# Internet of Things

## (COCSC20)

# IOT-BASED LPG LEAKAGE DETECTION SYSTEM


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**Teacher’s Signature**

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# SYNOPSIS

**TITLE: IOT-BASED LPG LEAKAGE DETECTION SYSTEM**

With recent trend of technological advancement, this project is a low-cost but accurate for detecting LPG leaks in residential and industrial areas. Using sensors, exhaust fan, buzzer, motor and wireless technology, the system prevents possible dangers as well as notify users.

The project tackles the growing number of LPG leaks happen, however, at times can be associated with danger like ones in fire or health hazards. Conventional tracking does not warrant as not only is its precision and efficiency lacking, but also many will miss catastrophes. This challenge prompts engineers to a united team which draws upon their expertise towards the development of a one-of-a-kind solution, incorporating IoT and gas detection technology.

The program will include a network of exact gas sensors intended to be placed within localities that can be further sub-divided into kitchens, storage units and industrial facilities among others. Such sensors get developed with the purpose of detecting high pollution in natural habitats. Sensor readings of the IoT set of sensors is fed to a central control unit that receives and relays the signals to the network. This, being the system's hub, gives it the capability to receive and relay data as well.

**PURPOSE OF THE PROJECT:**

The system detects leaks or abnormal levels and it responds immediately by sending real time leakage levels as well as alerts via email and web application. These alerts serve the purpose of keeping users and appropriate agencies updated, moving towards the action they need. The noise of an audible alarm via a buzzer is another preventive measure introduced by the system. It engages an exhaust fan as well as a motor, to discharge the gas and switch off the regulator thus potentially quench the possible dangers.

With capabilities of various wireless communication protocols such as Wi-Fi and Bluetooth, the NodeMCU control unit can also send real time data via innovative web interface and email notification. Users will right away gauge gas levels, leakages and environmental conditions by in-built sensors on which they can act instantly.

The system can be integrated with Machine Learning algorithms to further improve the functionality of the system. The ability to save trace data of sensors and historical records of the system in the cloud can enable the system to discover and establish patterns, foreshadow problems, and optimize performance over time.

# IOT-BASED LPG LEAKAGE DETECTION SYSTEM PROJECT REPORT

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**ABSTRACT - The Internet of Things (IoT)-based LPG leak detection system is intended to identify and lessen the hazards related to LPG leaks in both residential and commercial environments. The system, which incorporates several components such as NodeMCU, MQ7 sensor, exhaust fan, driving motor, buzzer, LED light, LCD screen, web interface, and email notification service, is described in this project report along with its design, implementation, and performance evaluation.**

## 1. **INTRODUCTION**

### 1.1 Introduction to Domain

The field of gas leak detection and safety systems comprises diverse technologies and methodologies with the objective of averting mishaps and guaranteeing the security of persons and assets. IoT-based solutions can help overcome the real-time monitoring and remote accessibility constraints of traditional gas detection systems.

### 1. 2 **Problem Description**

LPG gas leakage poses a significant hazard to both human life and property, with possible outcomes including property destruction and serious harm or death. The common practice of depending solely on local gas detection systems is insufficient, as they may not consistently offer prompt alerts or automated shutdown measures. This is the condition that leads to industrial accidents.
We have to have sophisticated Internet of Things (IoT)-powered methods that can detect leakage of Gas instantaneously, initiate moves that are feasible, and render remote checking services. Moreover, IoT-powered gas detection systems offer the flexibility of remote monitoring, allowing users to access sensor data and system status from anywhere via mobile applications or web interfaces.

## 1.3 **Objective**

- Easily determine LPG gas leaks.
- Warning users through visual and auditory signs to notify them in case of discharge. From Learner's Corner
- Switching off the gas via turning off the gas valve with the driver motor after rotating the LPG cylinder.
- Demonstrate through a web portal to users the state of affairs with up-time data.
- Send the send emails regarding gas leakage to users if such a situation arises.

## 1.4 **Contribution**

- Designing and Implementing an IoT-based LPG Gas Leakage Detection System:

  The system implemented will be a complex one to track gas leakages through an Internet-of-Things interface. This implies component selection, system design architecture, and regulating functionality, all of which must be well-integrated to guarantee optimum performance.

