Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 15, Issue. 1 : 2024
ISSN : **1906-9685**

EFFICIENT PLANT GAS LEAKAGE DETECTION AND MONITORING SYSTEM BASED ON IOT INTEGRATION

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Abstract—
In industrial areas, fire breakouts often stem from gas leaks within the surrounding environment. These leaks could be caused by faulty apparatus, inadequate maintenance, or human mistake either during handling or storage of flammable gases. The presence of combustible gases poses a significant risk, as they can ignite easily and escalate into large-scale fires, endangering both personnel and property within the industrial site. This research employs a compact detection device capable of identifying combustible gases like propane, LPG Gas, Carbon Monoxide, butane, and other hazardous gases. The device is designed to identify these gases quickly and accurately, aiding in ensuring safety in various environments such as industrial sites, homes, and workplaces. The leakage detector includes NODEMCU, gas sensors, buzzer, and LCD system. When harmful gases surpass acceptable thresholds, the micro-controller initiates a alerting SMS using Blynk server. The prototype emits a sound alert and illuminates LCDs to indicate the leaking gas. Gas concentration datais sent to Thinkspeak server for easy monitoring by plant personnel.

Keywords:
Gas leakage detection, Industrial safety,Thinkspeak server, Blynk server.

I. INTRODUCTION

In industrial environments, the risk of fire outbreaks stemming from gas leaks is a critical concern because of the possibility of severe outcomes,gas leaks have the capacity to cause significant harm. Gas leaks can arise from multiple factors, including equipment malfunctions, inadequate maintenance protocols, and human errors during gas handling and storage procedures[1].

The existence of combustible gases for example propane, LPG, Carbon Monoxide and butane amplifies the risk, as these gases can ignite easily and propagate large-scale fires rapidly. Such incidents not only endanger the lives of personnel working within the industrial facility but also pose a significant threat to surrounding property infrastructure.Therefore, mitigating the risk of gas leaks and promptly detecting any leaks that occur are essential for safeguarding the security and welfare of individuals and minimizing potential damage to assets within industrial environments. Comprehensive safety protocols, routine equipment assessments and deployment
of advanced detection technologies are essential strategies for mitigating the risk of fire outbreaks in industrial settings[2].

An essential obstacle mingled with gas leakage in industrial environments is difficulty of detecting

http://doi.org/10.36893/JNAO.2024.V15101.1702-1710

them in a efficiently. Conventional methods of gas detection, such as evaluation or periodic manner monitoring, are often insufficient for detecting leaks before they escalate into emergencies. As a result, there is a critical need for advanced detection technologies that can identify gas leaks quickly and accurately, enabling prompt intervention to mitigate the risk[3].To address this challenge, researchers have developed a compact detection device capable of quickly and accurately identifying combustible gases. This device is designed to enhance safety in a broad range of settings inclusive of industrial sites, homes, and workplaces.By quickly finding and warning about dangerous substances, the device helps lighten the risk of fire hazards and ensures well-being of personnel and assets[4].

The detection device incorporates advanced technology including NODEMCU, gas sensors, a buzzer, and LCD indicator. The combination of these components enables the device to effectively watch the area for any signs of gas outflow. When the concentration of harmful gases exceeds safe levels, the microcontroller within the device triggers an alerting mechanism[5].

Noteworthy feature of the device is the ability to send instantaneous alerts via SMS using the IFTTT (If This Then That) platform. This ensures that relevant personnel are promptly notified of any gas leaks, give permission to take immediate action to relieve the risk. Additionally, the device emits a sound alert and illuminates LCDs to provide visual indications of the presence of leaking gas, further enhancing situational awareness[6].

Furthermore, the device is equipped with capabilities for data logging and remote monitoring. Gas concentration data captured by the sensors is addressed to a Thinkspeak, where it can be easily retrieved and monitored by authorized personnel. This feature enables continuous monitoring of gas levels, allowing for proactive maintenance and intervention to prevent potential accidents[7].

Overall, the compact gas detection device represents a significant advancement in industrial safety technology. Its ability to quickly and accurately identify combustible gases, coupled with its alerting and monitoring capabilities, makes it an invaluable tool for enhancing safety in various environments. By providing early detection of gas leaks and facilitating timely response measures, the device helps safeguard lives and assets, ultimately contributing to a safer and moresecure working environment[8].

