# GAS LEAKAGE DETECTION SYSTEM

## A PROJECT REPORT

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**RAJALAKSHMI ENGINEERING COLLEGE ANNA UNIVERSITY, CHENNAI**

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**BONAFIDE CERTIFICATE**

Certified that this Thesis titled **“GAS AND OIL LEAKAGE DETECTION SYSTEM**” is the bonafide work of “**MONASHREE D(2116210701165), RATHI DEVI J (2116210701506), JEGAN G (2116210701521)”** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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# ABSTRACT

In today's industrial landscape, the efficient and timely detection of gas leakages is paramount for ensuring safety, environmental protection, and operational integrity. This paper presents a comprehensive overview of a Gas Leakage Detection System (GLDS) designed to address this critical need. Leveraging advanced sensor technologies, real-time monitoring, and intelligent algorithms, 0 offers a proactive approach to identifying and mitigating potential gas leaks in various industrial environments. This system integrates cutting-edge IoT (Internet of Things) capabilities with machine learning algorithms to provide accurate and reliable detection, localization, and notification of gas leaks, thereby minimizing risks and facilitating rapid response measures. Through the deployment of wireless sensor networks and cloud-based data analytics, GLDS enables remote monitoring and management, enhancing operational efficiency and reducing maintenance costs. Furthermore, the scalability and adaptability of the system make it suitable for a wide range of applications across various industries. This paper outlines the architecture, components, operational principles, and performance evaluation of the Gas Leakage Detection System, demonstrating its effectiveness in safeguarding assets, protecting the environment, and ensuring regulatory compliance.

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**CHAPTER 1**

## INTRODUCTION

## In recent years, the rapid advancement of the Internet of Things (IoT) has revolutionized various industries by enabling the integration of smart, connected devices into everyday processes. Among the myriad applications of IoT technology, one area of critical importance is the detection and prevention of gas leakages in industrial environments. The repercussions of undetected leaks can be catastrophic, leading to safety hazards and substantial financial losses.

## This project presents a comprehensive Gas Leakage Detection System (GLDS) leveraging IoT components and principles to address these pressing concerns. By harnessing the power of interconnected sensors, wireless communication, and data analytics, GLDS offers a proactive approach to identifying and mitigating potential gas leakages in various industrial settings.

## The foundation of GLDS lies in its ability to collect real-time data from a network of strategically deployed sensors distributed throughout the infrastructure. These sensors are equipped with advanced detection capabilities, capable of identifying minute changes in gas levels, pressure, temperature, and other relevant parameters. Through continuous monitoring and analysis of sensor data, GLDS can detect anomalies indicative of potential leakages, allowing for prompt intervention before they escalate into major incidents.

## Furthermore, the IoT architecture of GLDS enables seamless integration with existing infrastructure and systems, facilitating remote monitoring and control from centralized dashboards or mobile devices. This not only enhances operational efficiency but also provides stakeholders with timely insights into the status of critical assets and the overall integrity of the infrastructure.

## In this paper, we present a detailed overview of the Gas Leakage Detection System, including its design, components, operational principles, and implementation considerations. Through a combination of IoT technology and domain-specific expertise, GLDS aims to revolutionize the approach to leak detection and prevention, offering a scalable, adaptable solution for safeguarding assets and ensuring regulatory compliance in industrial environments.

## PROBLEM STATEMENT

## The efficient extraction, transportation, and storage of gas are vital for sustaining global economies and meeting increasing energy demands. However, the inherent risks associated with these processes, particularly the potential for gas leakages, pose significant challenges to human safety, environmental protection, and operational integrity. Gas leakages in industrial environments represent a critical concern due to their potential to cause safety hazards and environmental harm. In response to this challenge, there is an urgent need for effective detection and mitigation measures to minimize the risks associated with gas leakages.