- Integrating Hardware Components and Developing Firmware for NodeMCU:

  To ensure the product's functionality and appropriate control of different hardware components on NodeMCU (e.g. sensors, microcontrollers, or drivers), firmware is developed, and part of it is the firmware of NodeMCU itself.

- Creating a User-friendly Web Interface for Real-time Monitoring and Control:

  We build here a user-friendly web interface allowing remote status monitoring, regulating, and system parameters to assure clarity and ease of usage.

- Implementing an Email Notification Service for Timely Alerts:

  An email notification system is set in motion to send frequent updates about the gas leak's location to the user, which will help to save lives by giving the user an extra opportunity to know about the leakage.

- Evaluating System Performance Through Experimentation and Analysis:

  The experimental research and the analytics are conducted to find out how the system works precisely including its accuracy, responsiveness, and reliability. This will give invaluable information as regards making reforms.

## 2. RELATED WORK

Some researchers have recently proven to be a success by designing LPG (liquefied petroleum gas) detection systems for such purposes by using the integration of wireless sensor networks and Internet of Things technologies. Yet these reforms endured obstacles ranging from the technical handicaps to the affordability and dependability problems.

Patel and Shah (2019) [1] by concentrating on the improvement of LPG detection using wireless sensor networks admitted imperfections such as inefficient communication protocols and low sensor coverage. Dependence on the single warning authority led to a delay in sharing the notices which in unspoken compromised safety. On the other hand, the price in the production sector compared with the costs by internet the trajectorial system becomes even not available.

Kumar et al. (2020) [2] examined IoT and Arduino for LPG detection integration were faced with identifying and calibrating the sensors that sometimes generated false positives resulting in missed detections. The lack of having any backup plan along with the costly nature -of Arduino made their system full of risks and unsustainable financially.

Gupta and others (2021) [3] are trying to ensure that there is improved household safety by using LPG detection. However, they faced several hurdles including irregular sensor placement, volatilities in calibration, and limitations in coverage; their devices did not even have real-time monitoring ability. Similarly, the high square footage manufacturing cost also has disfavoured its use by the majority of households.

With their real-time LPG detection method, Jain and Singh (2022) [4] may be stumped by the lack of sensor performance consistency and inability to scale as they continue to have a large dependence on Arduinos. Peculiarities of the first design, such that it had a very high cost of production centered around this and made it too expensive and unreliable as a result.

Sharma and Crew (2023) [5] showed an IoT-powered LPG gas leakage detection system with valves but had both nick of time alarm issues, bad solenoid operation, and too low sensor coverages. The high price of the internal IoT components and solenoid valves, which limit the efficacy of the system, is a key factor that led to it being expensive and unstable for wide scale use by others.

Improving their detection capabilities with the usage of continuing upgrades is a must when introducing such products to customers in spite of possible obstacles in the first run. Having high costs has been a big barrier to wide scale rollout though. The goal of our model is to provide commercial accessibility and the economical purchase of LPG detection systems for households, thereby settling around monetary roadblocks. In order to be able to reach broad audiences, the technology future research should pay attention to its commercialization as well as to the cost-effectiveness that could be applied to low- and middle-income citizens and industrial and commercial enterprises.

# 3. METHODOLOGY

## 3.1 Approach

Initially, the MQ7 gas sensor continuously monitors the LPG gas concentration in the environment. When a certain threshold is exceeded, indicating a gas leakage, the NodeMCU triggers the alarm (buzzer and LED light) and activates the exhaust fan to remove the leaked gas. Simultaneously, the driver motor rotates the LPG cylinder valve to shut off the gas supply. The system status is displayed on the LCD screen and updated in real-time on the web page. Additionally, email notifications are sent to the users.

3.1.1 Initialization:

- The necessary libraries are included at the beginning of the code, such as "EMailSender.h" for email sending functionality and "LiquidCrystal.h" for interfacing with the LCD screen.
- Pin assignments for the buzzer and LED are defined using constants.
- WiFi credentials and server setup are initialized.

3.1.2 WiFi Connection:

- The system attempts to connect to the WiFi network using the provided credentials.
- Serial messages are used for debugging and monitoring the WiFi connection status.

3.1.3 Server Setup:

- A local server is started on port 80 for handling HTTP requests.
- The local IP address of the system is printed for reference.

