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# LPG Leakage Detection using IoT

**Aditi Wagh[1], Abhishek Waghmare[2], Vaishnavi Shinde[3], Sonali Dokhe[4] Prof. Jagruti R. Mahajan[5]**
Department of Computer Engineering[1,2,3,4,5]
Adsul's Technical Campus, Chas, Ahmednagar, India

**Abstract:** *Gas leakage in various industries and locations poses severe health risks, emphasizing the importance of early detection and alert systems to mitigate damage and save lives. This paper conducts a systematic literature reviewon the current state of gas leakage detection, specifically focusing on Internet of Things (IoT) and Cloud technology. The review explores sensor-based and non-sensor-based IoT systems, evaluating their advantages and disadvantages. It summarizes trends, challenges, and proposes future research directions to improve the reliability and accuracy of gas leakage detection systems. The review highlights the necessity for more efficient, cost-effective, and scalable IoT- based solutions for gas leakage detection, emphasizing the ongoing evolution of technologies in this critical field.*

**Keywords:** IoT, MQ Sensor and Arduino

## I. INTRODUCTION

The Internet of Things (IoT) encompasses a networked array of physical objects with embedded sensors, software, and advanced technologies. Ranging from basic household items to industrial machinery, IoT significantly impacts sectors such as healthcare, agriculture, traffic monitoring, safety management, and environmental surveillance. The rising global population has spurred the application of IoT in agriculture to meet escalating product demands **[1]**.

However, the migration of young people to urban areas destabilizes the essential human resources for agricultural growth. To address this challenge and automate farming processes, IoT and related technologies play a crucial role in ensuring global food supply. In sectors like the chemical industry, IoT is pivotal for safety protocol management, gas level monitoring, and response to potential gas leaks. It also aids in tracking the environmental impact of chemical production, calculating hazardous emissions, and overseeing waste disposal.

Integration challenges arise when implementing gas leakage detection systems with IoT. Security emerges as a paramount concern, given the vulnerability of IoT code to bugs and unauthorized access, particularly when engineers lack adequate security knowledge **[2]**. Moreover, the cost of IoT infrastructure, covering improvements, maintenance, and technical skill acquisition, introduces unforeseen expenses, comparable to other major initiatives.

Connectivity issues can impede the success of IoT projects, emphasizing the need for robust connectivity when linking physical devices, cloud servers, and applications. In the context of chemical disasters, with potential catastrophic effects on human lives, property, and the environment, early identification and warning systems for gas leaks become imperative. Failures in process and safety mechanisms, personal errors, and managerial lapses contribute to chemical disasters, exemplified by the tragic Bhopal Gas Tragedy in India in 1984, the deadliest industrial chemical disaster in history.

Despite past incidents, India continues to face chemical catastrophes, highlighting the ongoing vulnerability of industrial plants and surrounding communities. Timely gas leak identification, facilitated by technologies like SMS alerts, emerges as a critical preventive measure against casualties and environmental degradation associated with chemical disasters.

## II. RELATED WORKS

### Gas Leakage Detection using IoT:

Proposed is a two-way safety stove incorporating a gas leak detection feature and a child lock mechanism, addressing concerns about children's ability to operate the burner safely. Leveraging a Raspberry Pi and a buzzer-equipped gas detection module, the system integrates a Haar Cascade object detection method and a deep learning architecture (CNN) for efficient execution. The primary objective is to detect gas leaks, alert building occupants for proper ventilation, and mitigate potential hazards. Utilizing an integrated circuit and an MQ-9 chemical sensor, the system yields accurate visual information and timely audible notifications during testing.

In this article, an IoT-based gas detection model is introduced, employing an Arduino UNO. The system utilizes a fuel sensor to detect gas leaks, triggering the activation of the LCD and GSM modem. The GSM modem sends SMS alertsto users in the event of a gas leak **[1]**. The study aims to review gas alarm systems, their challenges, and the impact of their installation in homes or workplaces for safety. Recent technological advancements are expected to enhance security, enabling gas detection systems to monitor and control homes, businesses, hospitals, industries, andinstitutions, thereby preventing incidents.

