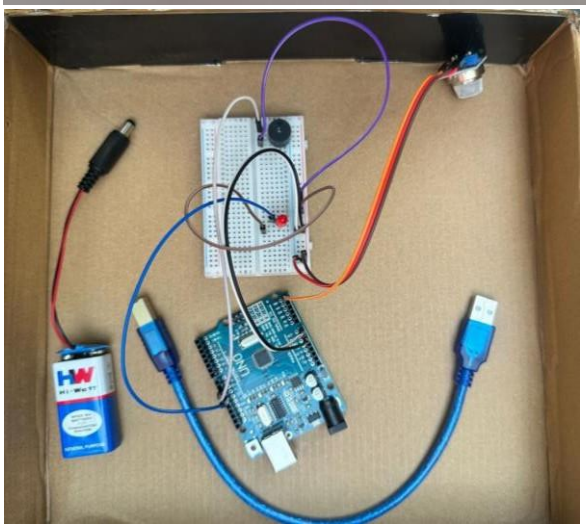
Journal/ Articles Title	***Authors***	***Outcomes***	***Pros***	***Cons***
Gas Leakage Detection System Using IoT And cloud Technology	V Praveen Sharma, Dr Raman Dugyala, Dr V Padmavathi, Vijendar Reddy Gurram	* The study provides insights into various IoT-based gas leakage detection systems. * It highlights the need for more efficient, cost-effective, and scalable solutions. * The authors discuss the importance of early detection to reduce damage and save lives. * The review emphasizes the role of sensors, software, and data sharing in IoT systems.	* *Early Detection*: By reducing risks and averting accidents, early detection of gas leaks is made possible by IoT-based devices. * *Scalability*: Large-scale deployment is made possible by scalable solutions made possible by cloud technology. * *Data sharing*: Real-time data sharing between IoT devices enhances overall safety procedures. * *Environmental Monitoring*: Internet of Things (IoT) monitoring of pollutants and waste disposal is essential for environmental safety.	* *Cost*: There may be setup fees associated with implementing cloud-based and IoT solutions. * *Complexity*: Integrating sensors, software, and cloud services requires technical expertise. * *Privacy and Security*: Cloud storage and data sharing give rise to privacy and security issues. * *Reliability*: Accurate sensors and network connectivity are prerequisites for system reliability.
Sensor-Based Gas Leakage Detector System	Mohammad Monirujjaman Khan	* To avoid mishaps, the article advises placing a gas leak detecting kit in strategic locations. * The suggested system seeks to automatically identify, notify, and manage gas leaks. * It has built-in user alerting mechanism.	* *Efficiency*: The system's ability to identify gas leaks is efficient. * *User-Friendly*: Its design prioritizes ease of usage. * *Portability*: The system is compact and easily transportable. * *Cost-Effective*: The suggested course of action is economical.	* *Sensor Accuracy*: Depending on the circumstances, the MQ-6 gas sensor's accuracy may change. * *False Positives/Negatives:* Like any gas detection system, there is a chance of false positives (erroneous alarms) or false negatives (missed detections). * *Maintenance*: To guarantee the system's continuous efficency, routine maintenance may be necessary.

Automatic Gas Leakage Detection and Notification System using IoT	N. Elaiyaraja, M. Santhosh Kumar, R. Murugan	* *Early Detection*: The system alerts users as soon as it detects an LPG gas leak. * *Automatic Gas Booking*: When the current gas cylinder is about to run out, it automatically schedules a refill. This feature guarantees a steady supply of gas. * *User Safety*: The system reduces risks and improves safety by warning users and stopping gas leaks.	* *Timely Alerts*: When a gas leak occurs, users receive quickly SMS alerts that let them take the appropriate safety measures. * *Automatic Booking*: By removing the need for human participation, the technology simplifies the booking procedure for gas refills. * *Cost-Effective*: The solution is appropriate for usage at home because it is relatively simple and affordable.	* *GSM Network Dependency*: GSM connectivity is necessary for the system to function. Timely alerts could be jeopardised in places with inadequate network coverage. * *Sensor Calibration*: Accurate detection depends on the gas sensor (MQ2) being calibrated properly. Inaccurate calibration may result in missed detections or false alarms. * *Maintenance*: To guarantee the system's effective operation, routine maintenance is required.
Gas Leakage Detection System Based on Wireless Sensor Networks and Embedded Web Server	Yuanzhi Chen, Peng Zhang, Zhaohua Wang, Yajun Cao	* *Real-time Detection*: The system's real-time gas leak detection feature enables quick response to avert mishaps. * *Localization*: The technology can also help emergency responders by estimating the location of the gas leak by employing WSNs. * *Remote Monitoring*: The embedded web server allows users to access the system remotely, allowing for continuous control and monitoring.	* *Wireless Deployment*: WSNs eliminate the need for wired connections, making installation flexible and scalable. * Accurate *Localization*: The system's capacity to approximate the location of a gas leak improves the effectiveness of emergency response. * *Web-Based Interface*: From any embedded web server, users may monitor and control the system thanks to the embedded web server.	* *Sensor Calibration*: Accurate detection depends on the gas sensors' proper calibration. Missed detections or false alarms could result from improper calibration. * *Maintenance Challenges*: To guarantee dependable performance, WSNs need to undergo routine maintenance (such as sensor calibration and battery replacement). * *Network Reliability*: The wireless network's dependability affects the system's performance. Network disruptions or signal interference may have an impact on data transmission.