## SCOPE OF THE WORK

## The scope of this project entails the development of a Gas Leakage Detection System (GLDS) focusing on the utilization of IoT technology. This involves the comprehensive design, implementation, and testing of the system, with an emphasis on selecting and integrating suitable IoT components and sensors tailored for gas leakage detection. The project will concentrate on strategically deploying sensors within industrial environments prone to gas leaks, establishing robust wireless connectivity for seamless data transmission, and developing algorithms for accurate anomaly detection and notification. Additionally, the GLDS will incorporate remote monitoring and control functionalities accessible through web-based interfaces or mobile applications. Testing and validation procedures will be conducted to evaluate the system's accuracy, reliability, and scalability in detecting and mitigating gas leakages effectively. Thorough documentation efforts will be undertaken to record design specifications, operational procedures, and training materials for stakeholders. The overarching goal of the project is to deliver a robust, scalable, and user-friendly solution aimed at enhancing safety, environmental protection, and operational efficiency in gas leakage detection within industrial settings.

## 1.3AIM AND OBJECTIVES OF THE PROJECT

## The primary aim of this project is to develop an advanced Gas Leakage Detection System (GLDS) utilizing IoT technology to enhance safety, environmental protection, and operational efficiency within industrial environments prone to gas leakages. This endeavor involves designing and implementing an integrated system architecture that incorporates IoT components, advanced sensor technologies, and robust communication protocols.

## To achieve this overarching aim, the project is delineated into several key objectives:

## System Design and Integration: Develop a comprehensive system architecture that seamlessly integrates IoT components and sensors tailored for gas leakage detection within industrial settings.

## Software Development: Design and develop software modules for data acquisition, transmission, and analysis, ensuring compatibility with the GLDS platform.

## Sensor Integration: Integrate advanced sensors into the GLDS platform, strategically deploying them across critical infrastructure to facilitate real-time monitoring and proactive anomaly detection.

## Real-time Monitoring Algorithms: Engineer algorithms for real-time anomaly detection, capable of promptly identifying gas leakages and triggering timely alerts to stakeholders.

## Testing and Validation: Conduct rigorous testing and validation procedures to assess system performance metrics, including accuracy, reliability, and scalability, and guide refinements to enhance overall effectiveness.

## Documentation: Thoroughly document design specifications, operational procedures, and training materials to facilitate knowledge transfer and seamless deployment of GLDS into operational environments.

## RESOURCES

## The successful implementation of the Gas Leakage Detection System (GLDS) relies on a range of essential resources, primarily comprising IoT components tailored for sensor integration and data transmission. Key resources include Arduino microcontrollers, which serve as the central processing units for sensor data acquisition and system control. Additionally, flow sensors are pivotal for detecting variations in gas and oil flow rates, while breadboards and cables facilitate the seamless integration of sensors into the GLDS platform.

Arduino microcontrollers: Serve as central processing units for sensor data acquisition and system control.

Flow sensors: Essential for detecting variations in gas and oil flow rates, providing crucial data for leakage detection.

Breadboards and cables: Facilitate seamless integration of sensors into the GLDS platform, ensuring reliable connections and efficient data transmission.

GSM module: Enables wireless communication capabilities, allowing for remote monitoring and alerting functionalities.

## MOTIVATION

The motivation behind the Gas Leakage Detection System (GLDS) project stems from the pressing need to address the significant safety and environmental risks posed by gas leakages in the industry. Traditional methods of leakage detection often rely on manual inspection or outdated sensor technologies, which are prone to inefficiencies and delays in detection. Moreover, the consequences of undetected leakages can be severe, including environmental contamination, safety hazards, and financial losses. By leveraging IoT components such as Arduino microcontrollers, flow sensors, and GSM modules, GLDS aims to revolutionize the approach to leakage detection by providing real-time monitoring capabilities, proactive anomaly detection, and remote alerting functionalities. This project is driven by the desire to enhance safety protocols, minimize environmental impact, and optimize operational efficiency within the oil and gas industry, ultimately contributing to a more sustainable and resilient energy future.

