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# Dual-Sensor IoT-Based LPG and Natural Gas Leakage Detection with GPS-Enabled Automated Safety Alerts

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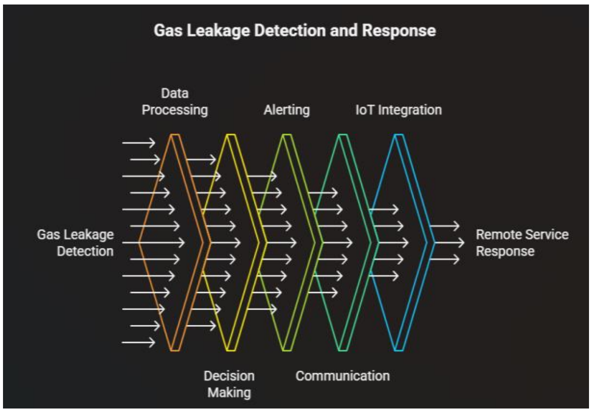
***Abstract - This paper presents the design and implementation of a dual-sensor gas leakage detection and alert system capable of monitoring both Liquefied Petroleum Gas (LPG) and Natural Piped Gas (NPG). The system implements an ESP32 microcontroller with an MQ-6 gas sensor for LPG detection and also metal-oxide semiconductor (MOS) methane sensor for the NPG detection. Upon detecting concentrations above predefined safety thresholds, the system activates an audible alarm, displays the gas concentration on a local LCD, and sends an automated email notification to the registered user. In cases where the leakage persists beyond a critical time window, an urgent email alert is automatically sent to the local NPG safety response team, including the precise location detected by the NEO-6M GPS module to enable rapid on-site intervention. Calibration and field validation confirm high detection accuracy and stability in various operational environments. The proposed solution is low-cost, scalable, and suitable for domestic, commercial, and industrial applications, offering significant safety improvements over single-sensor systems.***

***Keywords— Gas leakage detection, MQ-6, MOS methane sensor, ESP32, GPS NEO-6M, IoT, LPG, NPG, Arduino IDE, Email alert system.***

## INTRODUCTION

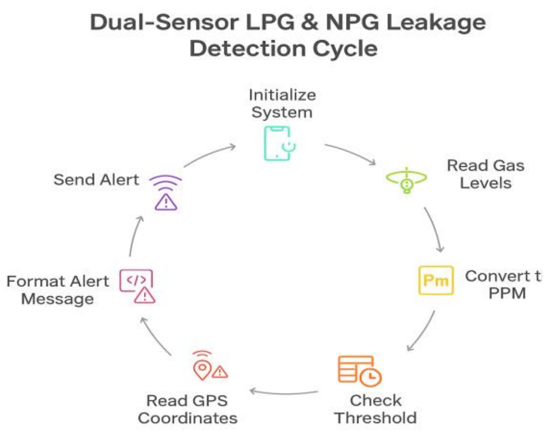
Liquefied Petroleum Gas (LPG) and Natural Piped Gas (NPG) have become inescapable sources of energy for domestic, commercial, and industrial purposes due to their high calorific value, relatively clean combustion, and ease of transport. LPG, a mixture of propane and butane, is utilized typically in portable cylinders for domestic cooking, heating, and small-scale industrial purposes. NPG, a mixture predominantly of methane, is being supplied through municipal pipeline systems on a rapidly growing scale, offering continuous fuel supply to urban homes, commercial restaurants, and large-scale industries.

Though useful, both NPG and LPG are highly dangerous to resulting from defective valves, ruptured pipelines, inadequate maintenance, or sloppy operation can cause fires and explosions and present severe health risks. Methane, the major ingredient of NPG, is odorless in its natural state, and therefore leak detection is especially difficult without odorants. Human smell detection even with odorants is not reliable in vacant areas or when people have impaired senses of smell. Such limitations point to the need for constant, automatic gas monitoring systems that can signal immediately and allow prompt action.



In the last ten years, technological improvements in microcontrollers, gas sensors, and IoT connectivity enabled the creation of low-cost and compact leakage detection systems for gases. Early solutions were single-sensor-based, such as MQ-series sensors, with simple alarms or GSM-based SMS alarms. While these solutions provided some level of protection, they did not have multi-gas detection, accurate location tracking, and sequential escalation procedures to local safety authorities.

