A Gas Leakage Detector Using IoT

[1]Suresh Kumar R, [2]Blesson Smith R, [3]Hariharan A and [4]Subash R
Department of Mechanical Engineering,
Sri Eshwar College of Engineering, Coimbatore, India
[1]sureshkumr.r@sece.ac.in

Article Info
S. Venkatesh et al. (eds.), *Emerging Trends in Mechanical Sciences for Sustainable Technologies,* Advances in Intelligent Systems and Technologies,
Doi: https://doi.org/10.53759/aist/978-9914-9946-4-3_25

Abstract – Propane and butane are the two sources extensively in domestic and commercial purposes for various applications ranging from industrial sector to household usages. The usage of these sources mandatorily requires safety precautions to be followed to avoid any hazardous impact. This is due to the gas's volatility and the potential for leakage, which increases the risk of a detonation or fire. This could be avoided or can be prevented by means of early detection that could sense the leakage of gas in a very simplified version, easily identifiable by all age groups of peoples. This research focuses on a prototype system in the first phase that simulates a gas leak in a confined space. The presence of leaked gas in the confined space is traced by the sensor (MQ 6) which in turn sends the traced signal to Arduino micro controller. The test results show successful detection of gas leakage followed by activation of warning message to the designated number. However, based on performance it is found that the system works efficiently in closed space when compared to open space. In open space due to dilution of gas, the detection of content is slower thereby resulting in time delay. In the second phase, the concept of Internet of Things (IoT) is implemented in this system using various devices that are networked together. The use of internet access allows the sensors to exchange data with one another. This paper concentrates on secure kitchens in IoT-enabled smart homes. A regulator and LPG cooker with knobs that regulate the flow are provided for safety in the home gas connections. Gas leaks can be dangerous, particularly in enclosed spaces. A safety system with a strong ability to identify leaks is necessary in these circumstances.

Keywords – Gas Leakage, Detection, Arduino, IoT

I. INTRODUCTION

In LPG the most recent years, Gas leakage is a significant problem for the business sector, residential regions and gas-powered vehicles such as CNG (Compressed Natural Gas) buses, cars, etc. This system provides information on, for example, how sensors in the project are utilized to find gas leaks and activate the buzzer for hazard signal. A buzzer is an obvious indicator of a gas discharge. Due to the detection of the hazardous gas, the GSM warning transmission is received by the person in charge of it. Using an exhaust fan, the gas is expelled from the chamber. The state of the gas leak is shown on an LCD monitor. LPG plays a significant part in meeting the needs of society due to its LPG usage, which is still prevalent today in 2023. Liquid petroleum gas, or LPG, is produced by increasing pressure and reducing temperature in order to turn gas into liquid. "Indonesia has seen a rise in LPG consumption only about one million metric tonnes annuallynearly hit seven million metric tonnes. For nine years, the amount increased by 700%. According to Ahmad Bambang, Deputy President and Director of PERTAMINA, the government's program to convert BBM to LPG, which has been in place, is to blame for the rise in LPG usage. It provides a HIGH output when LPG, i-butane, propane, methane, alcohol, hydrogen, and smoke gas are found. This module, known simply as "LPG Gas Sensor Module," is very simple to connect with microcontrollers and Arduino.

Advantages

To maintaining a safe and healthy work environment for employees. By continuously monitoring the air quality and alerting workers to potential hazards, they reduce the risk of accidents, occupational illnesses, and long-term health effects associated with exposure to hazardous gases.

Gas detectors provide early warning of the presence of hazardous gases, allowing people to take appropriate action before the gas concentration reaches dangerous levels. This early detection helps prevent accidents, explosions, or exposure to toxic gases.

Gas detectors act as a reliable safety measure, especially in environments where the presence of certain gases is common, such as industrial facilities, laboratories, mines, or confined spaces. They continuously monitor the air quality and provide immediate alerts if gas levels exceed predetermined thresholds, enabling swift evacuation or necessary safety measures.