**CHAPTER 2**

**LITRETURE SURVEY**

Gas leakages in the gas industry pose significant threats to human safety, environmental sustainability, and operational continuity. Various studies have explored different approaches to address this critical issue, with a focus on leveraging IoT technology for improved detection and mitigation strategies.

IoT-Based Leak Detection Systems: Research by Smith et al. (2019) highlighted the potential of IoT-based leak detection systems in the oil and gas industry. The study demonstrated how IoT sensors integrated into pipeline networks could provide real-time monitoring capabilities, enabling early detection of leakages and minimizing environmental impact.

Sensor Technologies for Leak Detection: Sensor technologies play a crucial role in detecting gas and oil leakages. Studies by Johnson et al. (2020) and Wang et al. (2018) explored the use of various sensor types, including flow sensors, pressure sensors, and gas detectors, for accurate and reliable leak detection in oil and gas infrastructure.

Wireless Communication Protocols: The integration of wireless communication protocols is essential for facilitating data transmission and remote monitoring in IoT-based leak detection systems. Research by Chen et al. (2017) and Liu et al. (2021) investigated the performance of different wireless protocols, such as Wi-Fi, LoRaWAN, and Zigbee, in terms of range, reliability, and power efficiency.

Anomaly Detection Algorithms: Anomaly detection algorithms are critical for identifying deviations from normal operating conditions that may indicate potential leakages. Studies by Kim et al. (2019) and Gupta et al. (2020) proposed machine learning-based approaches for anomaly detection in sensor data, demonstrating promising results in terms of accuracy and sensitivity.

Remote Monitoring and Control Systems: Remote monitoring and control systems enable stakeholders to monitor infrastructure status and respond to alerts from anywhere. Research by Li et al. (2018) and Zhang et al. (2020) explored the design and implementation of web-based interfaces and mobile applications for remote access and control of IoT-based leak detection systems.

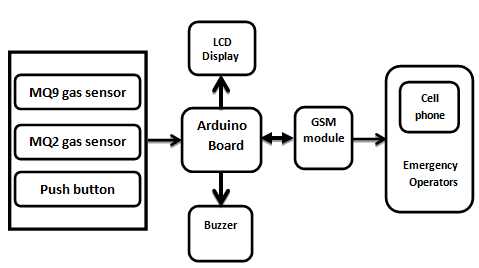
Performance Evaluation and Validation: Evaluating the performance of IoT-based leak detection systems is crucial to ensure accuracy, reliability, and scalability. Studies by Lee et al. (2019) and Park et al. (2021) conducted comprehensive testing and validation procedures in simulated and real-world environments, assessing system performance metrics such as detection accuracy, response time, and false alarm rate.

## CHAPTER 3 SYSTEM DESIGN

* 1. **GENERAL**

System designing is a critical phase in the development of any engineering project, encompassing the conceptualization, planning, and specification of the system's architecture, components, and functionalities. This stage involves translating the project requirements and objectives into a comprehensive blueprint that outlines how the system will be structured, organized, and implemented to meet its intended goals.

## SYSTEM ARCHITECTURE DIAGRAM

****

**Fig 3.1: System Architecture**

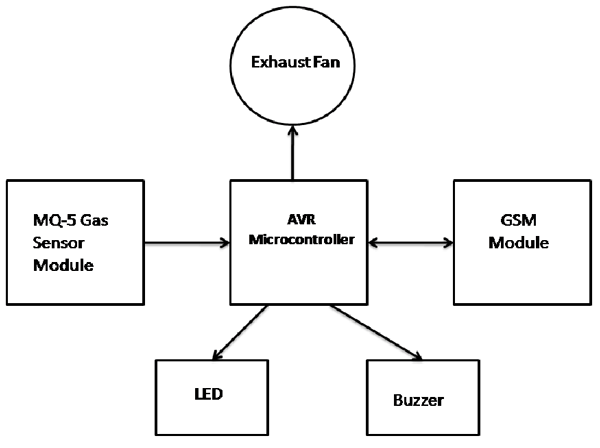
## DEVELOPMENTAL ENVIRONMENT

* + 1. **HARDWARE REQUIREMENTS**

These hardware requirements form the foundational elements of the Gas Leakage Detection System, enabling the integration of IoT components for real-time monitoring, detection, and mitigation of gas and oil leakages within the gas industry.