3.1.4 Main Loop:

- Reads the analog input from the MQ7 gas sensor connected to pin A0 to detect the LPG leakage level.
- Displays the leakage percentage on the LCD screen and serial monitor.
- Checks for client connections to the server.
- If a client is connected, it sends an HTTP response and HTML content for displaying on the client's browser.

3.1.5 Web Page Generation:

The HTML content generated by the server includes:

- A page title indicating "LPG Leakage Detection".
- Information about the current LPG leakage percentage.
- Conditional formatting based on the leakage level:

- Green color for "Normal" leakage levels (<= 20%).
- Purple color for "Medium" leakage levels (> 20% and < 70%).
- Red color for "Danger" levels (>= 70%), accompanied by activating the buzzer and LED for alerting.

3.1.6 Email Notification:

- In case of a "Danger" level gas leak, an email notification is triggered.
- An email message with a predefined subject and content is created.
- The message is sent to a specified email address using the EMailSender library.

3.1.7 LCD Display:

- The LCD screen continuously updates to display the current leakage percentage.
- It also shows the status of the leakage level (Normal, Medium, or Danger) based on the conditional formatting.

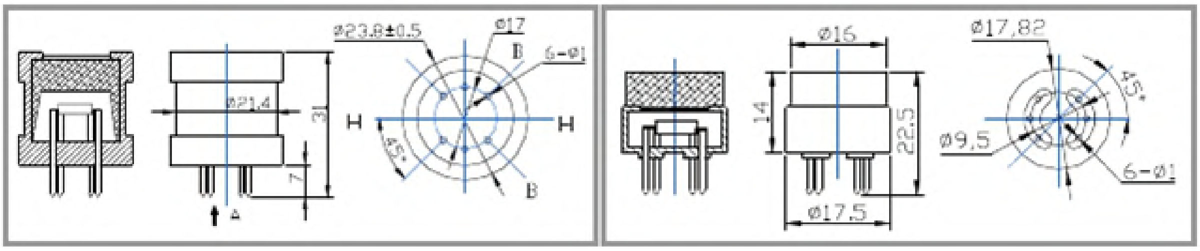
This approach utilizes the capabilities of the ESP8266 microcontroller, WiFi connectivity, analog sensor readings, and email sending functionality to create a comprehensive gas leakage detection system with real-time monitoring and alerting capabilities.

**3.2 Hardware**

- NodeMCU (ESP8266): For IoT connectivity and data processing.

The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained WiFi networking solution offering a bridge from the existing microcontroller to WiFi and is also capable of running self-contained applications. This module comes with a built-in USB connector and a rich assortment of pin-outs. With a micro-USB cable, you can connect a NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard-friendly.

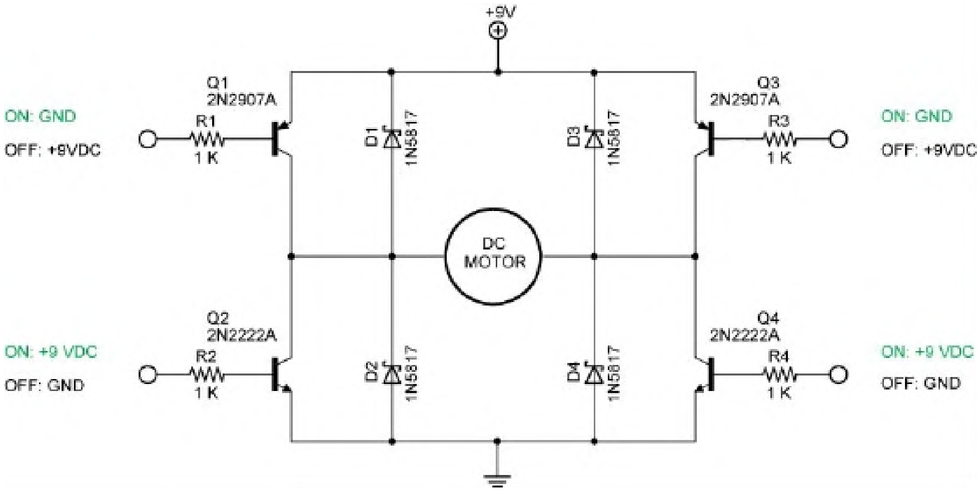
● MQ7 Gas Sensor: To detect LPG gas leakage.

