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Procedia Computer Science 235 (2024) 961–969

Procedia Computer Science

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International Conference on Machine Learning and Data Engineering (ICMLDE 2023)

# Enhancing Gas Leak Detection with IoT Technology: An Innovative Approach

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**Abstract**

The presence of a natural gas leak within a household carries the potential for fires and poses a risk of natural gas poisoning. Similar to how we approach other hazardous energy sources such as electricity and gasoline, it is crucial to exercise caution when dealing with natural gas exposure. To prevent potential hazards and dangerous situation, identified a smart gas detection system for rapid and accurate detection of gas leaks. The proposed gas leakage detection system combines advanced sensor technology, real-time monitoring, and automated alert mechanisms to ensure timely identification and response to gas leaks.The MQ2 sensor helps in detection of gas leakage. The MQ2 sensor possesses the capability to detect a wide range of gases, including methane, propane, carbon monoxide, and hydrogen. This versatility makes it an invaluable tool in ensuring safety and protecting against potential hazards and early identification of gas leaks. The collected data is analyzed using sophisticated algorithms to distinguish between normal background gas levels and potential leaks. NodeMCU, equipped with its Wi-Fi capabilities, functions as the central control unit of the system. The NodeMCU gathers real-time data from the gas sensors, constantly monitoring gas levels. It processes this data and sends it to the cloud or a central server using its internet connection.The system's ability to monitor in real-time ensures that any gas leaks detected are quickly reported to the relevant personnel or authorities through automated alerts. The fast notification system allows for quick actions, reducing the risks of accidents, saving lives, preventing property damage, and mitigating harm to the environment.



*Keywords:*
MQ2 Sensor; NodeMCU; Data Logging and Analytics; Real-time Alerts

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1877-0509 
10.1016/j.procs.2024.04.091

## 1. Introduction

Gas leakage is a significant concern across industrial, commercial, and residential settings due to its potential to cause accidents, property damage, and environmental harm[9]. Traditional methods of gas leak detection have limitations in terms of efficiency, speed, and coverage. However, recent advancements in sensor technology, data analytics, and wireless communication have paved the way for the development of innovative solutions in the form of Smart Gas Leakage Detection systems [14].

A proactive and intelligent approach to gas leak detection and prevention is created by smart gas leakage detection systems, which combine cutting-edge technologies [2]. These systems use a network of sensors that are capable of detecting a wide variety of gases, providing continuous monitoring of gas levels in varied situations. The data collected from these sensors are transmitted wirelessly to a central control unit, where sophisticated algorithms process and analyze the information in real-time. This real-time analysis allows for rapid response and immediate alerts in case of gas leaks [7].

In this proposed work various components and technologies that constitute smart gas leakage detection systems which explore the types of sensors used, the communication protocols employed, and the algorithms developed to interpret sensor data. Furthermore, it discuss the benefits of these systems, including improved safety measures, reduced response times, and enhanced environmental protection. Through an exploration of case studies and real-time applications, it targets to showcase the practical effectiveness and potential of smart gas leakage detection systems in diverse settings. The IoT features connectivity, which is internet connectivity over hardware to system controls. things, which are any object connected to the internet and data, which is gathered from sensors or other electronic devices.The work followed by developing an application that allows us to access the specifics or information about the alert and can be utilised on either a mobile device or a web browser. Therefore, after the alert is generated, we can quickly visit the application and review the alert's further details, such as the gas intensity, sensor reading.

The remaining section of the paper will be structured as follows: Section 2 presents the related literature, Section 3 resents the proposed methodology and outcomes and discussion are deliberated in Section 4. The study is concluded in Section 5.

## 2. Background

A comprehensive review of the literature on IoT-based smart gas leakage detection and alert systems reveals the growing significance of advanced technologies in ensuring safety and efficiency in various sectors. The integration of IoT into gas leakage detection systems has garnered considerable attention due to its potential to provide real-time monitoring, early detection, and swift alert mechanisms.

Several studies have explored different aspects of IoT-enabled gas leakage detection systems. Research by authors [1], [16], and [5] introduced a wireless sensor network for gas leak detection, utilizing nodes to collect data from various points and transmit it to a central control unit for analysis. These systems employed different gas sensors and communication protocols to establish a reliable network.