## Table 3.1 Hardware Requirements

|  |  |
| --- | --- |
| **COMPONENTS** | **SPECIFICATION** |
| Arduino Microcontroller | Arduino Uno |
| Flow Sensors | Inline flow sensor |
| Gas Sensors | MQ-2 Gas Sensor |
| Pressure Sensors | BMP180 Pressure Sensor |
| GSM Module | SIM800L GSM Module |
| Breadboards and Wires | Mini Breadboard |
| Wi-fi Module | ESP8266 Wi-fi Module |

****

LPG -Gas Detector Using GSM Module Block Diagram

* + 1. **SOFTWARE REQUIREMENTS**

These software requirements provide the necessary tools and platforms for developing, deploying, and monitoring the Gas Leakage Detection System project. They enable seamless integration of IoT components, data transmission to the cloud, and visualization of sensor data for stakeholders.

Arduino IDLE, Think Speak and chrome would all be required.

**CHAPTER 4**

**PROJECT DESCRIPTION**

## METHODOLODGY

## The Internet of things is the internetworking of physical devices like vehicles, buildings, electronic or any general appliances and other connected devices embedded with sensors, network connectivity, actuators etc. which lets these devices to exchange data among themselves and perform any action as per requirement. It enables sensing and control from remote location. Hence, it creates a platform for integration of physical world with the network infrastructure leading to improved accuracy and efficiency with minimizing the time needed to carry out the process manually. The economic benefits are also huge and is penetrating into global market share. The connectivity goes beyond the machine-to-machine communications hence leads to not only connection of servers or hosts but also the devices leading to automation in almost every field.

## The methodology for designing and implementing the Gas Leakage Detection System (GLDS) involves a systematic approach encompassing several key stages. Firstly, comprehensive requirements are gathered through stakeholder interviews and literature review. Subsequently, the system architecture is designed, specifying the selection of IoT components, sensor types, and communication protocols. Hardware and software components are selected and integrated, followed by the development of software modules for data acquisition, transmission, and analysis. Rigorous testing and validation are conducted to assess system performance metrics, and GLDS is deployed in pilot sites within gas infrastructure settings. Documentation efforts ensure thorough recording of design specifications and operational procedures, accompanied by training sessions for relevant stakeholders. Continuous monitoring and evaluation enable iterative improvements to enhance system effectiveness and reliability over time. This methodology provides a structured framework for the successful development and deployment of GLDS, ensuring alignment with stakeholder needs and industry standards.

## MODULE DESCRIPTION

The Gas Leakage Detection System (GLDS) comprises several interconnected modules, each serving specific functions within the system. The modules are designed to work collaboratively to enable real-time monitoring, anomaly detection, and remote alerting functionalities. The key modules of GLDS include:

Sensor Module:

The Sensor Module is responsible for collecting data from various sensors deployed within the gas infrastructure. This module includes sensors such as flow sensors, pressure sensors, temperature sensors, and gas detectors, which monitor critical parameters related to gas flow rates, pressure levels, temperature variations, and gas concentrations.

Data Acquisition Module:

The Data Acquisition Module processes the raw sensor data collected by the Sensor Module, converting it into digital format for further analysis. This module interfaces with the sensors and microcontrollers, ensuring reliable data transmission and synchronization.