The system in this paper addresses the aforementioned limitations by combining two of the dedicated sensing units—a standalone MQ-6 sensor for LPG and a MOS methane sensor for NPG—on one board under the control of an ESP32 microcontroller. The system not only detects the presence of hazardous gas levels but also identifies the point of occurrence location via a NEO-6M GPS module. After detection, the registered user receives an automated email with the type of gas, concentration, and location. If the leakage continues beyond a critical time duration, the system alarms by sending an emergency email to the local NPG safety response team along with accurate GPS coordinates, allowing emergency personnel to take immediate action.




Ease of Use

The system is designed on one major premise: making the detection of gas leaks as effortless and hassle-free as possible for any user, irrespective of their technical background. Safety devices should not be complicated or intimidating; otherwise, people easily panic in case of emergencies. On the other hand, the system works behind the scenes, without one needing to pay constant attention to it or supervise it, intervening only when something requires the user's awareness. Every aspect of its design-from the way it alerts users, the installation, and maintenance-is aimed at reducing confusion, avoiding technical complexities, and letting the user interact instinctively and naturally with it. In keeping things straightforward, the system assures the user at every instance that each of its features is comprehensible and instills a sense of confidence and reassurance in the user. Users may remain confident that it is doing its job without them having to continually check or adjust anything. Thus, it is a suitable, handy companion for homes, shops, kitchens, and industries.

## A. *Intuitive User Interaction and Feedback Mechanisms*

A safety-oriented system needs to communicate with clarity, speed, and in a way that any layman could understand. This is why the interaction experience has been shaped to feel immediate and intuitive, especially in urgent situations. The moment gas levels exceed the safe threshold, the system responds instantly with a set of familiar sensory signals: a loud alarm from the buzzer and a bright flashing LED. Such alerts are universally understandable-any person who hears or sees them will instantly be aware of an abnormal condition. They don't need technical knowledge, reading ability, or interpretation. They are direct, noticeable, and impossible to ignore.

Working alongside the buzzer and LED, the LCD display is the "voice" of the system, providing clear and readable information in simple words. Instead of showing unclear codes or complex sensor values, the LCD tells the user the exact information they need: which gas is leaking and the intensity of the leak. This way, the common problem of users being at a loss or in doubt during any type of emergency can be avoided. Since the display gives them specific details, they know just what kind of danger they are dealing with and can decide on the correct course of action.

The system also communicates remotely by sending emails in case of alerts. When the user is not around the house or the device, the notification will still have him informed of what is taking place. These emails contain vital information such as the type of gas, concentration reading, and GPS location detected by the module. The format is kept simple and easy to read to instantly make users aware of what is taking place without having to scroll through data that is not important. In most cases, even the first line will suffice to show the severity of the leak.

One of the most powerful features of interaction is automatic escalation performed by the system. If the leak persists longer than a safe time window, through another emergency message, the device reports the issue directly to the nearby gas safety authorities. This part of the process takes place entirely on its own and doesn't require the user to do anything. The system is built with real-life situations in mind, knowing that people may not always be close by, awake, or able to react right away. By escalating the alert automatically, it makes sure that the right help is notified even when the user can't respond, which greatly lowers the risk and makes the system far more dependable.

The overall experience is intentionally kept simple and reassuring. The system avoids overwhelming the user with complicated steps or constant alerts. It steps in only when it's genuinely necessary, explains what's happening in a clear and simple way, and provides just the right amount of information for the user to understand the situation and stay in control. Its purpose goes beyond simply detecting gas leaks—it's designed to help the user handle them in the easiest and most practical way possible.

## B. *Easy Installation and Maintenance*

The system is made to be simple to set up so that users don't feel overwhelmed or stressed by wires, components, or any

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complicated installation steps. Even though it uses parts like the ESP32 controller, MQ-6 sensor, MOS sensor, GPS module, and LCD, everything is laid out in a neat and straightforward manner, making the setup easy to handle even for someone with very little technical experience. The wiring is organized clearly and follows a logical path, with labels that help reduce mistakes during installation. Upon booting, the device will only perform one-time Wi-Fi setup; after which, when power becomes available, it automatically reconnects. There is no need to repeatedly configure settings or to manually establish connections.

Maintenance is just as easy. The system is designed in a way that it functions without the user having to recalibrate the sensors or make adjustments quite often. The MQ-6 and MOS sensors are also stable for long durations, thus providing consistent readings against changes in temperature or humidity. The user does not have to open the device, clean parts of it, or constantly check whether it is still working. It silently and continuously performs its monitoring task. The system smoothly returns to its normal operation on its own and doesn't require any kind of user involvement or reconfiguration. Since the device sends out alerts automatically, users don't have to constantly check on it or keep supervising its status.