In addition to wireless sensor networks, other works have delved into the utilization of IoT platforms to enhance gas leak detection efficiency. Research conducted by [6] and [15] utilized cloud-based IoT solutions to process and analyze gas sensor data, allowing for remote monitoring and immediate alert notifications. This approach offers scalability, remote accessibility, and data analytics capabilities.

Moreover, various studies have investigated the incorporation of machine learning [4, 13] and artificial intelligence techniques [3, 12] into IoT-based gas leakage detection systems. [11] and [8] proposed predictive modeling approaches that utilize historical data to predict potential leakages and preemptively trigger alerts. These systems aim to enhance the accuracy and reliability of detection mechanisms.

Furthermore, IoT-based gas leakage detection systems have demonstrated applicability in different contexts. In industrial environments, [10] and [17] proposed solutions that integrated gas leakage detection with other safety measures, such as emergency shutdown systems. This integration ensures a comprehensive safety approach for hazardous settings.

Overall, the literature reveals a growing interest in leveraging IoT technologies to create intelligent gas leakage detection systems. These systems offer benefits such as real-time monitoring, early detection, remote accessibility,

and predictive analytics. However, challenges such as sensor calibration, data accuracy, and communication reliability still require careful consideration for the successful implementation of IoT-based smart gas leakage detection and alert systems.

## 3. Proposed system

Serious threats like fire, explosions, and health problems are presented by gas leaks. Traditional gas detection techniques frequently lack centralised alerting systems and real-time monitoring. The suggested solution overcomes these constraints by improving the effectiveness of gas leak detection, visualisation, and reaction through the use of contemporary sensor technologies and web-based applications. A major safety hazard in many industrial, commercial, and residential environments is gas leakage. To avoid potential dangers and guarantee the security of people and property, quick and accurate gas leak detection is crucial.

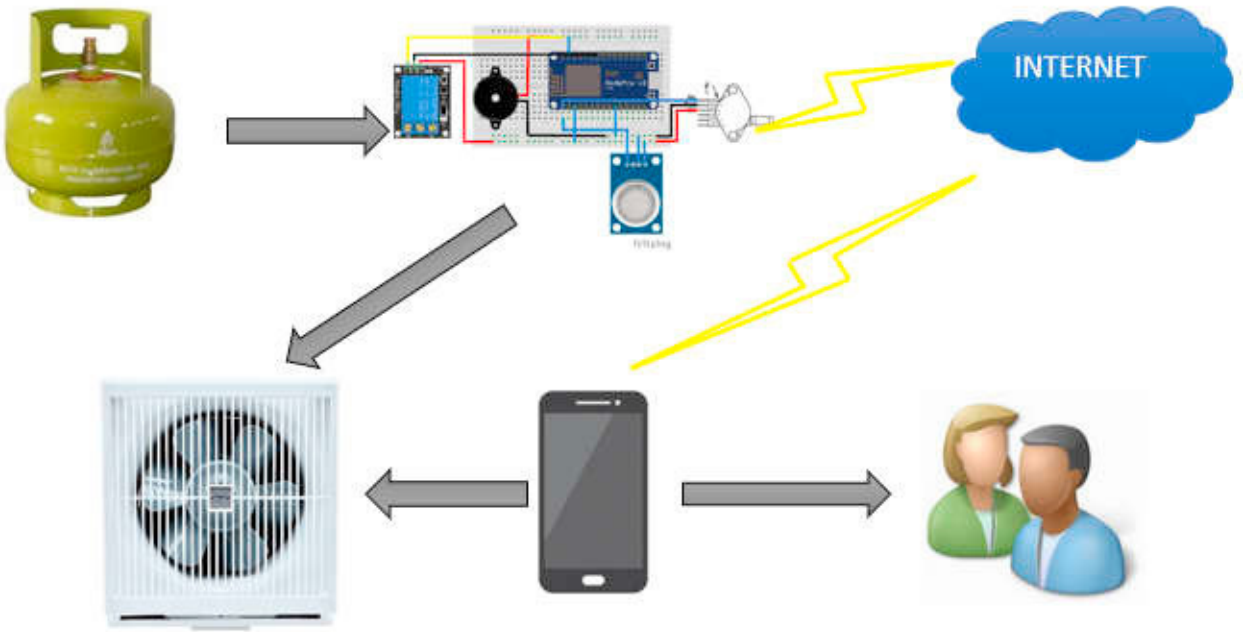


Fig. 1. proposed system architecture

An inventive option that can assist in detecting and informing consumers about gas leaks in real-time is a smart gas leakage detection and alert system using the Internet of Things. Here, we're introducing an alert system that works with the Internet of Things and sends notifications to the user's device.It is a pretty creative strategy. Moreover, we are integrating a web feature program that allows users to access a real-time data base to view data in real time application.