Gas detectors are crucial for protecting individuals from exposure to toxic gases, which can have severe health effects. Examples of such gases include carbon monoxide (CO), hydrogen sulfide (H2S), ammonia (NH3), and chlorine (Cl2). By triggering an alarm, gas detectors help prevent inhalation of these harmful gases and related health complications.

Real-time Data and Analysis: Many modern gas detectors offer data logging and wireless connectivity features, allowing real-time monitoring of gas levels and data analysis. This data can be used for trend analysis, identifying potential risks, and implementing preventive measures. It also facilitates compliance reporting and maintenance planning.

Application

Gas detectors and alarms are used to detect and alert individuals of the presence of potentially hazardous gases in an environment. They are commonly used in a variety of industries and settings,including:

i) used in industries such as mining, oil and gas, and chemical processing, where workers are exposed to toxic gases such as methane, carbon monoxide, and hydrogen sulfide.
ii) used in homes to detect gas leaks from natural gas, propane, or carbon monoxide. These detectors are often required by building codes in many regions.
iii) used in laboratories to monitor the presence of toxic or flammable gases.
iv) used in the food industry to monitor for the presence of carbon dioxide and other gases in food storage and processing facilities.
v) used by firefighters to detect hazardous gases during fire incidents, helping to keep them safe while they work.

II. LITERATURE SURVEY

A.Mahalingam et.al. [1]suggested a gas leak detector suitable for use in the workplace in the UK. Leakage of natural gas is a major safety issue in homes, businesses, and vehicles that use gas as an energy source. Installing a gas leakage detector in potentially hazardous areas is one precaution that can be taken to avoid harm from gas leaks. The purpose of this paper is to detail the creation of a reasonably priced automatic alarming system that can detect the leakage of liquefied petroleum gas in a variety of settings.K Padma Priya et al. [2]presented an embedded system for Gas Cylinder upkeep; the system has three primary components: a GSM/PIC module for communication; a leakage detecting module; and a protection circuitry module. The gas leak is detected by the module and an SMS is sent to the user via GSM. With the GSM module, you may notify others of a possible gas leak and even book a refill cylinder or set the gadget to do it automatically through text message.

Sunithaa.J et al. [3]created a wireless LPG leak monitoring device for family protection. The suggested system is able to detect LPG leaking, send a GSM alert to the consumer, and activate the exhaust fan. The total weight might serve as a rough indicator of consumption with this technique. The system triggers an alarm and simultaneously notifies the specified mobile phones whenever it detects a rise in LPG leakage concentration. Signals activate the fan to vent the gas and close the LPG safe valve on the cylinder to stop any further leaks. The gadget guarantees security and eliminates the risk of explosion.Jolhe et al. [4]developed a microcontroller-based system for detecting LPG leaks using a gas sensor (MQ6). This system also features an alert unit, which may either sound an alarm or flash a light when a leak is detected. The sensor is highly sensitive, has a short response time, and doesn't break the bank. In the event of a leak, a GSM-based text message is automatically delivered to the user or a designated family member. The LCD screen displays the measured weight of the LPG cylinder. When the cylinder's gas level drops to or below 10 kilograms, it automatically sends a text message to the distributor requesting a replacement. When the cylinder's weight drops to or equals 0.5 kilos, the user is notified by text message that it is time to refill the cylinder.

N Evalina [5]provided a framework for developing and deploying gas leak detection infrastructure. The primary goal of this project was to use an LPG gas sensor and micro-controller to create a leakage detector for the gas LPG. It improved safety measures by introducing a mechanism that sends out a signal at the first hint of gas. The early warning alarm of the system will activate if there is a gas leak, and the system will emit a signal of alert or buzzer if the gas is odorized as LPG. The MQ-6 is the go-to gas sensor for spotting leaking LPG since its presence triggers the sensors to activate.M. T. Chughtai [6]developed an IoT-based industrial monitoring system. Information gathered by the gas sensor (MQ-5) is uploaded to a cloud storage system. The sensor is able to detect gas leaks in the majority of environmental settings. An Arduino (UNO-1) serves as the setup's brain, controlling all the other parts. As soon as the sensor detects a gas leak, an audible alarm will sound. An LCD displays the area of gas leakage, notifies an observer, and triggers the exhaust fan in that area to remove the noxious gas. A gas detection system is necessary because it can keep an eye on things and stop gas from leaking, cutting down on the risk of explosions and fires.