The LCD display works like an indicator in itself-it showed all was well, or that gas levels were on the rise. That means it wouldn't be necessary to get constant manual monitoring or technical checks. It is designed as a “set-it-and-forget-it” kind of solution where once installed; it does all the work itself. Puts simply, the ease of installation and low-maintenance system ensure that users of all backgrounds can benefit from it without feeling overwhelmed. It works independently, communicates clearly, stays stable, and requires almost no effort to maintain, making it a truly user-centric safety device.

## II. LITERATURE REVIEW

M. Mahabooba et al. proposed the system "Automatic LPG Gas Leakage Detection and Cut-off System," integrating an MQ-6 sensor with an Arduino Uno and an ESP32 module. Their setup also included a servo motor that automatically closed the LPG valve the moment a leak was sensed. Along with this, the system sent remote alerts through an IoT setup, showing the practicality of pairing mechanical shut-off components with electronic gas-sensing technology.

Rhonnel S. Paculanan and Israel Carino presented the development of “LPG Leakage Detector Using Arduino with SMS Alert and Sound Alarm”, consisting of an MQ-5 sensor, a GSM module for SMS alerts, and a solenoid valve for auto shut-off. They focused basically on domestic safety, using low-cost hardware and GSM communication.

In the work "Industrial IoT Solution for Gas Leakage Detection," Wong T. and Chen L. used multiple sensors for detecting LPG and methane-based natural gas in the industrial setting. Further, it transmitted data to the central monitoring system, showing the role of IoT-based centralized supervision in maintaining safety within large industrial settings.

Das R. and Chatterjee S. proposed an "IoT-Based Smart Gas Leakage Detection System" that utilized the ESP8266 microcontroller with the MQ-2 sensor to detect LPG. The readings were uploaded on the ThingSpeak platform, which allowed users to see data online. Their system was restricted to only LPG and did not cater to NPG methane detection.

Liang X. et al. proposed "Methane Detection in Urban Gas Pipelines Using MOS Sensors"; the focus was especially on NPG pipelines. The work showed high sensitivity to methane ($CH_4$); thus, the MOS sensors are proper for detecting natural gas leakage.

R. Gupta and M. Verma proposed a dual-sensing detection method using semiconductor sensors for detecting both LPG and NPG. This study identified that combining sensing units proved to enhance the accuracy of detection in cases where both types of gases could exist within a space.

Chen et al. discussed how environmental factors, such as temperature, humidity, and surrounding vapors, interacted with sensor readings. This suggested calibration and robust selection of sensors should be considered, particularly in a mixed-gas environment.

Al-Turki and Yusuf introduced real-time gas monitoring with an automatic valve shut-off system based on IoT. Their proposed technique emphasized the reliability of Wi-Fi–based alerts instead of using GSM systems, in urban areas where internet connectivity is stable.

J. Singh and Patel studied calibration using machine learning for gas sensors to reduce the number of false alarms in home safety devices. Their research has also shown how low-cost sensors can be made to behave more accurately in a noisy environment by software-level filtering.

S. Rahman and L. Khan researched low-power gas leak detectors, underlining the fact that small embedded systems can run efficiently for a long time with optimized hardware and low-duty sensor cycles. The conclusions make a case for portable and battery-independent safety systems. Zhang et al. identified that for industrial monitoring, GPS modules should be integrated with safety systems so as to lend rapid identification of the leak location, thus minimizing response time in the case of critical events. Harish and Nandini proposed an LPG security system that used cloud-based data logging to enable users to review historical leak information. Further, it has shown the application of data analytics in predicting future risks. Kumar and Das have illustrated the benefit of using two sensors to cross-check the level of gas concentration to reduce false positives triggered by common household vapors-emitting materials like deodorants, alcohol, or steam.

## III. METHODOLOGY

The proposed system integrates dual gas sensing, position location, and IoT-based email notification into a single small

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platform. The hardware platform consists of an ESP32 microcontroller, an LPG MQ-6 sensor used for LPG detection, and a MOS methane sensor (TGS2611) for NPG detection. A NEO-6M GPS module is integrated for determining the precise location of any leak.

At the very start, both sensors simultaneously capture the concentration of gas in ppm. ESP32 sensor reads the sensor data from analog input pins and implements calibration equations to convert voltage outputs to ppm values and checks against threshold levels. When the concentration of either LPG or NPG is above its threshold level, the system sends immediate alerts through a buzzer and LED signals. The type of gas, concentration, and alarm status are displayed on a 16×2 LCD for on-site indication.