The data processing part in gas leakage detection using IoT plays a critical role in transforming raw sensor data into actionable information. It involves several steps to ensure that the collected data is analyzed, interpreted, and presented effectively. Here's an overview of the data processing steps:

- Data Acquisition:Gather data from gas sensors placed in the monitored area. Collect sensor readings, which may include gas concentration levels, timestamps, and sensor identifiers.
- Data Preprocessing:Clean and preprocess the raw data to handle anomalies, missing values, or outliers. Apply data filtering techniques to remove noise from sensor readings. Align and synchronize data from multiple sensors if necessary.

- Real-time Analysis:Implement real-time analysis algorithms to detect sudden spikes or trends in gas concentration that may indicate a rapidly developing gas leak. Use machine learning or pattern recognition techniques to identify abnormal patterns in the data.
- Alert Generation:Trigger immediate alerts (e.g., push notifications, emails, SMS) when gas levels exceed predefined thresholds or when abnormal patterns are detected. Include relevant information in alerts, such as the sensor location and gas concentration levels.

The data processing part is crucial for timely detection of gas leaks, providing valuable insights, and ensuring the overall effectiveness of the gas leakage detection system. Regular monitoring and optimization of data processing workflows are essential to maintain system reliability and accuracy.The gas sensor initially receives data and monitors it for any readings that surpass a predefined threshold value. When this threshold is exceeded, the sensor transmits the data to the cloud infrastructure, where it undergoes processing. Subsequently, an alarm is generated and relayed to the user's application for notification.Meanwhile, the real-time sensor data is consistently stored within a dedicated database. In tandem, a web application has been developed that harnesses this database as its backend. This design allows users to seamlessly access the real-time data and the accompanying log of events.

### *3.1. Hardware specification*

The hardware specifications of a gas leakage detection system can vary based on factors such as the scope of the system, the types of gases being detected, the intended environment (industrial, residential, commercial), and the desired level of accuracy and connectivity. Here's a general outline of the hardware components that could be part of a gas leakage detection system:

- Gas Sensors:Gas sensors are the core components responsible for detecting and measuring gas concentrations. Different sensors are designed to detect specific types of gases. Common types of gas sensors include:
- Methane (CH4) Sensor: Detects methane gas, commonly used for detecting natural gas leaks. Propane (C3H8) Sensor: Detects propane gas, often used in residential and commercial environments.
- Carbon Monoxide (CO) Sensor: Detects carbon monoxide gas, which is produced by incomplete combustion and poses a serious health risk.
- MQ2 sensor: The MQ-2 sensor is a popular type of gas sensor module used for detecting a range of gases in the environment. It's widely used for gas leakage detection and is often used in applications like fire detection systems, gas leak alarms, and indoor air quality monitoring. The sensor is relatively inexpensive and is available as a small module that can be easily interfaced with microcontrollers or microprocessors.
- Communication Module: The communication module enables the gas leakage detection system to send data and receive commands. Depending on the application, this module can support various communication protocols: Wi-Fi: Allows the system to connect to local networks and the internet for remote monitoring. Cellular: Enables remote monitoring in areas without Wi-Fi coverage. Ethernet: Provides a wired network connection option. Bluetooth or Zigbee: For short-range communication with local devices.
- Power Supply: A reliable power supply is essential for continuous operation. Options include: Battery: Provides mobility and is suitable for remote locations. AC Power: Offers continuous power, usually in indoor or fixed installations. Solar Power: Suitable for remote locations where consistent sunlight is available.
- User Interface: For local monitoring and configuration, some systems may have a basic display and buttons. However, in a web-based application setup, the user interface is primarily software-based and accessed through computers or mobile devices.

### *3.2. System Architecure*

The gas leakage detection system consists of three main components:

- Gas Sensors: Distributed IoT-based gas sensors are strategically placed in the monitored area to detect various gases such as methane, propane, and carbon monoxide.