SivaprasadLebaka [7] developed a model that included an alarm and a buzzer to alert the user whenever a gas leakage occurs. The model incorporated gas sensors, including the detection of smoke, LPG, and toxic gases. The MQ-2 Sensor was used for detecting a gas leak in commercial or residential buildings, and if leakage is sensed it will notify the Arduino UNO. The LCD, exhaust fan, and buzzer are all activated by the Arduino UNO. After powering on the GSM modem, it will keep sending SMS messages to the cellphone number specified in the program's source code, thereby warning those in danger. Thus, this technology can save lives and property by lowering the number of incidents caused by gas leaks.Developments in IoT-based industrial monitoring system architecture has paved for smart systems enhancing the quality ensured safety systems. The MQ-135 sensor, which can detect gas leaks in all weather, was used to

create a gas leakage monitoring system by Deepthi Miriyampalli et. al [8]. All of the system's components are interfaced with the Raspberry pi, making it a central component in this setup. This allows the viewer to see the shifts regardless of where they are located on Earth.

Jinesha Sharma et. al. [9] introduced an Arduino-based LPG gas leak detector capable of sensing the presence of potentially dangerous leaking LPG gas. This system's best feature is that it can be utilized in any setting without fear of harm. Industries, homes, restaurants, gas stations, automobiles, storage tanks, etc. can all benefit from the usage of gas sensors. When a gas leak is detected, an alarm circuit is activated, and a buzzer sounds to notify the operators. Smart buildings and factories are a primary goal of this IOT model's introduction.

This paper details an Arduino-based system for detecting LPG leaks [10], complete with an audible alarm. In addition to sounding an alert, the model take measures to mitigate the danger posed by the gas leak. In order to detect any LPG leaks that are larger than average, will be turned off instantly. The inhabitants can be protected from the gas leakage. The anticipated work will set off the siren.

III. METHODOLOGY

Clearly identify the purpose and requirements of the gas detector alarm system. Determine the target gases to be detected, the detection range, sensitivity levels, response time, environmental conditions, power source, and any specific regulations or standards to be met.Select the appropriate gas sensors based on the target gases and application requirements. Common types of gas sensors include electrochemical sensors, semiconductor sensors, infrared sensors, and PID (photoionization detector) sensors. Consider factors such as sensitivity, selectivity, stability, and response time of the sensors.Design the overall gas detector alarm system architecture. This includes the selection of suitable components such as microcontrollers, signal conditioning circuits, power management modules, and communication interfaces. Determine whether the system will be portable, fixed, or wireless. Calibrate the gas sensors to ensure accurate and reliable detection. Establish calibration procedures and protocols based on the sensor specifications. Perform rigorous testing to validate the sensor's performance, including sensitivity, linearity, stability, and response time. Test the system's overall functionality and alarms under various gas concentrations and environmental condition. Set appropriate alarm thresholds for each target gas based on safety guidelines and regulatory requirements. Determine the alarm levels that trigger audible, visual, or wireless notifications. Consider alarm hysteresis and time delays to avoid false alarms. Integrate the gas sensor data with the alarm system. Develop the necessary software algorithms for data processing, alarm triggering, and notification generation. If applicable, incorporate wireless communication protocols to enable real-time monitoring, remote control, and data logging.