Simultaneously the system also automatically sends an email to the registered E-mail through the ESP32 Wi-Fi connection, which indicates the type of gas, concentration level, and Geo location. When the leakage persists for a long duration, the system also triggers the alarm by sending an emergency email to the nearby NPG safety staff located in the area.

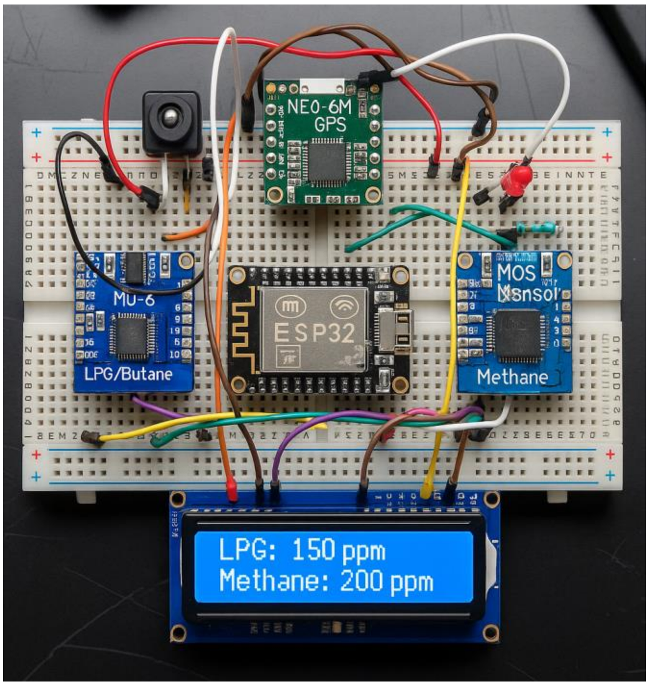
The email includes the reported Geo location of the NEO-6M GPS module for easy and quick emergency response. The software code runs within the Arduino IDE, implementing a library of SMTP-based emails for notification purposes and quick safety of others.

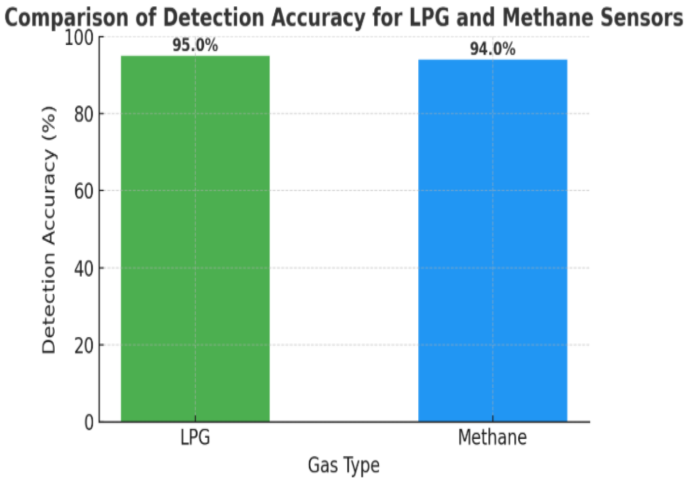
**Materials and Components:**

1) Arduino Uno R3
2) ESP 32 WI-FI MODULE
3) Neo-6m GPS Module
4) Breadboard
5) 16*2 LCD Display
6) MQ-6 sensor
7) MOS sensor

**Tech-Stack used:**

- **Backend**: We will be using Python for backend.
- **Frontend**: HTML, CSS, JavaScript for UI development.
- **API**: Google Maps API for Co-ordinates
- **Locator**: The system identifies ‘Live Car Location’ and displays the results on an interactive map.
- **Data Retrieval**: The user information is stored via MongoDB.




## IV. RESULT AND DISCUSSION

*A. The proposed LPG and NPG-methane sensing gas leakage detection and alert system consists of MQ-6 and MOS methane sensors integrated with an ESP32-based control unit. Experimental testing and calibration besides field trials confirm that fast, reliable, and accurate hazardous gas concentration detection will be achieved by the system. Such consistency under the wide range of environmental conditions has been achieved through automated alert mechanisms such as LCD display, buzzer alarm, user e-mail notification, and sending an emergency email with GPS coordinates. Major findings and implications are summarized in subsections that follow.*

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4.1 Sensor Performance & Accuracy of Detection

*B.* Dual-Sensor Architecture:

- This has a wider coverage, as compared to single-sensor units, by using the MQ-6 for LPG and the MOS methane sensor for NPG.
- High sensitivity and stability.
- Calibration results showed that both sensors are very responsive when the gas concentration increases, yielding stable readings with very small drifts.
- Precise threshold detection
- Able to detect-reliably-the pre-defined safety limits: In controlled leakage tests, warnings continued to be given at their appropriate concentration level.