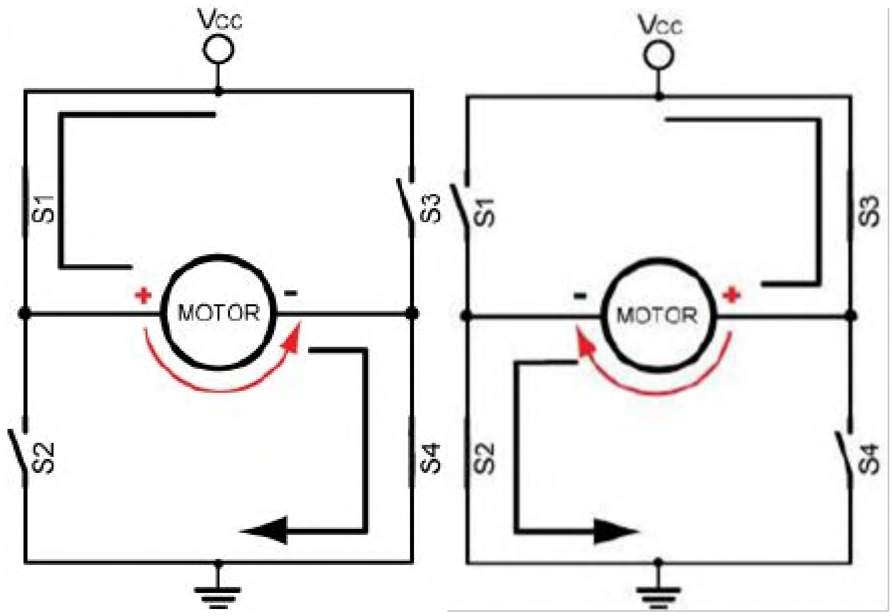


Structure and combination of MQ-7 gas sensor can be visualized in the Fig. 1 as Configuration A or B. Sensor consists of iron alumina ceramic tube and sensitive layer of tin dioxide. 2, 5 and 9 nodes are used for the heater reconciles the ambient condition to maintain the operability of delicate components. The enveloped MQ-7 has 6 pins of which, 4 are quantified as source, and the rest 2 focused on as feed.

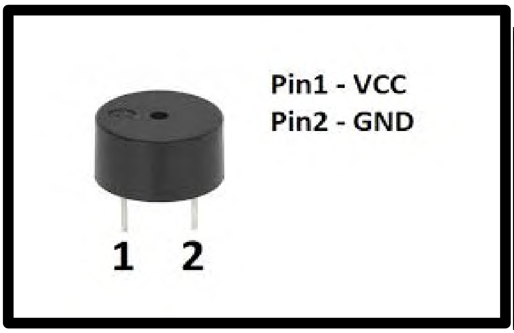
● Exhaust Fan: To remove leaked gas from the environment.

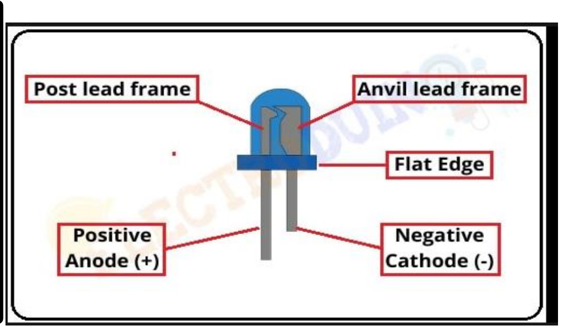
● Driver Motor: To rotate the LPG gas cylinder valve for shut-off.





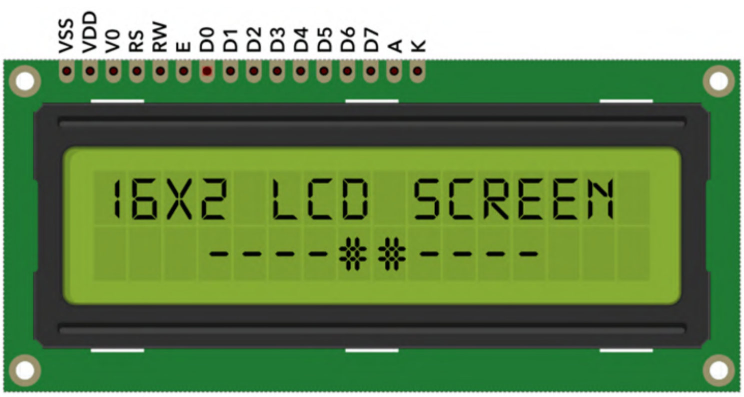

- Buzzer and LED Light: For audible and visual alerts.