Deploy the gas detector alarm system in real-world environments for field testing. Assess its performance, reliability, and sensitivity to ensure it meets the defined requirements. Gather feedback and make any necessary adjustments or improvements.Provide training and guidelines to users on the proper use, maintenance, and periodic calibration of the gas detector alarm system. Emphasize the importance of regular maintenance, sensor replacement, and calibration to maintain accurate and reliable operation

IV. OBJECTIVES

The main objectives of our project are:

- To protect the safety of people: Gas detectors are often used in industries where toxic or flammable gases can pose a risk to human health and safety. The primary objective of a gas detector in such environments is to detect and alert people to the presence of hazardous gases so that they can take appropriate actions to avoid harm.
- To prevent property damage: Gas detectors can also be used in areas where the presence of gases can cause damage to property, such as in chemical processing plants or laboratories. The objective of a gas detector in such environments is to detect the presence of gas and prevent it from reaching levels that could cause explosions or other forms of damage.

V. MATERIAL USED

The following materials were used in this prototype

- MQ2 Sensor
- GSM Module
- Arduino UNO
- LCD Display

MQ2 Sensor

It is a detector used to find flammable gas smoke proportion of flammable gases in the atmosphere, output in analogue voltage, and output in digital number. The power supply's input voltage is 5 volts. Smoke, propane, H2, LPG, CH4, and other gases have a negative influence on it. It has three wires: a ground wire, a receiver wire, and an emitter wire. A potentiometer may be used to change the sensitivity. LPG may be detected at concentrations between 200 and 10,000 ppm.

GSM Module

The Arduino feeds the GSM gadget with data.If the sensor detects a leak of LPG gas or any other gas, the GSM will send an output to the number programmed into the SIM card stored in its SIM slot. The GSM modem is used to communicating with AT instructions. SMS notifications are sent using a SIM900 GSM adapter when gas is detected. GSM is designed to be a tool for information sharing. [11-12] To operate the wireless node, a SIM card is retrieved from the GSM system. The GSM needs a DC input voltage of 5 volts in order to operate. There are just three connectors used to link the modem and Arduino processor Atmega-328. (Transmitter, receiver, and ground.[11]

Arduino UNO

The Arduino board serves as the core processing engine, and all of the other parts of the system are connected to it via external connections and set up to function as a whole. An 8-bit, 16-MHz microcontroller called the Atmega-328 serves as the basis for this electrical prototyping tool. The serial communication options are provided with 14 digital I/O pins (6 of which are PWM), as well as the 6 analog input pins. It requires 5 volts to function. Every connector's pin can be used to activate a different feature. The database relies on EEPROM and other forms of non-volatile memory. Non-volatile storage can be distinguished from an EEPROM by its erasable data. The entire device is erased, as opposed to just the data, in an EEPROM. location where byte and section analysis and deletion are possible.[12]

LCD Display

The message "gas detected at zone" appears on the LCD screen as predetermined by the algorithm to signal the danger. The LCD, which also contains instruction and data registers, displayed the message. Using the register selections, one can alter the register settings. The instruction register (RS=0) and the data register (RS=1) are utilized in a computer.

VI. SYSTEM FLOW CHART

The flow chart depicts the sequential steps taken to design and develop the prototype.

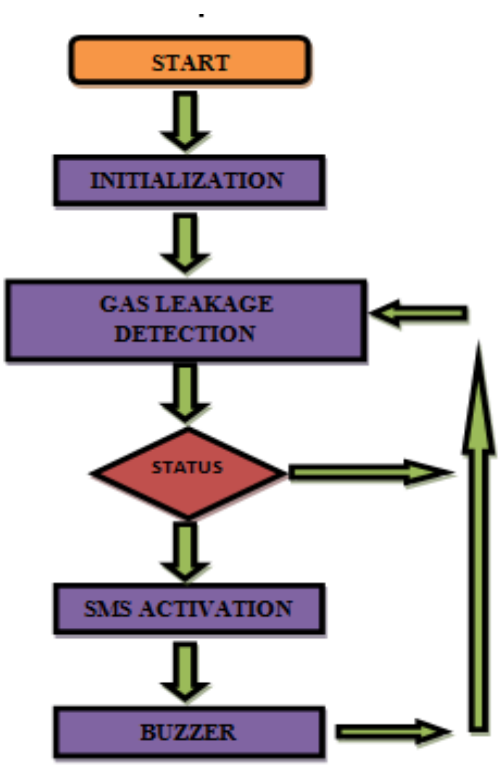

Fig 1. Flow Chart.