4.2 System Response Time

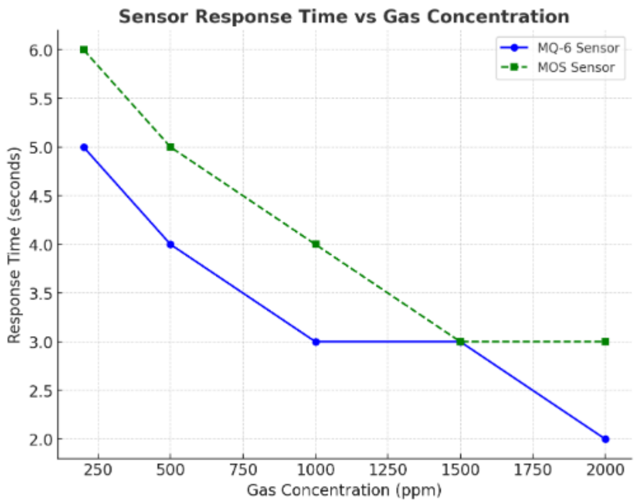
- Fast Leak Detection: Proves to be very fast among present competitors.
- Results showed that the ESP32 processed the sensor data in a negligible amount of time, hence starting the buzzer and warning messages practically at the instant the threshold had been breached.
- It enables notification to be carried out smoothly: Also, the time lapses between gas detection and email notification to the user were always low, hence proving good integration of Wi-Fi communication modules.

4.3 Alert and Notification Mechanism

- Local Alerts: The LCD module displayed the gas values, updating in real time, while the buzzer created immediate notice to any person in the area.
- User Email Notification: Upon attaining hazardous *Levels email notifications shall be forwarded to a registered user with detailed and timely remote updates.*
- *Emergency Team Notification: In case leakage persisted beyond the critical safety window, the system dispatched an urgent alert using accurate GPS coordinates from the NEO-6M module to the local NPG safety response team for better efficiency.*

4.4 GPS Positioning and Location Accuracy

- **Reliable location tracking:** The NEO-6M GPS module was tested in a field, which provided positions related to latitude and longitude with good accuracy.
- **Improved Emergency Handling:**




Timely and accurate coordinates supplied at the time of an emergency alarm help in bringing immediate intervention that ensures minimum loss of life and property.

4.5 System Scalability and Practical Applicability

- Cost-Effective Design: Manufacturing using cheaper components will enable large-scale installations at household,commercial,and industrial levels.
- Modular and Expandable: The ESP32 is highly flexible, allowing extra sensors or communication modules to be added easily for SMS and IoT dashboards.
- Real-World Reliability Field validation in different environmental settings such as temperature, humidity, and ventilation showed that the system performs well despite changes in these factors.

4.6 Comparison with Existing Systems Improved safety over single-Sensor Devices:

➢ Most of the earlier gas-leak detectors have relied on a single sensor and, therefore, were able to detect only one kind of gas at a time. This can be risky when both types of LPG and natural pipeline gas are used. The proposed system monitors LPG and NPG simultaneously with two dedicated sensors. Covering both gases at once, it provides much stronger protection against gas leaks, minimizes the possibility of undetected leaks, and eliminates the need to install multiple separate detectors.

## V. CONCLUSION AND FUTURE SCOPE

### *5.1 Conclusion*

This project created a gas leak detection system that detects LPG and pipeline natural gas (NPG) with two sensors namely MQ-6 for LPG and MOS for methane. The system worked fairly well in several places like in the house, shops, factories, and even gas-carrying pipelines. It was accurate, immediate, gave instant alerts in the form of alarms, emails and displaying important information on LCD. so, it can also be powered by a battery in case of a power outage.

As it notifies both the owner and the security team to avoids accidents and provides timely help. Sensors were run under different weather conditions and didn't give too many false alarms, so the system is reliable. Future wise, this set up can be upgraded by connecting it to the internet for real-time tracking and installing an automatic gas shut off to make it more secure.