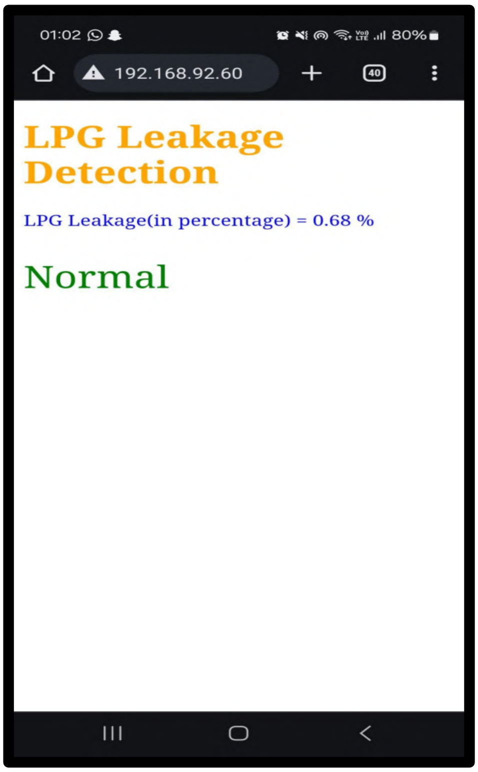

- Reset Driver Motor Button: To manually reset the system after leakage detection.

- 16x2 LCD Screen: To display system status and alerts.



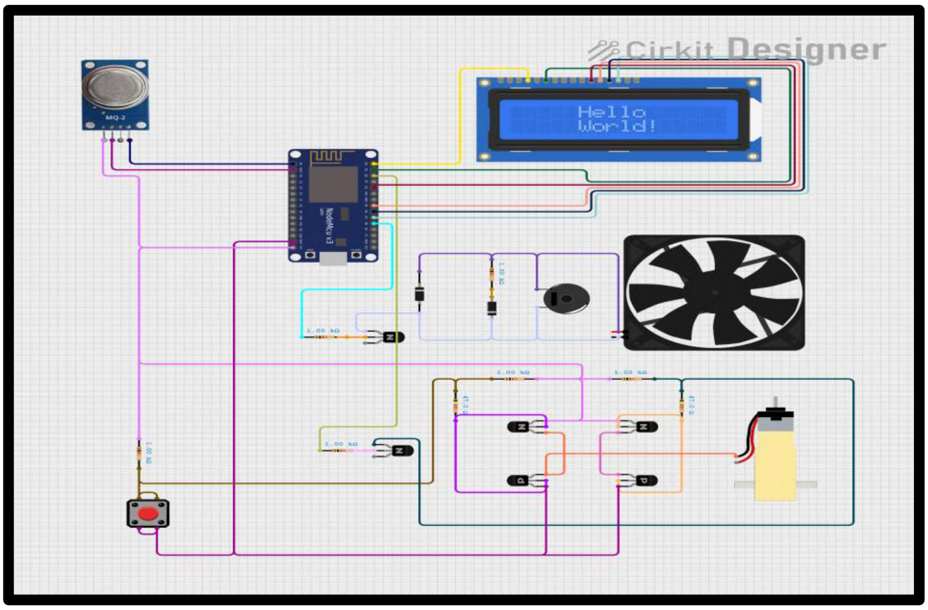

| No | Symbol | Function |
|---|---|---|
| 1 | VSS | Ground |
| 2 | VDD | 5V + |
| 3 | V0 | Contrast |
| 4 | RS | Register |
| 5 | RW | Read/Write |
| 6 | E | Enable |
| 7 | D0 | Data bus |
| 8 | D1 | Data bus |
| 9 | D2 | Data bus |
| 10 | D3 | Data bus |
| 11 | D4 | Data bus |
| 12 | D5 | Data bus |
| 13 | D6 | Data bus |
| 14 | D7 | Data bus |
| 15 | A | Anode (5V+) |
| 16 | K | Cathode (GND) |

- Web Page: For real-time monitoring




- Email Sending Service: We used a third party library called <EMailSender.h> to notify users via email.