Another gas leak detection system incorporates the MQ-6 sensor and a solenoid valve to locate and shut off gas leaks. The investigation involves evaluating the sensor's voltage using a preset programmer, optimizing the sensor's responsiveness by narrowing the gas escape path. Address the flammability of liquid petroleum gas (LPG), a system employing the MQ-6 gas sensor is proposed, aiming to detect and warn against LPG leaks **[2]**.

An article focuses on an IoT gas request system to monitor gas weight in compartments. The system utilizes a microcontroller connected to a heap cell for consistent weight measurements, with additional safety features such as the MQ-2 gas sensor and LM 35 temperature sensor to detect and alert in case of an error. Lastly, an Internet of Things-based gas leak detection system is proposed, incorporating sensors to automatically identify and alert users to gas leaks. The system also includes a warning mechanism for users **[3]**.

**Gas leakage detection combining both on IoT and Cloud Technology:**

The suggested model incorporates sensor devices detecting environmental values such as Voltage, employing the IoT platform Xively for channel utility to deploy the prototype into an integrated solution. This system utilizes a Raspberry Pi and a buzzer-equipped gas detection module, integrating a Haar Cascade object detection method and a deep learning architecture (CNN) for efficient execution. The project's objective is to prevent industrial mishaps, monitor hazardous chemicals, and communicate alert messages to the industry's safety control board. An Arduino Uno R3 board serves as the central board, linked to various sensors monitoring environmental conditions, including temperature, gas, and alcohol sensors. Data from the sensors are stored online for further processing and evaluation, enhancing safety **[4]**.

In another study, a wireless gas leak detection and localization method is proposed, achieving a 91% detection rate with seven false alarms over a three-day period. The system utilizes 20 devices covering 200 m² and is assessed based on concentration data gathered during propane releases. The IoT serves as the foundation for a gas leakage detection system using the Node MCU ESP8266 Wi-Fi module as the main microcontroller and the MQ2 sensor to determine gas concentration. The system transmits data readings to the Blynk IoT platform for effective monitoring.

A project aims to create a tool for identifying and avoiding wireless risks using the Arduino UNO microcontroller and Node MCU ESP8266 connected to the internet. These components communicate to provide notifications and warnings to users. Another study reviews literature on IoT-based gas detection systems, employing the MQ5 gas sensor and Arduino Uno controller. Cloud storage is utilized for data collection, storage, and analysis **[5]**.

For pipeline leakage detection, a novel approach using lead zirconate titanate (PZT) sensors is suggested, achieving accurate location identification of manually controlled leakage spots. The method may prove useful for monitoring short- and medium-length gas pipelines with leak rates as low as 0.1% of the flow volume. A proposed monitoring gas leakage detector system utilizes the Wi-Fi Node MCU ESP8266 as the microcontroller and the MQ2 combustible gas sensor. The system transmits data readings to the Blynk IoT platform, activating a fan and alarm in case of a gas leak **[6]**.

Using the Sim900 SMS Gateway, Arduino Uno R3 Microcontroller, and MQ2 gas sensor, another study discusses technological improvements in gas leak detection systems. A system for tracking and detecting liquefied petroleum gas leaks is developed, incorporating a physical alarm with a buzzer and a non-physical alarm with email and smartphone notifications via the Blynk application as an IoT platform. A gas detection prototype is built using the Arduino UNO, measuring humidity, temperature, LPG, and smoke using the MQ2 and DHT11 sensors **[7]**.

A wireless sensor network for detecting LPG gas leaks is developed using XBee, a gas sensor, and an Arduino Nano. The Lab VIEW GUI displays data received from the gas sensor, with communication between the mobile phone unit

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and microcontroller unit facilitated by a GSM module. Another system for detecting LPG gas leaks utilizes the MQ5gas detection sensor, providing real-time data analysis and alerting in case of a gas leak **[8]**.

To address wireless risks, an affordable system using an Arduino microcontroller, MQ2 gas leakage sensor, and ESP8266 Wi-Fi module is proposed. The system sends warning messages through email using the Blynk app. An LPG gas leakage detection system using MQ2 gas sensors is developed, providing automatic notifications and warnings to users via smartphone through the Blynk app **[9]**.

