IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, December 2024

A Review on Gas Leakage Detection and Alert System

Shailesh[1], Rahul U[2], Prathik Khed[3], Siddu N Dhannoor[4], Mrs. Vijetha T S[5]
Department of Electronics and Communication Engineering[1–5]
Alva's Institute of Engineering and Technology, Mijar, Moodbidri, Karnataka, India
poojaryshailesh74@gmail.com, rahulpoojari120@gmail.com,
pratikkhed7975@gmail.com, siddudhannoor@gmail.com, tsvijetha@aiet.org.in

Abstract: *Gas leakage is a serious concern with regard to safety; it may cause severe accidents such as explosions, injury, and property damage. A number of studies are carried out on the detection and mitigation of gas leakage risks by using modern technology. Such systems are capable of giving early warnings using features such as real-time alerts, audible alarms, and visual indicators. The most recent designs are automated systems designed to control gas flow during emergencies and integrate smart technology to monitor continuously. They are safer because they quickly respond, reduce the risk of accidents, and offer the user with reliable solutions suited for residential and industrial application*

Keywords: Gas leakage

I. INTRODUCTION

Gas leakage detection systems are essential for preventing accidents in residential and industrial settings. Modern systems utilize microcontrollers like Arduino, combined with sensors and actuators, to respond automatically to gas leaks. These systems detect gas using sensors, close valves automatically, and alert users through buzzers and GSM modules. Additional features, such as temperature sensors and PIR sensors for human presence detection, enhance functionality and safety. Backup power supplies are also integrated to ensure the system remains operational during power outages[2].

The application of IoT in home automation has further expanded the possibilities for safety systems. IoT-enabled devices, such as those utilizing Wi-Fi chipsets like ESP8266, allow for remote monitoring and control of appliances. This technology enhances convenience, particularly for individuals requiring assistance, by automating household devices. Such systems can monitor and control gas appliances, reducing the risks of leaks and providing users with greater flexibility and peace of mind [3].

The MQ-6 sensor is widely used in gas detection due to its sensitivity to various gases, including LPG, butane, and smoke. It functions by altering conductivity based on gas concentration, enabling precise leak detection. Once a leak is detected, the sensor signals a microcontroller to activate safety mechanisms like buzzers, exhaust fans, and motorized valve controls. GSM modules are often included to send realtime alerts to users, ensuring swift action. These advancements demonstrate the effectiveness and reliability of modern gas leak detection systems in enhancing safety across multiple environments [5].

II. LITERATURE SURVEY

Most of the gas leakage detection systems use various sensors, microcontrollers, and alerting mechanisms to ensure safety. These components work in harmony to detect the leak, process the data, and provide timely alerts to users in case of an emergency. The core of a gas leakage detection system is its sensor technology, which detects the presence of harmful gases such as LPG (liquefied petroleum gas).

The methodologies for gas leakage detection vary based on the classification of detection methods. Hardware-based methods include optical sensors, ultrasonic flow meters, and soil-based detection systems. Non-technical methods include chemically infused papers that change color when exposed to gas. Software-based approaches rely on monitoring parameters such as pressure points, flow changes, and digital signal processing to identify anomalies.

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.53

Volume 4, Issue 3, December 2024

The MQ series of gas sensors, for example, MQ-6, MQ2, and MQ-135, are some of the commonly used sensors for this purpose. These sensors are sensitive to a wide range of gases, including butane, propane, methane, and smoke. These sensors generally comprise a semiconductor material, such as SnO_2, whose electrical conductivity changes in the presence of gas molecules. The higher the concentration of gas, the higher the conductivity, which is measured and processed by the microcontroller [1]. The sensors are often interfaced with the microcontroller (e.g., Arduino or Atmega) to trigger appropriate responses when a certain threshold of gas concentration is detected.

Another critical sensor applied in some systems is the temperature sensor, used to monitor ambient conditions that may lead to gas leakage or potential fire hazards. Temperature sensors, such as the LM-35, provide real-time temperature data to the microcontroller that can be used to detect abnormal conditions that may point to a gas leak or fire risk [2]. Besides gas and temperature sensors, presence sensors like Passive Infrared (PIR) sensors may be included in these systems to detect human presence in places where gas leakage is likely to happen, like in kitchens. This is crucial because the system should respond dynamically, for instance, by sounding an alarm or cutting off the gas supply if no one is available to respond to a warning [3].

A gas leakage detection system generally employs a microcontroller for the processing unit. These may be the Arduino Uno or Atmega series. They take inputs from the gas, temperature, and presence sensors and calculate if a dangerous concentration or abnormal condition exists. The microcontroller then initiates appropriate responses based on the programmed logic, such as activating alarm systems or the gas valve. Arduino Uno is a common choice, for example, because it has an easy-touse interface and is easy to program, making it one of the most popular tools for building prototype systems in research or home safety applications. These systems are very valued for their ability to prevent potentially catastrophic gas leaks, protecting property and lives. The affordability and availability of Arduino microcontrollers also make them accessible to hobbyists and professionals alike, further promoting their use in innovative safety solutions.