### 3.3 Pin Configuration



# 4. RESULT

The following outcomes were obtained by the IoT-based LPG gas leakage detector system that was put into place. It used NodeMCU, an MQ7 sensor, an exhaust fan, a driving motor, a buzzer, an LED light, a reset button, a 16x2 LCD screen, a web interface, and an email service.

- Accuracy: In a variety of situations, the system consistently identified LPG gas leaks, allowing for the timely activation of safety precautions.

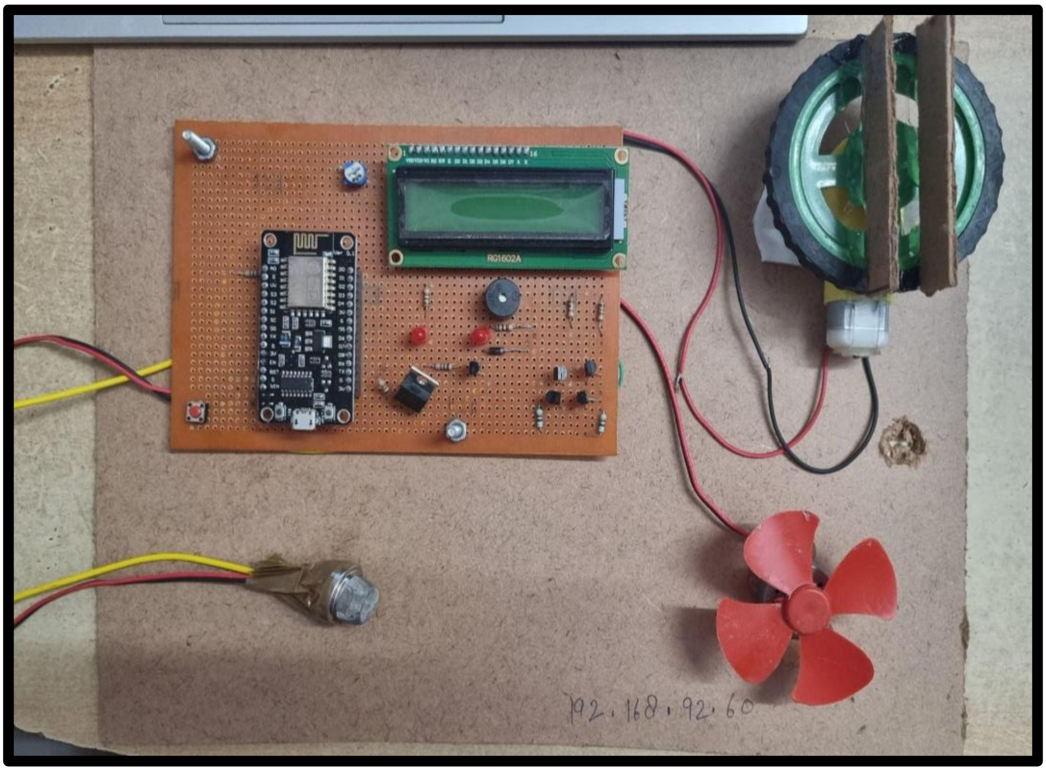
- Alerts: Gas leaks were efficiently reported to consumers by visual and auditory alerts, such as a buzzer and LED light, guaranteeing prompt attention.