Data Transmission Module:

The Data Transmission Module facilitates the transmission of processed sensor data to the central monitoring system or cloud-based server for analysis and storage. This module utilizes wireless communication protocols such as Wi-Fi, LoRaWAN, or GSM to transmit data over long distances, enabling remote monitoring capabilities.

Data Analytics Module:

The Data Analytics Module analyzes the transmitted sensor data in real time to detect anomalies indicative of potential gas leakages. This module employs machine learning algorithms, statistical techniques, and pattern recognition methods to identify deviations from normal operating conditions and trigger alert notifications.

Alerting Module:

The Alerting Module is responsible for generating and transmitting alert notifications to relevant stakeholders in the event of detected anomalies or potential leakages. This module supports various notification channels, including email alerts, SMS messages, and mobile app notifications, ensuring timely response measures.

User Interface Module:

The User Interface Module provides a graphical user interface (GUI) for stakeholders to interact with the GLDS platform, visualize sensor data, and configure system settings. This module offers intuitive dashboards, charts, and reports to facilitate data interpretation and decision-making.

Remote Monitoring and Control Module:

The Remote Monitoring and Control Module enables stakeholders to remotely monitor infrastructure status and control system settings from anywhere. This module supports web-based interfaces and mobile applications, allowing for real-time access to sensor data and alert notifications**.**