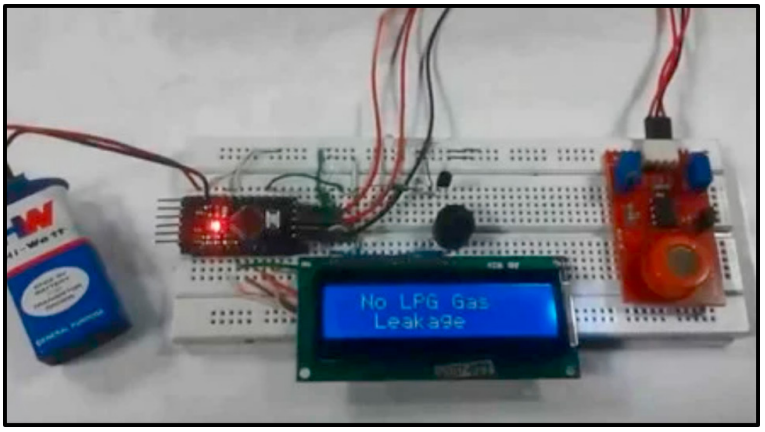


Fig. 2. Working model

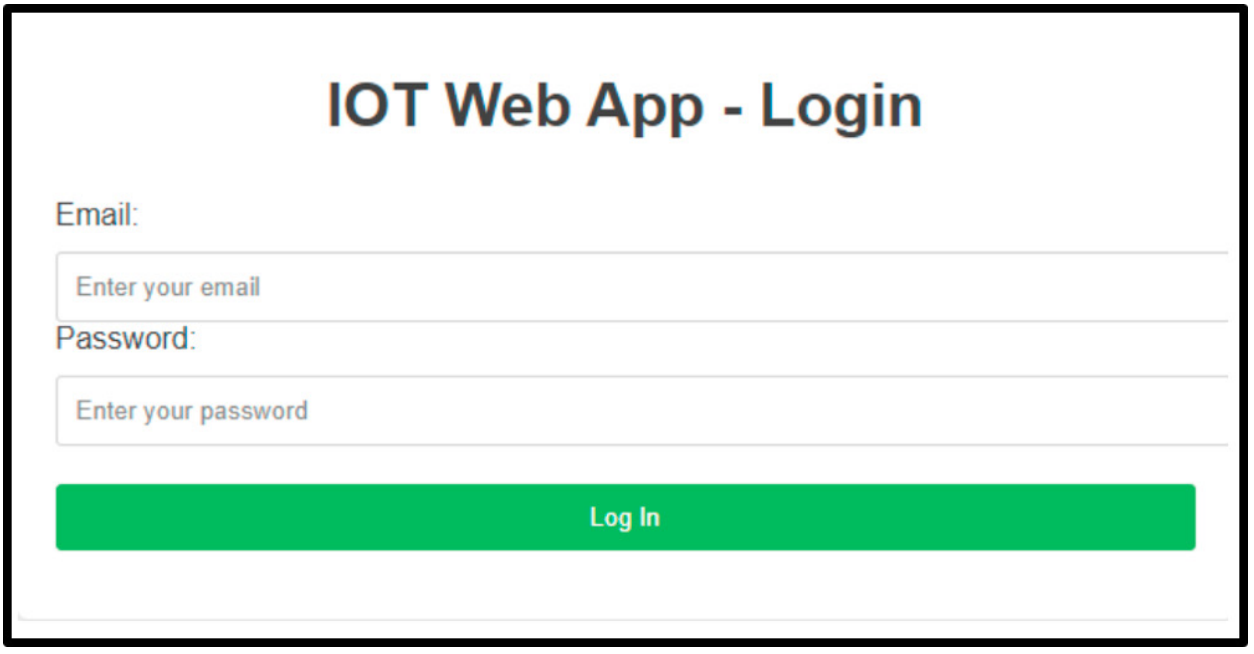


Fig. 3. Web application

- Data Processing Unit: The collected data from sensors are processed in real-time to detect anomalies and potential gas leaks.
- Web Application: A user-friendly web interface allows users to monitor gas levels, receive alerts, and manage system settings remotely.
  In Figure 1 shows the proposed architecture of working model.

### 3.3. *Key features*

- Gas Leak Detection: The system is equipped with gas sensors that can detect the presence of gases such as methane, propane, or carbon monoxide. It can accurately identify gas leaks in real-time.