Proposed Circuit Diagram

The proposed circuit diagram is shown in **Fig 1.**The board's default in-built LED blinks to show that power is being delivered to the board whenever the system is turned on. The uploaded set of codes activates the sensor, security alarm, and GSM modem.

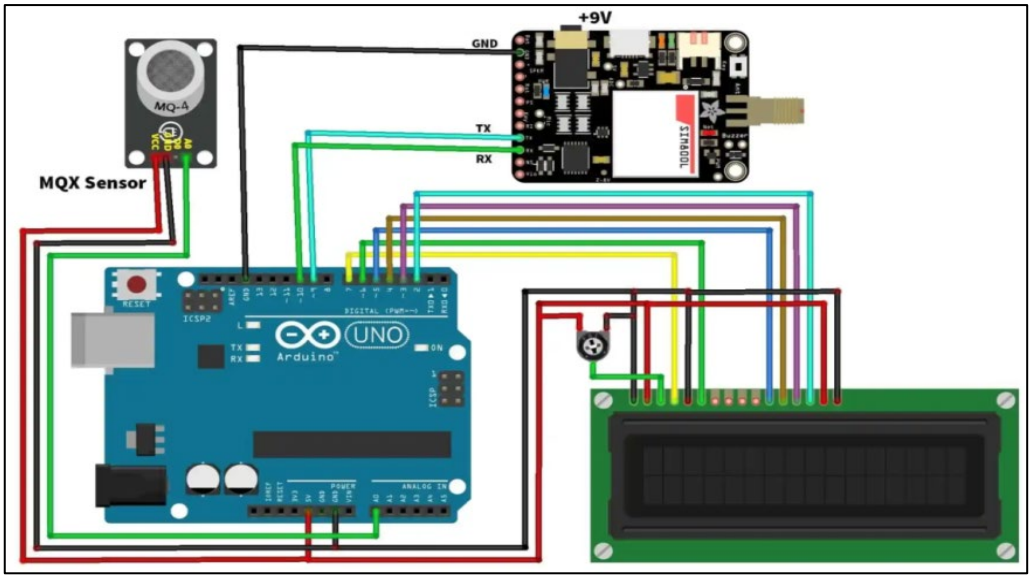

Fig 2. Proposed Circuit Diagram.

In the event of a gas leak, the MQ-9 sensor will keep a constant eye out, and when it does, it will send a signal to the PIC16F877A microcontroller, which will then process the signal, set off the alarm system, and notify the owner by SMS sent via the SIM900 GSM Modem. Continued alarming and monitoring will occur until appropriate action is taken. **Fig 2**showsproposed circuit diagram.

VII. PROTOTYPE

The integration of modules and interfacing were executed using C-programming. The developed prototype is shown below in the **Fig 3.**

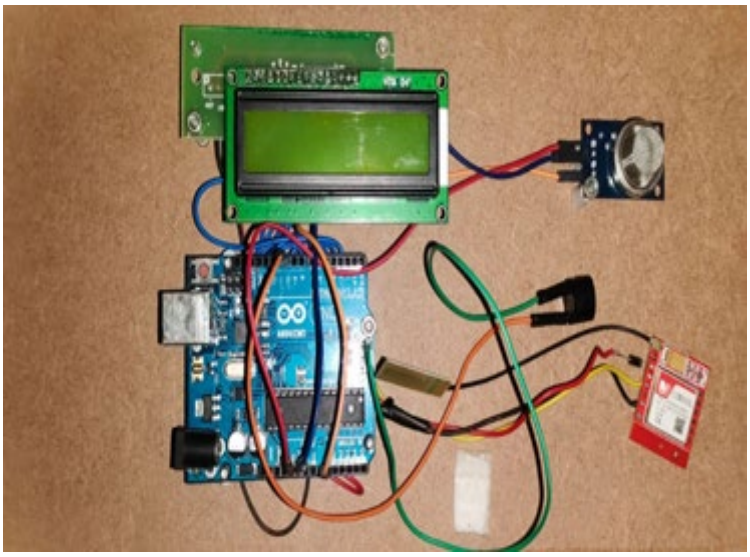

Fig 3. Prototype.