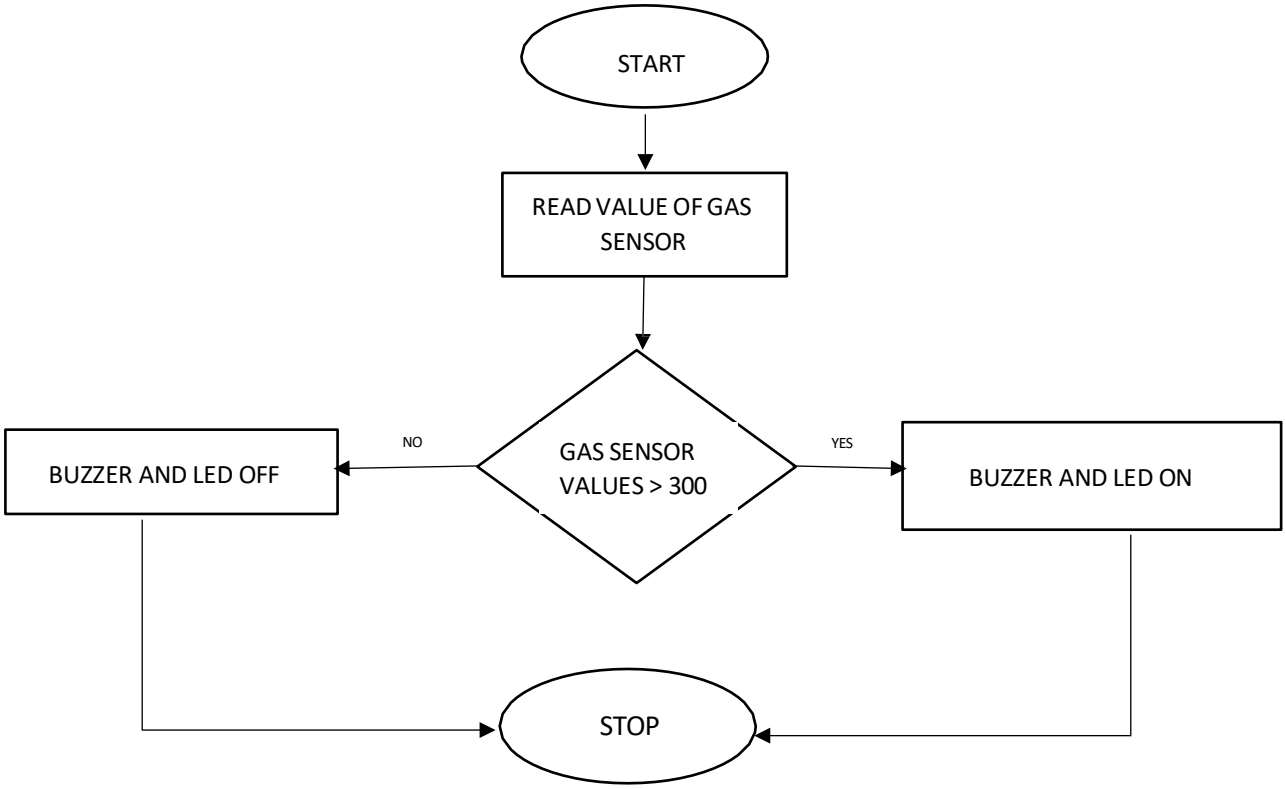
3. Visual Representation

Circuit Diagram:





Functionality Diagram:



4. Components Used

- *Arduino UNO:*
  The Arduino UNO is a powerful and versatile microcontroller board that can be used to create a variety of projects, including gas leak detection. The board is based on the ATmega328P and is easily programmable using the Arduino IDE. With the Arduino UNO, you can create a circuit that connects the MQ6 gas sensor, LED and buzzer to detect LPG gas leaks. The MQ6 gas sensor can detect LPG gas leaks in the concentration range of 300 to 10000ppm and sends the signal to the Arduino UNO. The Arduino UNO then processes the signal and triggers the LED and buzzer to indicate a gas leak. The Arduino UNO can also be programmed to send an alert to a smartphone or other device using wireless communication such as Bluetooth or Wi-Fi. This allows for remote monitoring of gas leaks and ensures timely response to potential hazards.
- *LED:*
  An LED, or Light Emitting Diode, is a small electronic device that emits light when an electric current is passed through it. In the context of the LPG gas leakage detector, it is used as an indicator light to show the status of the detector. The LED used in this project is connected to the Arduino UNO to receive a signal from the MQ6 gas sensor. When the gas sensor detects a LPG gas leak, it sends a signal to the Arduino UNO which then triggers the LED to light up as an indication of a gas leak. The LED provides a visual indication of a gas leak, making it easy for the user to identify the presence of gas even in low light conditions. Additionally, LED's are available in different colors, the most common being red and green, this allows the user to easily distinguish the status of the detector. LED's are also low power consumption and have a long lifespan, which makes them a suitable option for gas leakage detection systems.
- *Buzzer:*
  A buzzer, also known as an audio alarm, is an electronic device that produces sound. In the context of the LPG gas leakage detector, it is used as an alarm, to alert the user of the presence of LPG gas leaks. The buzzer used in this project is a small round 2 pin buzzer, which is an electronic device that produces sound. It is connected to the Arduino UNO to receive a signal from the MQ6 gas sensor. When the gas sensor detects a LPG gas leak, it sends a signal to the Arduino UNO which then triggers the buzzer to produce a loud sound as an alarm. The loud sound produced by the buzzer ensures that the user is alerted even in noisy environments. Additionally, small round 2 pin buzzers are also resistant to vibration, shock and humidity, making them a durable and reliable sound producing option for gas leakage detection systems.
- *220 Ohm Resistor:*
  A 220 ohm resistor is an electronic component used to control the flow of electric current in a circuit. In the context of the LPG gas leakage detector, it is used in

conjunction with the LED as an indicator light to show the status of the detector. The 220 ohm resistor is connected in series with the LED, it limits the current flowing through the LED, preventing it from being damaged by high current. It also helps to control the brightness of the LED, making it easier to see the status of the detector. The resistor value is chosen based on the voltage and current requirements of the LED, in this case, a 220 ohm resistor is used as it is a commonly used value for LEDs in many applications. The use of a resistor ensures the proper functioning of the LED, as well as prolonging its lifespan. This makes it a crucial component in the circuit of the LPG gas leakage detector using Arduino UNO, MQ6 Gas Sensor LED and Buzzer.

Sensors	Functionality	Technical Specifications
MQ-6 Gas Sensor	*Gas Detection:* The MQ-6 sensor can detect LPG (composed of mostly propane and butane) gas concentrations. *Digital Output:* It provides a digital output that can be used to trigger an alert when gas levels exceed a predefined threshold. *Analog Output:* The sensor also offers an analog output voltage proportional to the gas concentration.	*Operating Voltage:* +5V (Typical) *Detectable Gases:* LPG, Butane *Analog Output Voltage Range:* 0V to 5V *Digital Output Voltage Levels:* Low (0V): No gas detected (below threshold) High (5V): Gas detected (above threshold) *Preheat Duration:* 20 seconds (minimum) *Sensitivity:* High sensitivity to gases within the detection range Interchangeable A and B *Pins:* The A and B pins can be used interchangeably. *Potentiometer:* The sensitivity of the digital pin can be adjusted using the potentiometer.

5. Implementation

Real-time Deployment:

Deploying a real-time gas leakage detection system involves implementing the hardware and software components in a practical environment. Here are the steps for deploying such a system:

Hardware Setup:

- Arduino UNO: Ensure the Arduino board is functional and connected to a stable power supply.
- MQ-2 Gas Sensor: Position the sensor near potential gas leak sources (e.g., kitchen, gas pipelines).
- LED: Mount the LEDs in visible locations.
- Buzzer: Place the buzzer where it can be heard easily.

Mounting and Enclosure:

- Place the components inside a protective enclosure.
- Ensure proper ventilation for gas detection.
- Securely mount the enclosure in the desired location (e.g., kitchen wall, utility room).

Wiring and Connections:

- Connect the components according to the circuit diagram.
- Double-check all connections to avoid loose wires or short circuits.

Power On:

- Power up the Arduino UNO using a stable 5V power source.
- The gas sensor will start preheating (usually around 20 seconds).

Calibration:

- Allow the sensor to stabilize in clean air.
- Adjust the potentiometer to set the baseline reading (analog value).

Testing and Monitoring:

- Introduce gas (e.g., LPG) near the sensor.
- Observe LED and buzzer behavior.
- Ensure the system responds appropriately to gas presence.