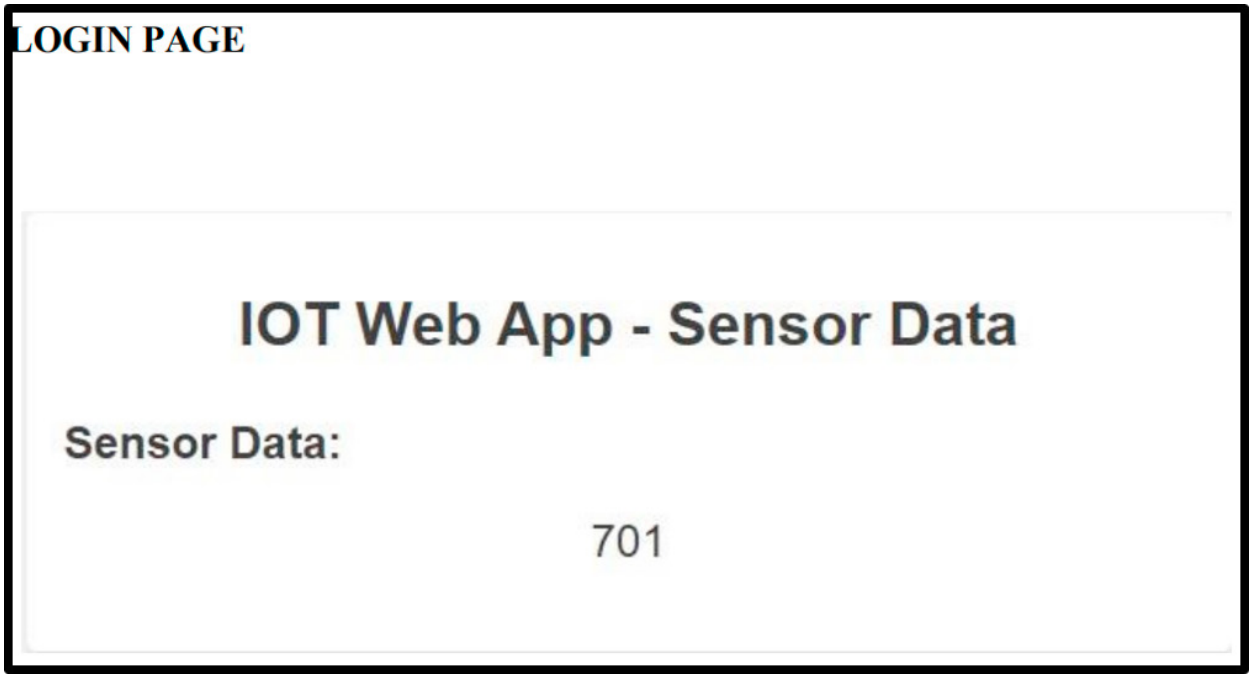


Fig. 4. Data page

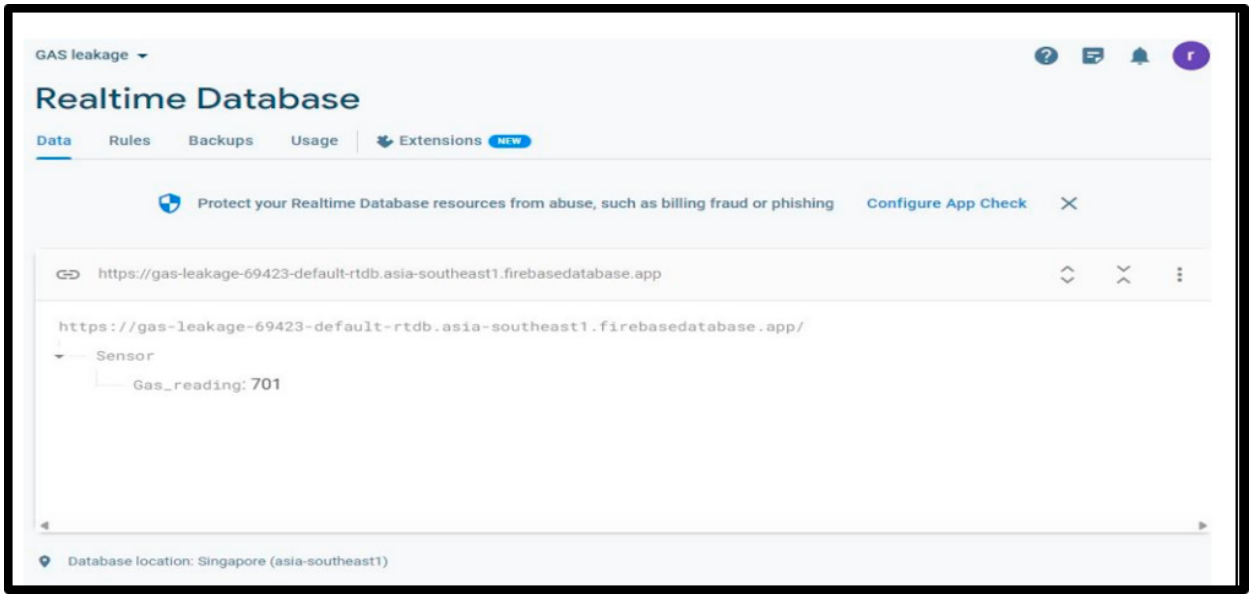


Fig. 5. Real time database

- Real-time Alerts: When a gas leak is detected, the system generates immediate alerts to notify relevant individuals or stakeholders. Alerts can be sent via mobile push notifications, SMS, email, or automated phone calls, ensuring timely response to potential hazards.
- Remote Monitoring: Users can remotely monitor the status of the gas detection system through a user interface, such as a mobile app or web portal. This enables them to stay updated on the system's functionality and receive alerts even when they are not physically present at the location.