VIII. CONCLUSION

The model developed is useful for both domestic and professional uses. This technique allows us to save lives in perilous situations. The GSM gadget indicates a warning. Propane and other gases are detected by a sensing node. Power usage and transfer range estimates are made. Simple methods and an Arduino UNO, Micro CPU were used to build the sensor.This method lowers the risk to human life and offers a quick and affordable way to avoid the effects of a gas release. The information on gas concentration acquired by the program may be used to detect faulty valves and regulators early on and make the necessary repairs. The system is more dependable thanks to a two-stage protection device in addition to leakage detection. The proposed model is a low cost and effective means of protection.

References

[1]. RhonnelS.Paculanan and Israel Carino, "Arduino-Based Gas Leakage Detection with Alarm Sound," International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol. 8, April 2019.

[2]. Soujanya K, Sanjoy Das, Sahana S and Swathi M. C, "Gas leakage detection and prevention using IoT," In International Journal of Scientific Research Engineering Trends,

[3]. AmatulMunnaza, Rupa Tejaswi, Tarun Kumar Reddy and SarangaMoahan,"IoT Based Gas Leakage Monitoring System,"Journal of Xi'an University of Architecture &Technology, 2020.

[4]. B. F. Alshammari and M. T. Chughtai, "IoT Gas Leakage Detector and Warning Generator," Engineering, Technology and Applied Science Research, vol. 10, no. 4, pp. 6142–6146, Aug. 2020, doi: 10.48084/etasr.3712.

[5]. Rohan KH1, Navanika Reddy, Pranamya Maddy, Sachit Girish and Dr.Badari Nath K "IOT based gas leakage detection and Alerting system," JRP Publications, Vol. 1, no.1, February 2021.

[6]. M. Eisenhauer, P. Rosengren, and P. Antolin, "HYDRA: A Development Platform for Integrating Wireless Devices and Sensors into Ambient Intelligence Systems," The Internet of Things, pp. 367–373, 2010, doi: 10.1007/978-1-4419-1674-7_36.

[7]. "Automation of lpg cylinder booking and leakge monitoring system", International Journal of Combined Research and Development (IJCRD).

[8]. Ramu, M. and Prasad, C. R., "Cost-effective atomization of the Indian agricultural system utilizing 8051 microcontrollers". in the International Journal of Advanced Research in Computer and Communication Engineering, Vol.2, no.7, 2563–2566, 2013.

[9]. N. Evalina and H. A Azis, "Implementation and design gas leakage detection system using ATMega8 microcontroller," IOP Conference Series: Materials Science and Engineering, vol. 821, no. 1, p. 012049, Apr. 2020, doi: 10.1088/1757-899x/821/1/012049.

[10]. Mahalingam, A, Naayagi, R.T and Mastorakis, N.E. "Design and implementation of an economic gas leakage detector", In Proceedings of 6th International Conference on Circuits, Systems and Signals, Athens, Greece, 7–9 March 2012.

[11]. Meenakshi, A.A, Meghana, R.B.N,Krishna, P.R. "LPG Gas Leakage Detection and Prevention System,"Int. J. Future Revolut. Comput. Sci. Commun. Eng. 2017.

[12]. A. Banik, B. Aich, and S. Ghosh, "Microcontroller based low cost gas leakage detector with SMS alert," 2018 Emerging Trends in Electronic Devices and Computational Techniques (EDCT), Mar. 2018, doi: 10.1109/edct.2018.8405094.