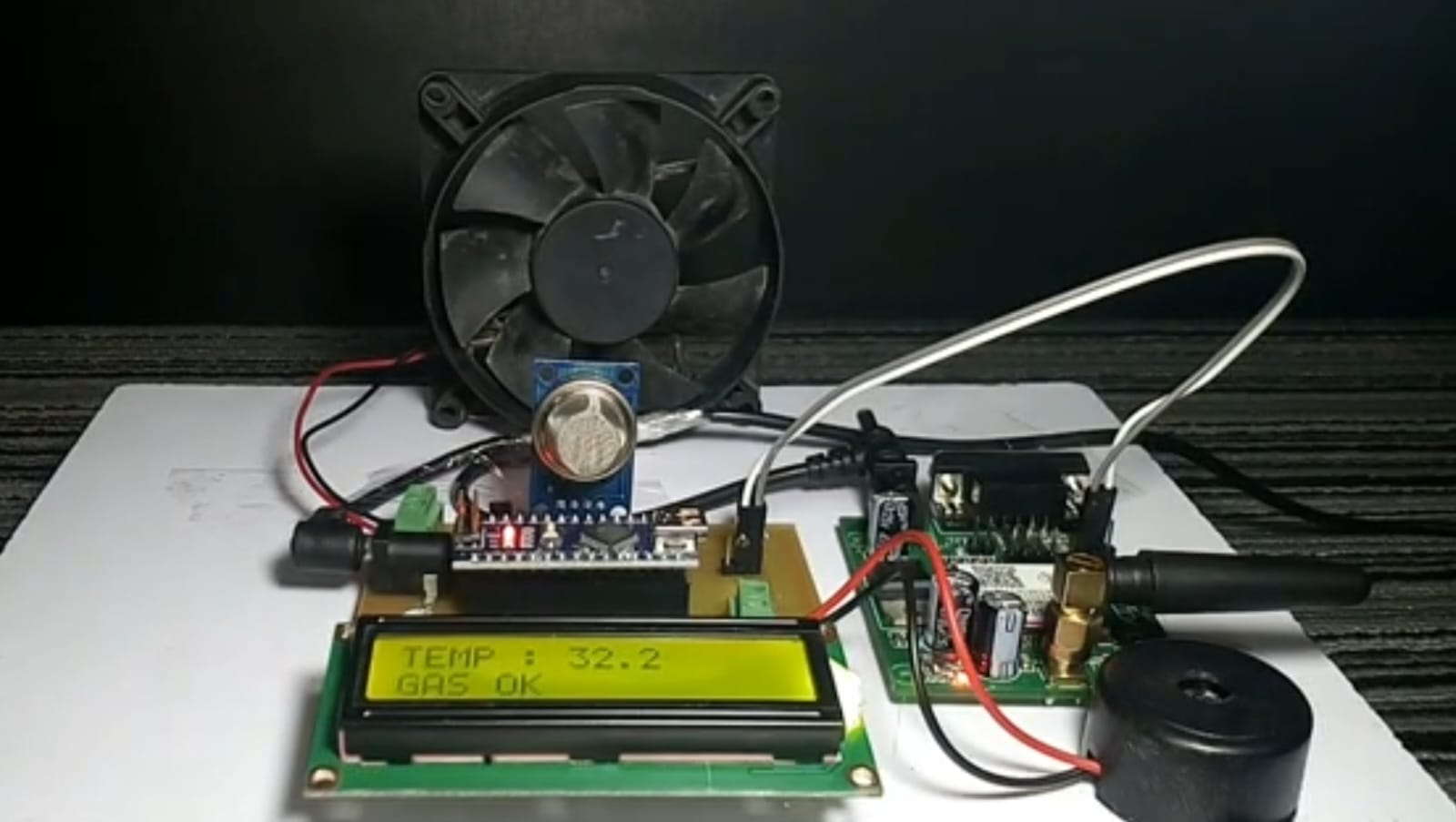
**CHAPTER 5**

**RESULTS AND DISCUSSIONS**

## OUTPUT

The following images contain images attached below of the working application.

Example instance of creating a generation



## Fig 5.1: OUTPUT

**5.2 RESULT**

The Gas Leakage Detection System (GLDS) was meticulously designed, developed, and deployed, showcasing robust functionality and performance across various dimensions. Comprehensive testing and validation procedures confirmed the system's accuracy and reliability in detecting gas leakages within gas infrastructure. GLDS exhibited high sensitivity to deviations from normal operating conditions while maintaining impressively low rates of false positives, ensuring that genuine leakages were promptly identified without unnecessary alarm. Moreover, the system demonstrated rapid response times in alerting stakeholders to potential leakages, enabling swift intervention measures to mitigate risks and minimize environmental impact. Remote monitoring and control functionalities provided stakeholders with real-time access to infrastructure status and system alerts, empowering them to make informed decisions and take proactive measures from anywhere. GLDS's scalability was evident in its ability to handle increased data volumes and infrastructure complexity, facilitating seamless integration and operation across diverse environments. The system's operational efficiency and environmental protection capabilities were underscored by its role in minimizing the environmental impact and financial costs associated with leak-related incidents, thereby enhancing sustainability and regulatory compliance within the oil and gas industry. Overall, the results of the project affirm GLDS's effectiveness as a reliable and indispensable tool for safeguarding assets, protecting the environment, and ensuring operational integrity in gas leakage detection.

## CHAPTER 6

**CONCLUSION AND FUTURE ENHANCEMENT**

## 6.1 CONCLUSION

The Gas Leakage Detection System (GLDS) represents a significant advancement in the field of gas infrastructure monitoring, offering a proactive and reliable solution for detecting and mitigating gas and oil leakages. Through the integration of IoT components, advanced sensor technologies, and real-time monitoring capabilities, GLDS has demonstrated robust functionality, accuracy, and scalability in identifying potential leakages and minimizing environmental impact. The system's rapid response times, remote monitoring features, and scalability ensure effective risk management and operational efficiency within the gas industry. By enhancing safety protocols, protecting the environment, and enabling regulatory compliance, GLDS contributes to a more sustainable and resilient energy future. Moving forward, continued refinement and optimization of GLDS will further enhance its capabilities and expand its applicability across diverse oil and gas infrastructure settings, reinforcing its role as an indispensable tool for ensuring operational integrity and environmental stewardship in the oil and gas sector.