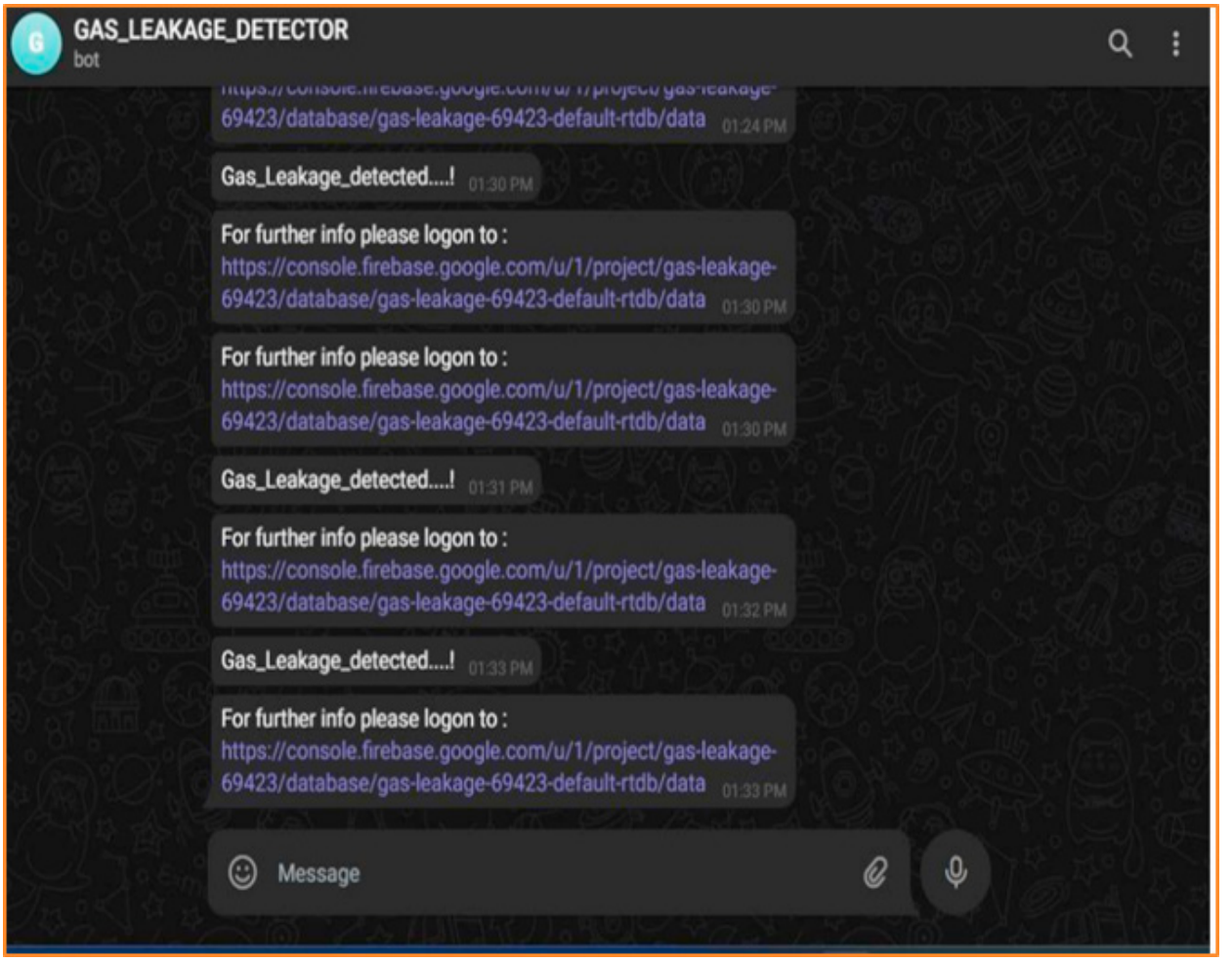


Fig. 6. Alert messages

- Data Logging and Analytics: The system captures and logs data related to gas leak events, including timestamps, gas concentrations, and other relevant information. This data can be analyzed and used fortrend analysis, pattern recognition, and performance evaluation.
- Integration with Automation Systems: The gas leakage detection system can be integrated with other automation systems in the buildingor home. For example, it can trigger actions such as automatically shutting off the gas supply, activating ventilation systems, or notifying emergency services
- User-Friendly Interface: The system provides a user-friendly interface, typically through a mobile app or web portal, where users can easily configure system settings, view real-time data, access historical records, and manage notifications and alerts.

## 4. Results and Discussions

In summary, gas leakage detection systems provide various results and descriptions that help users monitor gas concentrations, detect leaks, and respond quickly to potential hazards. Accurate readings, timely alerts, historical data, and remote access are key components of these systems, contributing to enhanced safety and preventive measures.

The type of gas being detected, the environment in which the system is deployed, the amount of sensitivity and accuracy of the sensors, and the individual gas detection system being utilised can all affect the results and descriptions of gas leakage detection. The following are some broad explanations and possible effects of gas leakage detection:

- Detection Accuracy: Gas leakage detection systems aim to accurately identify the presence and concentration of target gases. The accuracy of detection is crucial to prevent false alarms or missing actual gas leaks. High-quality sensors with proper calibration contribute to accurate results.
- Gas Concentration Measurements: Gas detection systems provide measurements of gas concentrations in terms of parts per million (ppm) or percentage of the Lower Explosive Limit (LEL) for flammable gases. These measurements give an indication of the severity of the gas leak.
- Early Alert and Alarm Generation: When gas concentrations exceed predefined thresholds, the system generates alerts and alarms. These alerts can be in the form of visual indicators, audible alarms, or notifications sent to a monitoring station, mobile device, or web application.