The microcontroller continuously monitors sensor inputs to ensure that any deviation from normal levels is addressed promptly, thereby enhancing the overall safety and reliability of the system. Integration with other components, such as GSM modules for sending alerts via SMS, further extends the functionality of these systems, allowing for real-time notification and remote monitoring. [4]

Once a gas leak is detected, it is important to alert the users as soon as possible. Modern gas detection systems incorporate a variety of alert systems, each with a different function to ensure that users are alerted effectively.

In many gas leakage detection systems, a buzzer is utilized to provide an audible alarm when gas is detected. It always sounds an alarm whenever the gas concentration exceeds a predefined threshold, alerting the users within the vicinity of a potential hazard. In many cases, LED indicators are used to visually signal the system's status. For instance, a green LED can indicate normal conditions, but a red LED can indicate the presence of gas. This dual alert system has both audible and visual alerts, which will ensure that the warning is noticeable from a distance [5].

An LCD display is often used for displaying specific information related to the detected gas leak. For example, it will display gas concentration levels or the status of the system. The most common one is a 2x16 character LCD, displaying a clear and concise message such as "Gas Leak Detected" or "Safe." This is useful for users needing immediate and visible confirmation of the system's status [1].

This module of GSM module integrates with the system and sends SMS alerts to the user or emergency contacts in case of a gas leak. The GSM module connects with the microcontroller, and when a gas leak is detected, it sends a pre-programmed SMS to the user's mobile phone, notifying them of the emergency. This far-flung alert system means that users are informed of the leak even if they are not physically present in the area of the leak [2].

The gas leakage detection devices include servo motors for self-automatic shutting off the valves from the gas source. In such systems, efforts are made to ensure zero or negligible leakage risks, thus automatically cutting off gas supplies upon detection of hazards. The microcontroller regulates the servo motor to take control when a leakage condition has been confirmed [5].

Besides closing the gas valve, other systems are fitted with exhaust fans that will start working once the gas leak is sensed. The fan disperses the leaked gas and prevents it from settling in the area, further reducing the chances of explosion or suffocation [6].

In recent advancements, IoT-based systems have been implemented in gas leakage detection to enhance functionality and provide remote access. These systems allow the gas detection data to be transmitted wirelessly to a central server or cloud storage, enabling users to monitor the status of the system from anywhere. IoT integration also allows for realtime data analysis and automated actions based on predefined rules. For example, when the system detects a leakage, it can automatically forward notices through a mobile app or web platform. This will make the gas detection system more responsive and accessible as it will be a much more effective and friendly-to-use system [4].

III. ANALYSIS OF EXISTING APPROACHES

The review of methodologies applied in gas leakage detection systems shows great improvements and diversity in their design and performance. Gas sensors such as the MQ series, including MQ-6, MQ-2, and MQ-135, are the backbone of these systems because of their high sensitivity to LPG, methane, propane, and other harmful gases [1]. The semiconductor-based technology in the sensor enables the accurate determination of gas concentrations, although environmental factors such as temperature, humidity, and composition may affect the performance of these sensors. Research has shown that despite the rapid detection observed for these sensors under ideal conditions, their sensitivity may degrade under moist conditions, requiring calibration for consistent accuracy [3].

Complementary to gas sensors, temperature sensors like LM-35 play a critical role in monitoring environmental conditions that could lead to or exacerbate gas-related hazards [2]. For instance, a rise in ambient temperature may indicate potential fire risks or accelerated gas leakage. Systems that incorporate temperature sensors alongside gas sensors exhibit enhanced reliability by addressing multifactorial risks. Additionally, PIR (Passive Infrared) sensors have been integrated in some setups to detect human presence, which aids in prioritizing safety responses, such as triggering alarms or shutting off gas supply only in occupied areas [8]. This approach minimizes unnecessary disruptions while ensuring effective responses during critical situations.

Microcontrollers, such as Arduino Uno and Atmega series, have proven to have efficient processing, acting as the central units that collect, analyze, and respond to sensor data. Arduino Uno’s flexibility and ease of programming make it a popular choice for prototyping and educational purposes. However, variations in microcontroller capabilities impact system scalability and response time. For example, industrial-type systems need more advanced microcontrollers or microprocessors in order to be able to manage a complex array of sensors, which will facilitate smooth IoT integration. Systems employing such high-performance controllers provide improved data processing speed and reliability.

Alert mechanisms show diverse efficiency based on their application. Buzzer and LED indicators remain fundamental for instantaneous and local alerts, offering both auditory and visual alerts [5]. However, the reliance on these localized systems can become a drawback when users are not in proximity to the detection system. GSM modules overcome this by transmitting alerts via SMS to remote users, thus notifying users regardless of their location [2]. The functionality has been most beneficial in residential and industrial environments where immediate on-site action is not always possible.