Alerts and Response:

- When the LED and buzzer activate, take immediate action.
- Ventilate the area.
- Shut off gas supply (if integrated with a servo motor).
- Regularly inspect and maintain the system.

User Education:

- Educate users about the system's purpose and operation.
- Provide instructions on what to do when alerts are triggered.

Continuous Monitoring:

- Monitor the system regularly to ensure proper functioning.
- Replace any faulty components promptly.

Documentation:

- Document the deployment process, including wiring diagrams and sensor calibration details.
- Keep records for future reference and maintenance.

Remember that real-time deployment involves practical considerations such as physical placement, safety measures, and user awareness. Regular maintenance and testing are crucial to ensure the system's reliability and effectiveness in detecting gas leaks.

Code:

```
#include <MQUnifiedSensor.h>

#define GAS_SENSOR_PIN A0

#define BUZZER_PIN 9

#define LPG_THRESHOLD 500

MQUnifiedSensor mqSensor(GAS_SENSOR_PIN, R0, RL);

void setup() {
  Serial.begin(9600);
  mqSensor.begin();
  pinMode(BUZZER_PIN, OUTPUT);
}

void loop() {
  float lpgLevel = mqSensor.readSensor();
  Serial.print("LPG Level: ");
  Serial.println(lpgLevel);
  if (lpgLevel > LPG_THRESHOLD) {
    activateAlarm();
  } else {
    deactivateAlarm();
  }
  delay(1000); // Adjust delay time as needed
}
```

```
void activateAlarm() {
  digitalWrite(BUZZER_PIN, HIGH);
  Serial.println("Gas detected! Alarm activated!");
}
void deactivateAlarm() {
  digitalWrite(BUZZER_PIN, LOW);
}
```

6. *Outcome*

The outcome of this system is twofold-

- *Visual Indication*: The red LED illuminates to alert the user visually when an LPG gas leak is detected.
- *Audible Alarm*: The buzzer sounds simultaneously, warning the user of the gas leak loudly.

Together, these results guarantee that consumers are notified as soon as there is an LPG gas leak, enabling them to take the appropriate safety measures and avert possible dangers.

To View Output: https://drive.google.com/drive/folders/1LztK2gyE-Qk8ckGsBJAv6KnC8E7MeSYh?usp=sharing

7. *Precautions*

Sensor Placement and Calibration:

- Location: Install gas sensors near potential leak sources (e.g., gas pipelines, kitchen stoves).
- Calibration: Regularly calibrate gas sensors to ensure accurate readings.

Ventilation and Airflow:

- Ensure proper ventilation in the area where the system is deployed.
- Good airflow helps disperse gas and prevents false alarms due to stagnant air.

Regular Maintenance:

- Inspect sensors, wires, and connections periodically.
- Clean sensors to remove dust or contaminants.
- Replace faulty components promptly.

Power Supply Safety:

- Use stable power sources for the Arduino and sensors.
- Avoid loose or exposed wires to prevent electrical hazards.

Emergency Shutdown Mechanism:

- Integrate an emergency shutdown feature (e.g., gas valve closure) in case of high gas levels.
- Ensure this mechanism is fail-safe and reliable.

User Awareness:

- Educate users about the system's purpose and operation.
- Train personnel on how to respond when gas leaks are detected.

Avoid False Alarms:

- Set appropriate gas concentration thresholds to avoid unnecessary alerts.
- Consider using hysteresis to prevent rapid on-off cycles.

Regular Testing:

- Test the system periodically using controlled gas sources.
- Verify that visual and audible alerts are functioning correctly.

Emergency Response Plan:

- Define clear procedures for gas leak incidents.
- Evacuation routes, emergency contacts, and safety protocols should be established.

Enclosure Design:

- Use protective enclosures for components.
- Ensure enclosures are weatherproof (if used outdoors).

Avoid Corrosion:

- Some gases are corrosive. Use appropriate materials for sensors and wiring.
- Regularly inspect for signs of corrosion.

Avoid Tampering:

- Prevent unauthorized access or tampering with the system.
- Lock enclosures if necessary.

8. References

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  Journal: International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
  Year: 2019

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9. Task Distribution for the Project

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Objective + Approach required to solve the problem	Expected solution + it's impact on the society
2 articles for literature review: - Gas Leakage Detection System Using IoT And cloud Technology -Sensor-Based Gas Leakage Detector System	2 articles for literature review: - Automatic Gas Leakage Detection and Notification System using IoT - Gas Leakage Detection System Based on Wireless Sensor Networks and Embedded Web Server
List of sensors and microcontrollers used along with their functionality	Flowchart + Circuit diagram
Outcome	The code
references and citations	references and citations