II. LITERATURE REVIEW

Nadia Mahmood Hussien et al. proposed a setup to find gas leaks from cylinders and alert users through the mobile network..Gas leaks pose significant risks to personal and financial well-being. Efforts to prevent such leaks and develop reliable detection techniques are ongoing. Typically, gas sensors trigger alarms upon detecting hazardous gases.The setup consists of a detector for LPG gas leaks, a small Arduino Uno computer, a system to send messages over the GSM network, and a screen to display information., and buzzer for alerts[2].

V. Tamizharasan et al. proposed a system for measuring LPG levels in household barrel, enabling automatic booking and gas leak detection. The system utilizes load sensors and gas sensors connected to an Arduino R3, with information sent to users via SMS through a GSM module. The system enhances safety and convenience in LPG usage[3].

Kiran et al. creating a smoke alarm system with ESP32 addresses the critical need for real-time monitoring of potential fire hazards in residential environments. The system detects smoke or gas leakage and promptly notifies homeownervia a Telegram Bot on their mobile phones, providing alerts accompanied by real-time images. This proactive approach to fire detection is essential for preventing the loss of life and property, especially in instances where homeowners may be away for extended periods. The system's focus on detecting gas leakage from cylinders, particularly LPG, highlights the importance of addressing potential hazards associated with household appliances. By incorporating advanced technology and providing timely alerts, the smoke detection system be of central concern in ensuring safety and well-being of homeowners along with their families, helping to mitigate the risks posed by fire accidents and gas leaks in residential settings[4].

Martin Maier et al. address the growing demand for accurate biosignal quality indices in telehealth applications, focusing on electrocardiogram (ECG) monitoring. ECG signals are proneto various noise

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sources, including environmental, experimental, and physiological factors, particularly in in-home monitoring scenarios. The paper proposes an innovative the ECG quality index, known as MS-QI, relies on analyzing the modulation spectral signal to evaluate the ECG'sspectral components changes over time distinguishing them from typical noise sources. Testing on synthetic signals and recorded data from different activity levels and ECG machines demonstrates the effectiveness of MS-QI, particularly in real-world environments. The proposed index outperforms conventional quality measures, showcasing its potential for automated decision support systems in remote physiologic monitoring. This research contributes in improving reliability and accuracy of ECG monitoring systems, enhancing patient care and safety in telehealth applications[5].

Asnor Juraiza Ishak et al. developed a transatlantic module to detect gas leakage, concentrating on household settings where fires or Liquefied Petroleum Gas (LPG) are frequent causes of disasters. LPG, being highly inflammable, can lead to fires even far away from where the gas is leaking The module targets fabrication facilities heavily reliant on LPG for operations. Functionally divided into gas leak monitoring and precautionary measures, it reads gas sensor data to detect concentration levels exceeding predefined thresholds. Upon detecting altered gas concentrations, the system activates an alarm and an air puller device while simultaneously sending a warning SMS via a GSM module to a designated recipient. This system offers crucial safety enhancements, helping to reduce the dangers from gas leaks and potential fire accidents in various industrial and residential settings[6].