Automation within these systems has also been a critical factor in mitigating risks. Servo motors are increasingly being integrated to automate the closing of gas valves, which is a proactive measure to halt gas leakage at its source [5]. Systems that combine servo motors with real-time monitoring significantly reduce the potential for explosions or prolonged exposure to harmful gases. For example, the addition of exhaust fans provides an additional security aspect as it will help scatter leaked gases hence prevent accumulation and risks [6]. The self-automatic responses clearly prove their advantage over human intervention with less reaction time and no dependence on humans.

TThis new generation of smart gas leakage detection systems has been introduced by the advent of IoT integration. With IoT-enabled systems, data can be transmitted in realtime to cloud platforms, allowing users to monitor system status remotely using mobile applications or web interfaces [7]. These systems also allow for predictive analytics, wherein patterns in sensor data can be used to identify potential risks before they escalate. However, data security, network reliability, and complexity in the system must be overcome to fully exploit this potential of IoT in the said domain.

A comparative analysis of these systems reveals several trends and patterns. Systems with a combination of gas, temperature, and presence sensors are often superior to those using single sensor configurations in terms of precision and reliability [3]. Additionally, systems equipped with remote alert mechanisms like GSM modules or IoT integration provide better coverage and response as compared to standalone alarms [8]. This indicates how the variations in the system's design, such as what type of microcontroller and sensor array, impact its overall efficiency and scalability but shows that the application's demand is a reason for special solutions.

IV. CONCLUSION

Gas leakage detection systems have advanced significantly by integrating gas sensors, temperature sensors, and microcontrollers to detect leaks in a timely and accurate manner. The use of MQ series sensors along with Arduino Uno has proven to be effective for the real-time processing of data and activation of response mechanisms. Alert mechanisms such as buzzers and LED indicators ensure immediate notification, while GSM modules and IoT integration further extend the reach of the system with remote monitoring capabilities. It comes with automated features, which include servo motorcontrolled gas valves and exhaust fans to reduce the risks of accumulation of gas or prolonged exposure.

These advances notwithstanding, challenges such as environmental sensitivity of sensors, false alarm rates, and cybersecurity concerns in IoT-based systems are some of the challenges that still persist. Future improvements should enhance sensor reliability, leverage predictive analytics through machine learning, and simplify system designs for greater scalability. Addressing these challenges will further solidify the role of gas leakage detection systems as vital tools for ensuring safety in residential, commercial, and industrial applications.

REFERENCES

[1]. R. K. Dwibedi, V. Vanitha, S. R. D., P. PhaniSai, and G. Yeshwanth, ”Automatic Gas Leakage Detection using IOT,” IOP Conf. Ser.: Mater. Sci. Eng., vol. 981, p. 042085, 2020.

[2]. Siddika and I. Hossain, ”LPG Gas Leakage Monitoring and Alert System using Arduino,” Int. J. Sci. Res. (IJSR), vol. 2319-7064, 2020.

[3]. V. Priya. R and K. G., ”Detecting LPG Leakage and Automatic Turn off using Arduino Connected with PIR Sensor,” J. Phys.: Conf. Ser., vol. 1717, p. 012043.

[4]. S. L. Lavanya, M. D. V. Prasad, A. Sravya, Ch. D. Prasad, A. Seshadri, and R. K. S. Kumar, ”Gas Leakage Detector Using Arduino,” Int. Res. J. Eng. Technol. (IRJET), vol. 10, Special Issue, pp. 2395-0056, Apr. 2023.

[5]. V. Yadav, A. Shukla, S. Bandra, V. Kumar, U. Ansari, and S. Khanna, ”A Review on Microcontroller Based LPG Gas Leakage Detector,” J. VLSI Des. Signal Process., vol. 2, no. 3.

[6]. T. Babua, R. R. Naira, K. Sb, and V. Mc, ”Enhancing Gas Leak Detection with IoT Technology: An Innovative Approach,” presented at the International Conference on Machine Learning and Data Engineering (ICMLDE), Nitte University, Mangalore, India, 2023.

[7]. N. Evalina and H. A. Azis, ”Implementation and design gas leakage detection system using ATMega8 microcontroller,” IOP Conf. Ser.: Mater. Sci. Eng., vol. 821, p. 012049, 2020, presented at the 2019 3rd International Conference on Engineering and Applied Technology (ICEAT).

[8]. M. L. Sree, I. S., P. A., and P. G., Sensor-Based Gas Leakage Detector System, Bachelor of Engineering Thesis, Dept. of Electrical and Electronics Engineering, School of Electrical and Electronics Engineering, Sathyabama Institute of Science and Technology, 2020