- Monitoring and Visualization: Gas detection systems often include monitoring and visualization tools. Users can see real-time gas concentration levels on displays, graphs, or web interfaces. Historical data logging and visualization help identify patterns and trends.

In Fig 2 shows the real time working model of proposed architecture.

In the experiment all the required apparatus were properly connected as shown in the figure. When the gas leakage happens it will give alerts through web application and real time database.

In any circumstances if any leakage happens an alert will be sent through some platform through some alert sounds and web links. In Fig 6 shows some alert kind of messages when gas leakage goes beyond some threshold limit. By clicking the web link it will navigate to real time database web page as shown in Fig 3

## 5. Conclusion

The creation and deployment of a gas leakage detection system stand as a critical endeavor, holding utmost significance in guaranteeing safety and averting possible dangers across diverse settings. In a world where gas leaks can result in catastrophic outcomes, the gas leakage detection system established in this project presents an indispensable safeguard. Its capacity to offer early detection, continuous real-time monitoring, and automated alert mechanisms endows individuals and institutions with the capability to promptly and resolutely address potential gas leak incidents. The primary objective of this endeavor was to respond to the pressing requirement for early and precise gas leak detection, thus reducing potential threats to human lives, property, and the environment. The system effectively fulfilled its goals by conducting a thorough examination of existing technologies and methodologies.Key to the system's success were its real-time communication channels, encompassing SMS notifications, email alerts, and mobile applications. These channels played an essential role in ensuring that timely alerts reached the pertinent stakeholders, including homeowners, facility managers, and emergency response teams.Ultimately, the gas leakage detection system represents a significant step forward in ensuring a safer and more secure future for various industries and households alike.

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