II. METHODOLOGY

The research focuses on addressing the risk of fire breakouts in industrial areas stemming from gas leaks.Gas leaks often occur due to faulty equipment, inadequate maintenance, or human error during handling or storage of combustible gases.Combustible gases such as propane, LPG, butane and carbon monoxide pose a significant risk as they can easily ignite and cause large- scale fires.This research aims to create a small device for detecting things capable of identifying combustible gases quickly and accurately.The device is designed to ensure safety in various environments including industrial sites, homes, and workplaces.The detection device includes components such as NODEMCU, gas sensors, a buzzer, and LCD indicators.We use gas sensors to find dangerous gases nearby.When harmful gases surpass safe levels, the microcontroller triggers an alerting mechanism.The alerting mechanism includes sending SMS notifications via Blynk to relevant personnel.Additionally, the prototype emits a sound alert and illuminates LCD to indicate the presence of leaking gas.Gas concentration data captured by the sensors is transmitted to a Thinkspeak server for monitoring purposes.The Thinkspeak server facilitates easy monitoring of gas levels by authorized personnel.We created a small device that can detect gas efficiently and effectively. of the compact gas detection device.Various sensors are selected and integrated into the device to detect different types of combustible gases.The NODEMCU microcontroller is programmed to process sensor data and trigger alerts when necessary.The Blynk platform is utilized to send when there's a gas leak, send text messages to chosen people as alerts.The prototype undergoes testing to make sure it can find and warn about gas leaks effectively.Testing involves simulating different scenarios to evaluate the device's performance in various conditions.Parameters such as response time, accuracy, and reliability are assessed during testing.The sound alert and LCD indicator is calibrated to provide clear and intuitive warnings to users.This analysis helps identify potential areas for improvement in gas leak prevention and management.The Thinkspeak platform provides real-time monitoring capabilities, allowing for proactive intervention in case of abnormal gas levels.The methodology emphasizes the importance of user safety and property protection in industrial environments. Overall, the methodology aims to develop a dependable way to find things accurately and managing gas leaks in industrial settings, ultimately enhancing safety and protecting lives and property.

http://doi.org/10.36893/JNAO.2024.V15101.1702-1710

III. PROPOSED MODEL

A) Block Diagram of our work

The block diagram of the project illustrates the fundamental components and connections about the system that detects and monitors gas using the Internet of Things.The device begins with sensors that can find different flammable gases like propane, butane and Carbon Monoxide.At the center of the diagram is ESP32 microprocessor, serving as the brain of the server. Associate with the microcontroller are multiple sensors for monitoring water quality parameters, including MQ sensors, and temperature sensor. The sensors gather information from the area and send it to the microcontroller for analysis.

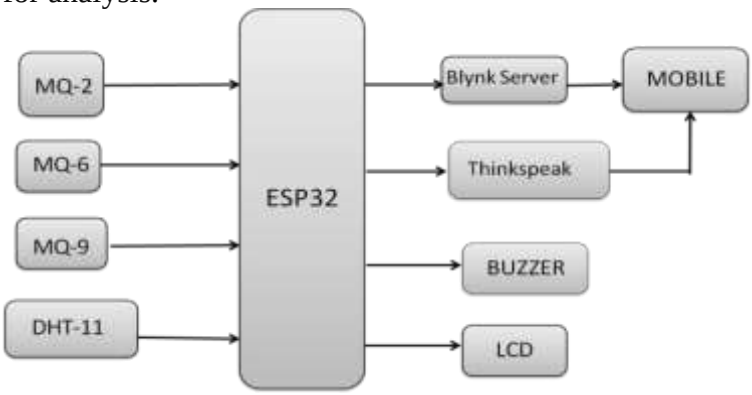

Fig.1. Block Diagram of Gas Detection and Monitoring System

Additionally, the microcontroller is configured to send an alerting SMS via the Blynk platform.The Blynk platform enables seamless integration with mobile devices, ensuring that relevant personnel are promptly notified of the gas leak.The microcontroller then communicates with a cloud server, such as thinkspeak, via Wi-Fi, users can see current gas levels fromanywhere using remote access.The device it sends instant SMS alerts This ensures that relevant personnel are promptly notified of any gas leaks,letting them act right away to lessen the impact.Overall, the integration of these components enables the comprehensive assessment of gas concentration and facilitates control and monitor the detection system from a distance.

Microcontroller:
The ESP32 is a powerful chip made by Espressif Systems that has two cores and various functions built into the WiFi and bluetooth connectivity.It consists of both analog and digital pins.It operates at a frequency range of 80-250 MHz.

Gas Sensors:
In this project we are using multiple gas sensors for detecting various combustible gases.

MQ2 Sensor:
This sensor detects gases like propane, butane, smoke, and other highly flammable gases to ensure safety.The safe level range for this gas sensor is around 800 ppm.

MQ6 Sensor:
This gas sensor finds LPG (Liquified Petroleum Gas) and natural gas.This sensor also consists the tin dioxide(SnO2) element.