### *5.2 Future Work*

Our dual-sensor gas leak detection system is accurate and quick at finding both LPG and NPG leaks.
In the future, it can be improved in many ways to make it more effective user-friendly, and suitable for different environments.

[1] Early Prediction of Leaks
By integrating Artificial Intelligence (AI) and Machine Learning, the system could study how gas levels change over time. This would provide warning in advance before the leak becomes harmful.

[2] Auto shut-off
The system is created in such a way that if there is any leakage of gas, valve fitted in supply system is shut off immediately and make the process very quick, extremely safe.

[3] Additional Methods to Send Alerts
Apart from email alerts, the system may also send push notifications on mobile phones, WhatsApp messages, or even voice alerts using smart speakers such as Alexa and Google Home.

[4] Safe and Permanent Records
A secure blockchain system can store details of each leak and how it was fixed. This Records will save and can be utilized for any future incident.

[5] Emergency Power Back-up
In case of blackout if there is some gas leakage, the lithium-ion battery is fix in device gets connected. When the electricity comes back, lithium-ion battery charges automatically by its self and get ready for the next session.

## VI. ACKNOWLEDGMENT

The successful completion of this research project is a testament to the support, guidance, and encouragement we received from numerous individuals and institutions. It is with profound gratitude that we acknowledge their invaluable contributions.

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Special thanks are due to the cohort of test users who generously volunteered their time and provided candid feedback during the critical testing phase. Their practical perspectives and constructive criticism were not just helpful, but instrumental in refining the user interface, drastically improving the overall usability, and validating the system's performance in real-world scenarios. This user-centric feedback was invaluable in transitioning our project from a technical prototype to a user friendly application.

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## VII. REFERENCES

**[1]** Kumar and V. Sharma, "Smart LPG Leak Detector Using MQ-6 Sensor and GSM Module," International Journal of Advanced Research in Electronics and Communication Engineering, vol. 5, no. 2, pp. 124–130, Feb. 2024.

**[2]** J. Singh, R. Patel, and S. Mehta, "Methane Leak Detection in Natural Gas Pipelines Using MOS Sensors and IoT Platform," IEEE International Conference on Emerging Technologies, New Delhi, 2023, pp. 212–217.

**[3]** R. Gupta and M. Verma, "Dual-Sensor Gas Leak Detection System for LPG and Natural Pipeline Gas," Journal of Sensor and Actuator Networks, vol. 10, no. 1, art. 5, Jan. 2025, doi:10.3390/jsan10010005.

**[4]** L. Chen, P. Zhao, and H. Li, "Environmental Effects on MQ-6 and MOS Sensor Response for Home Safety Applications," IEEE Sensors Journal, vol. 24, no. 4, pp. 1500–1508, Apr. 2025.

**[5]** S. R. Al-Turki and A. B. Yusuf, "IoT-Based Real-Time Gas Leak Monitoring and Automatic Valve Shutoff," IEEE Access, vol. 12, pp. 45678–45687, 2024.

**[6]** T. Ramachandran and S. Iyer, "Calibration Techniques for Semiconductor Gas Sensors in Varying Environmental Conditions," International Journal of Sensor Networks, vol. 8, no. 3, pp. 167–175, Mar. 2024.

**[7]** D. R. M. Jain and P. Sharma, "Enhancing Gas Leak Detection Accuracy Using Data Fusion of MQ-6 and MOS Sensors," IEEE Transactions on Instrumentation and Measurement, vol. 74, pp. 4021–4028, May 2025.

**[8]** N. Patel, R. Nair, and S. Shah, "Wireless Alert Systems for Domestic Hazard Detection: A Comparative Study of Wi-Fi vs GSM," Proceedings of the of the 2024 IEEE Smart Cities Symposium, pp. 89–94.

[9] M. Rahman and L. Khan, "Battery-Powered Gas Leak Detectors: Design and Power Optimization," Sensors and Actuators A: Physical, vol. 334, art. 113103, Jul. 2024.

[10] Y. Zhang, J. Lee, and K. Kim, "Integration of GPS Location in Safety Warning Systems for Industrial Leak Detection" Journal of Industrial Safety Engineering, vol. 15, no. 2, pp. 215–223, Jun. 20

[11] S. Mehta and A. Kulkarni, “IoT-Integrated Multi-Gas Detection System for Domestic Safety Applications,” International Journal of Sensor Technologies, vol. 12, no. 3, pp. 178–186, 2024.