A gas leak detection system using IoT and Proteus software is developed, incorporating a circuit with MQ2 gas sensors and smartphone app Blynk for real-time alerts. A system for consistent weight estimation and gas leakage detection is proposed, utilizing a heap cell connected to a microcontroller and additional safety features such as the MQ-2 gas sensor and LM 35 temperature sensor. Another system constantly checks the environment for leaks, notifying the user through a buzzer, Android application, and social media platforms about gas levels and temperature **[10]**.

The proposed idea enhances fire prevention in residential and commercial structures using the IoT system. It notifies users through an application when a fire or gas is detected, activating a ventilator fan to release gases and preventing nearby electrical devices from becoming fire sources **[11]**.

## III. TECHNOLOGIES USED IN GAS SENSING

Gas detectors commonly employ the scaling approach to identify hazardous gases. This method involves setting thresholds on a scale, and when a hazardous gas surpasses the upper threshold, triggering an alarm. Gas sensors are adept at recognizing several types of flammable and toxic gases. Several sensor technologies are utilized for gas detection:

- **Catalytic Sensors:** These sensors are effective in detecting combustible gases. They operate by causing a change in resistance when a gas concentration increases and contacts the catalytic surface, activating the alarm.0
- **Infrared Sensors:** An infrared sensor, functioning as a light detector, detects gases when they cross the path of light between the transmitter and receiver. This type of sensor is particularly useful for specific gas types.
- **Electrochemical Sensors:** These sensors detect hazardous substances by generating signals on the electrode. Theyare commonly employed for accurate detection of specific gases.
- **MOS Technology (e.g., MQ-2 through MQ-9):** MOS technology encompasses various sensor types designatedby letters like MQ-2 through MQ-9. For example, the Gas Sensor MQ2 can detect H2, LPG, CH4, CO, alcohol, smoke, or propane. Similarly, the Gas Sensor MQ3 is useful for detecting alcohol, benzene, CH4, hexane, and LPG.
- Here are specific examples of gas sensors and their applications:
- **MQ-4 Natural Gas Sensor:** Dependable for detecting natural gas, methane, propane, and butane.
- **Gas Sensor MQ5:** Effective for identifying gas leaks and can be used for alcohol, H2, LPG, CH4, and other substances.
- **MQ-6:** Simple-to-use instrument for measuring airborne concentrations of LPG.
- **MQ-7:** Utilizes a cycle of high and low temperatures to detect carbon monoxide (CO).
- **MQ-8 Hydrogen Gas Sensor:** Measures the quantity of hydrogen (H2) in the atmosphere.
- **MQ-9 Analogue Gas Sensor:** Extremely sensitive to carbon monoxide, methane, and propane.

These sensors play a crucial role in various applications where the detection of specific gases is paramount, ensuring safety and prompt response in the presence of hazardous substances.

## IV. CONCLUSION & FUTURE SCOPE

The integration of Internet of Things (IoT) and cloud technologies holds significant potential for enhancing the efficiency, accuracy, and scalability of gas leakage detection systems. This synergistic approach enables real-time monitoring, data analysis, and rapid response to gas leaks. Cloud-based computing and storage facilitate effective data management, incorporating advanced analytics and machine learning algorithms to elevate overall system performance. However, it is crucial to underscore the imperative need for addressing privacy and security concerns associated with the implementation of cloud-based gas leak detection technologies. Future research endeavours should prioritize the development of comprehensive plans to effectively resolve these issues, ensuring the security and safety of these systems.

Drawing insights from the literature review, the recommendation is to implement a gas leakage detection system leveraging IoT and cloud technologies. This comprehensive system should encompass the integration of a GPS module to precisely identify gas leak locations, utilizing cloud-based storage for efficient sensor data management.

Additionally, the inclusion of a smoke sensor for detecting smoke leakage, along with components such as a GSM module, Arduino microcontroller, fire sensor, and MQ 2 Gas sensor, is essential for ensuring optimal system performance.

In conclusion, the potential for revolutionizing gas leakage detection procedures is substantial through the integrationof IoT and cloud technologies, ensuring the safety and security of gas detection systems. The proposed gas leakage detection system, incorporating IoT and cloud technologies, serves as a promising foundation for future research and development efforts in this field

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