MQ9 Sensor:
This sensor finds carbon monoxide gas

http://doi.org/10.36893/JNAO.2024.V15101.1702-1710

(CO) gas.The threshold range for this gas is 50 ppm.

DHT11 Sensor:
This sensor checks the temperature and humidity around it.It simultaneously detectsboth temerature and humidity present in the atmosphere.

Blynk:
Blynk is a web-based service that enables users to create conditional statements, known as applets, to automate tasks. It serves as a task automation platform for IoT (Internet of Things) and various web services. With Blynk, users can integrate different services such as SMS and email to create applets for specific actions.

Thinkspeak:
Thinkspeak is a cloud server utilized for sharing the sensor data information. Concentration values of detected gases are transmitted to the Thinkspeak server, allowing personnel associated with the plant to easily monitor these gases.

B) Schematic Diagram
The schematic diagram depicts the interfacing of components within the surveillance system. The main part of the system is the ESP32 microcontroller which is a central control unit. Themicrocontroller communicates with various sensors, including MQ sensors, and temperature sensor to gather data on gas concentration parameters.

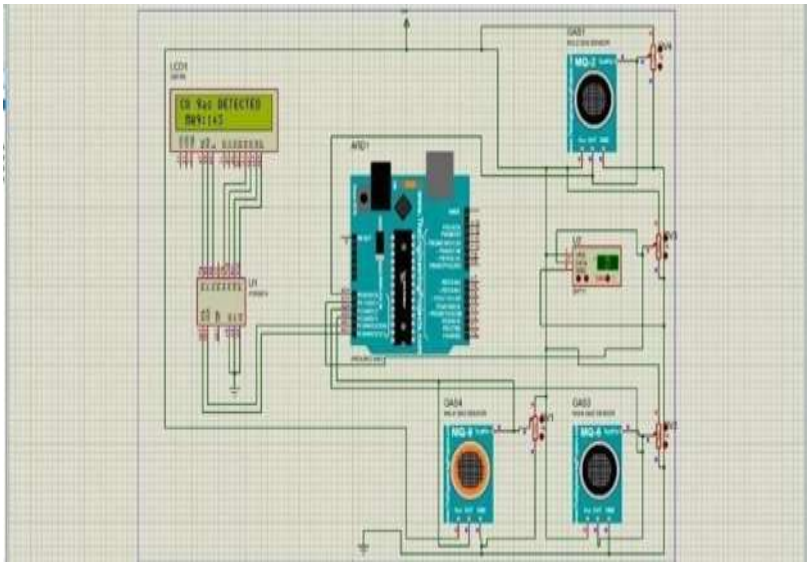

Fig.2. Schematic Diagram of Gas detection and monitoring system

This system utilizes compact detection device comprising NODEMCU, gas sensors, a buzzer, and an LCD system to identify combustible gases quickly and accurately. Gas sensors detect dangerous gases like propane, LPG, butane and carbon monoxide often found in factories and workplaces. The NODEMCU serves as the microcontroller to process sensor data and set off alarms when gas levels get too high for safety. When a gas leak is detected, the microcontroller makes a buzzer sound and lights up the LCD to show there's gas leaking. Additionally, the system is integrated with the Blynk platform to send alerting SMS messages when gas levels surpass safe thresholds. This ensures that relevant personnel are promptly notified of potential hazards. Furthermore, gas concentration information is sent to a Thinkspeak server for authorized personnel to monitor remotely. It lets you watch gas levels in real-time and take action early to stop accidents.Overall, the system offers a complete solution for finding and handling gas leaks in various settings like factories and homes, and workplace environments, enhancing safety and mitigating the risk of fire outbreaks

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C) Software Design

Flowchart of the working procedure of hardware:

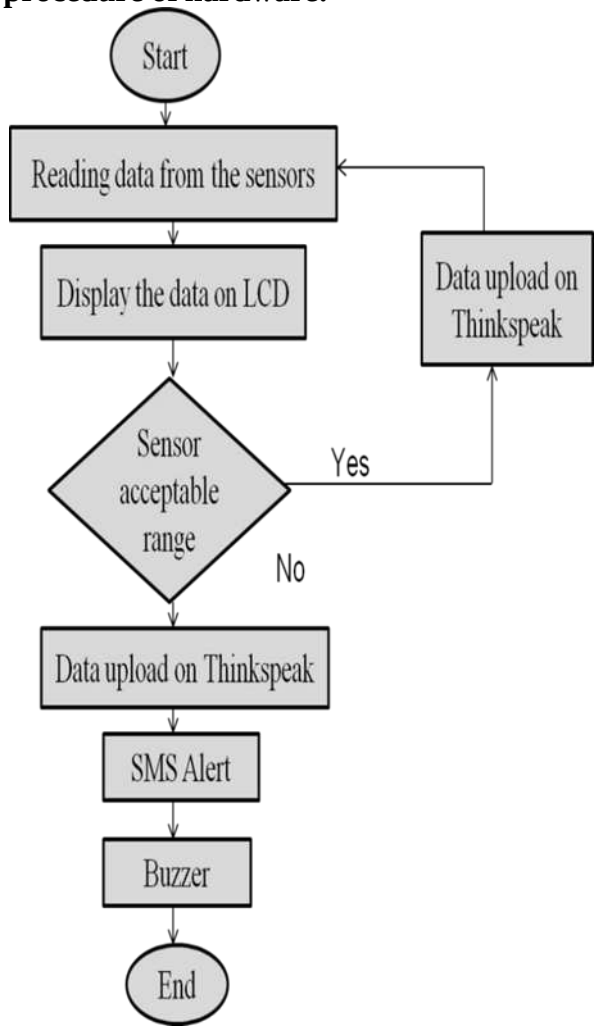

Fig.3. Flowchart of gas leakage detection and monitoring system using IoT

The provided description outlines operational sequence to create a system for plants that can easily detect and monitor gas leaks utilizing IoT technology.Gas sensors start by measuring how much gas is in the air around them.The sensor data shows up on a screen and gets sent out to the ESP32 microcontroller. The ESP32 module assesses whether the gas concentration levels are below or equal to the designated safe threshold. If the data indicates a safe level, the system continues to monitor the environment, repeating the process.However,if the gas level goes above the safe limit, it's not good, the system initiates alerts to notify individuals. This is achieved through SMS alerts sent to mobile devices using Blynk, and by activating a buzzer to provide
audible warnings. Additionally,the information from the sensors is saved or displayed on the Thinkspeak server, allowing for future analysis and monitoring. Overall, this system aims to ensure the safety of personnel and property by promptly finding and warning about possible gas leaks effectively in the plant environment.

RESULT AND DISCUSSION:

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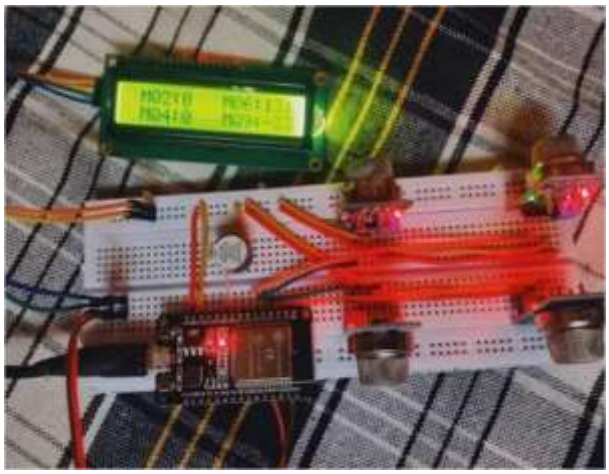

Fig.4. Experimental setup

Fig.5. Gas concentration values in Thinkspeak during gas leak

Fig.6. Data on Thinkspeak Application

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Fig.7. SMS alerts acquired during gas leak

Through this project we developed a wireless system that detects and monitors gas with the help of the IoT integration.In this work when there is an occurrence of gas leak in the surrounding areas the system will caution the authorities and the individuals through alerts and the above figures shows the particulars that are set aside and displayed in Thinkspeak web server which are used for the further case studies to prevent the damage caused by the gas leakages.Blynk webserver is used to acquire the alert notifications when there is an occurrence of gas leak or firecause in the surrounding environment.

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