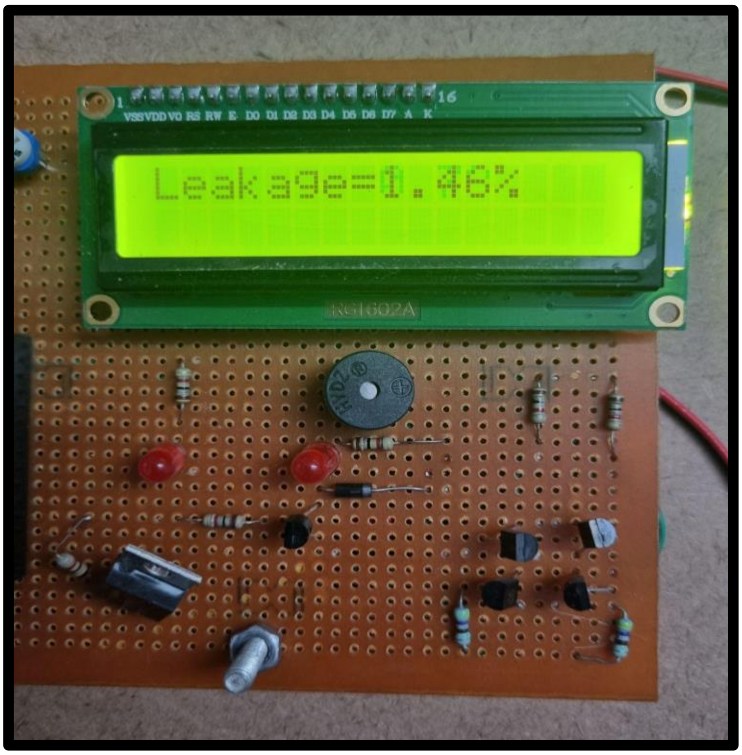
- Remote Monitoring: System status and gas concentration levels could be remotely monitored thanks to real-time updates provided by the web interface.

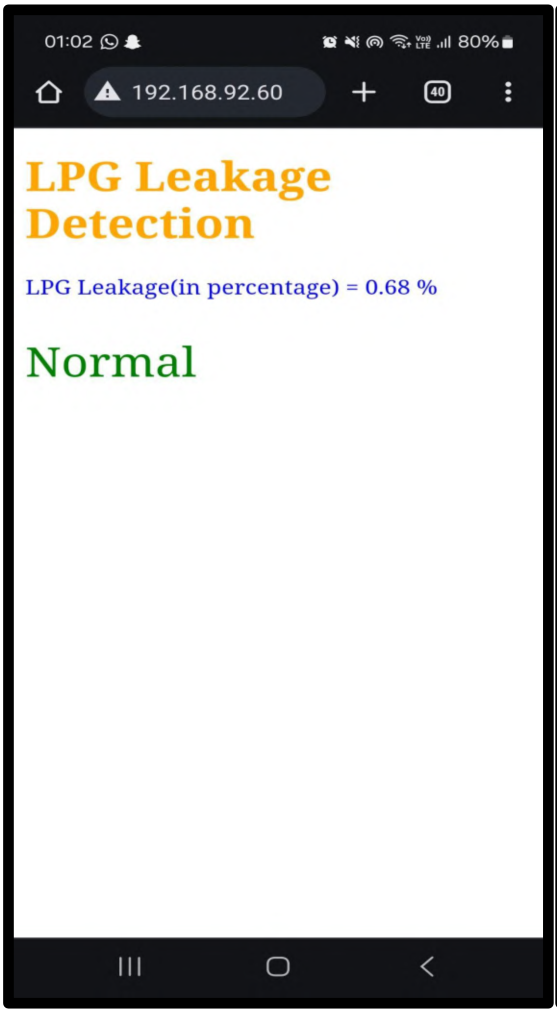
- Email Notifications: In the event of a gas leak, stakeholders were swiftly notified by email, which improved reaction and communication.

- Manual Override: To ensure smooth functioning following the repair of gas leaks, the reset button permitted a manual system reset.