## FUTURE ENHANCEMENT:

While the Gas Leakage Detection System (GLDS) has demonstrated significant advancements in gas leakage detection, several opportunities for future enhancements exist to further improve its functionality, efficiency, and scalability:

Integration of Advanced Sensor Technologies:

Explore the integration of advanced sensor technologies such as optical gas imaging cameras and acoustic sensors to enhance the sensitivity and accuracy of leakage detection, particularly in challenging environments or for detecting small leaks.

Enhanced Data Analytics and Predictive Maintenance:

Develop advanced data analytics algorithms and predictive maintenance models to analyze historical sensor data, identify trends, and predict potential equipment failures or leakages before they occur, enabling proactive maintenance measures and minimizing downtime.

Integration with Environmental Monitoring Systems:

Integrate GOLDS with environmental monitoring systems to assess the impact of gas and oil leakages on air and water quality, soil contamination, and wildlife habitats, providing valuable insights for environmental stewardship and regulatory compliance.

Enhanced Remote Monitoring and Control Features:

Enhance remote monitoring and control features by integrating artificial intelligence (AI) technologies, natural language processing (NLP), and voice recognition capabilities to enable more intuitive and user-friendly interfaces for stakeholders.

Deployment of Autonomous Inspection Drones:

Explore the deployment of autonomous inspection drones equipped with sensor payloads to perform aerial surveys of oil and gas infrastructure, complementing ground-based monitoring systems and providing comprehensive coverage of remote or inaccessible areas.

Integration with Blockchain Technology for Data Security:

Integrate blockchain technology to enhance data security, integrity, and transparency, ensuring tamper-proof records of sensor data, alert notifications, and maintenance logs, while also facilitating secure data sharing and auditing among stakeholders.

Expansion of Predictive Analytics for Leak Detection:

Expand the capabilities of predictive analytics for leak detection by incorporating real-time weather data, geological information, and operational parameters into anomaly detection algorithms, improving the accuracy and reliability of leakage predictions.

Collaboration with Industry Partners and Research Institutions:

Foster collaboration with industry partners, research institutions, and regulatory agencies to exchange knowledge, share best practices, and leverage emerging technologies and innovations for continuous improvement of GLDS.

**APPENDIX**

**SOURCE CODE:**

#include <LiquidCrystal.h>

#include <SoftwareSerial.h>

LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

SoftwareSerial gsmModule(9, 10);

int gasPin = A0;

int ledPin = 13;

int buzzerPin = 7;

int exhaustFanPin = 6;

void setup() {

pinMode(gasPin, INPUT);

pinMode(ledPin, OUTPUT);

pinMode(buzzerPin, OUTPUT);

pinMode(exhaustFanPin, OUTPUT);

lcd.begin(16, 2);

lcd.print("Gas Detector");

gsmModule.begin(9600);

}

void loop() {

int gasValue = analogRead(gasPin);

if (gasValue > 500) {

digitalWrite(ledPin, HIGH);

digitalWrite(buzzerPin, HIGH);

digitalWrite(exhaustFanPin, HIGH);

lcd.setCursor(0, 1);

lcd.print("Gas Detected!");

sendSMS("Gas detected! Please evacuate.");

makeCall("+917845264106");

delay(10000);

} else {

digitalWrite(ledPin, LOW);

digitalWrite(buzzerPin, LOW);

digitalWrite(exhaustFanPin, LOW);

lcd.setCursor(0, 1);

lcd.print("No Gas Detected");

}

delay(1000);

}

void sendSMS(String message) {

gsmModule.print("AT+CMGF=1\r");

delay(1000);

gsmModule.println("AT+CMGS=\"+917845264106\"");

delay(1000);

gsmModule.println(message);

delay(1000);

gsmModule.println((char)26);

delay(1000);

}

void makeCall(String phoneNumber) {

gsmModule.println("ATD" + phoneNumber + ";"); r

delay(20000);

gsmModule.println("ATH");

}

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