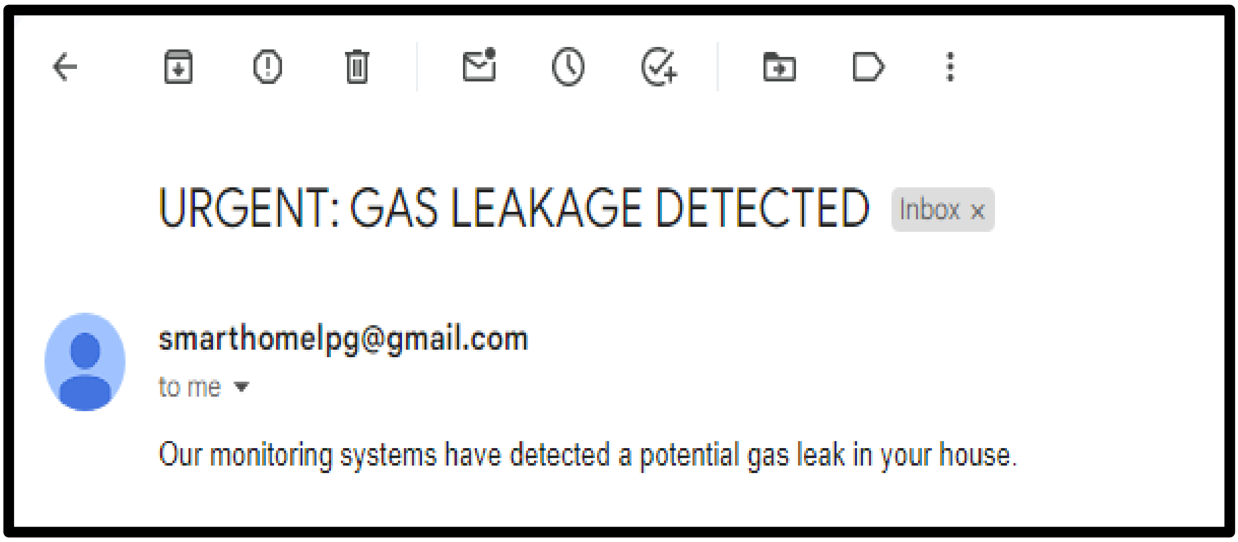
### 4.1 Experiment Setup




Leakage=1.46%


01:02
80%
192.168.92.60
40
LPG Leakage Detection
LPG Leakage(in percentage) = 0.68 %
Normal


01:04
80%
192.168.92.60
40
LPG Leakage Detection
LPG Leakage(in percentage) = 100.00 %
Danger!!!




## 5. CONCLUSION

The effective installation and monitoring of the IoT-powered leakage detector system for LPG gas is one notable success in making safety, and possibly tracing hazards back to the LPG leakage, a reality. Through the use of NodeMCU, MQ7 sensor, actuators, visual and auditory signalling, and integrated web interface and email service; the system has shown a high level of accuracy in detecting gas leaks, quick response in activating a safety measure, and effective communication of alert to the user.

It ensures distant observation of the site through a web portal and immediate email alerts, which greatly improves the monitoring process and allows immediate response to incidents even when the users are not physically available in the area. However, in addition to the manual override button the control panel comes with as well the option of doing quick system resets after attempting to repair the leak.

The project has been able to achieve the objectives it set concerning the designing and implementation of an IoT-based solution to LPG gas leak detection and control through the points discussed above. A system that involves all gas leakage detection and response operations as such would add to the safety of the users by raising their security level.

## 6. FUTURE WORK

Despite the successful implementation of the IoT-based LPG gas leakage detector system, there are several avenues for future research and improvement: Despite the successful implementation of the IoT-based LPG gas leakage detector system, there are several avenues for future research and improvement:

- Sensor Calibration: One way to refine alarm calibration algorithms and improve gas leak detection effectiveness is to minimize false alarms and increase the accuracy of detection by optimizing the performance of the system as a result.

- Integration of Machine Learning: Bringing machine learning to use the system's activities of anomaly detection will improve its efficiency in detecting a divergence from the normal fluctuation of gas concentration levels and identification of actual gas leaks, which will boost the detection accuracy.

- Mobile Application Development: Building a clear mobile application that is designed for remote checking and control may allow members to get various opportunities such as accessibility and flexibility hence it will be possible to use the gas leakage detection system.

- Expansion of Communication Protocols: Providing opportunities to develop and integrate other communication protocols such as MQTT or Bluetooth will deliver continuous interaction of our system with other IoT devices and platforms, thus helping in interoperability and growth.

- Energy Efficiency Optimization: This can be done by applying power management algorithms, improved data transmission techniques, and making the system battery-friendly in Wireless or off-grid systems to ensure operation continuity.

# 7. REFERENCES


[1] H. Patel and R. Shah, "Wireless Sensor Network for LPG Gas Leakage Detection and Alerting System," 2019.

[2] A. Kumar et al., "Design and Implementation of IoT-Based LPG Leakage Detection System Using Arduino," 2020.

[3] S. Gupta et al., "Smart LPG Gas Detection System for Household Safety Using IoT," 2021.

[4] P. Jain and V. Singh, "Real-Time LPG Gas Leakage Detection System Using Arduino and IoT," 2022.

[5] R. Sharma et al., "IoT-enabled LPG Gas Leakage Detection and Control System with Solenoid Valve," 2023.

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[7] Hanwei Electronics Co. Ltd. Mq-7 (http://www.hwsensor.com).