GAS PIPELINE MONITORING SYSTEM FOR HOSPITALS

A PROJECT REPORT

TEAM ID: NM2023TMID13931

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **"GAS PIPELINE MONITORING SYSTEM FOR HOSPITALS"** is the bonafide work of **"VANIPRIYA.V(732520106039),POOVIKA.V(732520106025), HEMA SREE.K(732520106012), DEEPIGA.R(732520106006)"** who carried out the project work under my supervision.

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Submitted for the Project Viva-Voice Examination held on ……..

INTERNAL EXAMINER **EXTERNAL EXAMINER**

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1. INTRODUCTION

1.1 PROJECT OVERVIEW

The pipeline distribution system is an integral part of all medical gas management system. It serves to bring all required medical gases and vacuum to areas where they are needed. Without a properly designed, installed, and maintained distribution system, the security of the whole hospitals can be at risk. Mishaps involving the malfunction or misuse of medical gas supply to operating theatres have cost many lives. Oxygen is one of the most widely used gases for life-support and respiratory therapy. In this project, we have implemented a system which monitors the storage of gas using pressure sensors and leakage of gas.

OBJECTIVES

The primary objectives of the Gas Pipeline Monitoring System for Hospitals are as follows:

a.Enhance Safety: Implement a robust monitoring system to detect gas leaks, pressure fluctuations, and other abnormalities to ensure the safety of patients, staff, and the facility.

b.Continuous Monitoring: Develop a real-time monitoring solution to provide constant surveillance of the gas pipeline network, enabling quick identification and response to potential issues.

c.Prompt Alerts: Implement an alert mechanism that notifies designated personnel immediately upon detecting any anomalies or gas leaks, enabling them to take appropriate actions promptly.

d.Preventive Maintenance: Enable proactive maintenance by providing data and analytics on pipeline performance, enabling the identification of potential issues before they lead to system failures.

e.Compliance: Ensure compliance with relevant safety regulations, standards, and guidelines related to gas pipeline systems within healthcare facilities.

Key Features

The Gas Pipeline Monitoring System for Hospitals will incorporate the following key features:

a. Leak Detection: Utilize sensors and intelligent algorithms to identify gas leaks within the pipeline network promptly.

b. Pressure Monitoring: Continuously monitor and analyse pipeline pressure to detect fluctuations or abnormal patterns that may indicate potential issues.

c. Real-time Alerts: Provide instant alerts through various communication channels, such as SMS, email, or a centralized monitoring dashboard, to notify designated personnel about gas leaks or abnormalities.

d. Data Analytics: Collect and analyse data from the monitoring system to generate insights, trends, and reports to facilitate preventive maintenance and system optimization.

e. Remote Access: Enable authorized personnel to access the monitoring system remotely, allowing them to monitor the gas pipeline network from anywhere within the hospital or even off-site.

Implementation Steps

The implementation of the Gas Pipeline Monitoring System for Hospitals may involve the following steps:

a. System Design: Define the system architecture, including the selection of appropriate sensors, communication protocols, and monitoring infrastructure.

b. Sensor Deployment: Install gas leak detection sensors and pressure monitoring devices at strategic points along the gas pipeline network within the hospital.

c. Data Integration: Integrate the sensor data with a centralized monitoring platform or software application capable of real-time data processing and analysis.

d. Alert Configuration: Set up alert mechanisms to notify designated personnel promptly when gas leaks, pressure abnormalities, or other critical events occur.

e. User Interface Development: Develop a user-friendly interface, such as a web-based dashboard or mobile application, to provide real-time status updates, alerts, and access to historical data.

f. Testing and Validation: Conduct thorough testing of the monitoring system to ensure its reliability, accuracy, and adherence to safety standards.

g. Training and Deployment: Train the hospital staff on using the monitoring system effectively and deploy it across the gas pipeline network within the facility.

Benefits

The Gas Pipeline Monitoring System for Hospitals offers several benefits, including:

a. Enhanced Safety: Minimize the risk of gas leaks, ensuring the safety of patients, staff, and the facility.

b. Timely Response: Enable quick detection and response to gas leaks or abnormalities, reducing the potential for accidents or disruptions.

c. Cost Savings: Prevent costly damages resulting from gas leaks, avoid interruptions in gas supply, and facilitate proactive maintenance to extend the lifespan of the pipeline system.

d. Compliance Assurance: Ensure compliance with safety regulations and standards related to gas pipeline systems in healthcare facilities.

e. Data-driven Insights: Provide valuable data and analytics for optimizing pipeline performance, identifying patterns, and planning preventive maintenance activities.

By implementing the Gas Pipeline Monitoring System for Hospitals, healthcare facilities can ensure the safety, reliability, and efficiency of their gas pipeline networks, thereby supporting their critical operations and providing a secure environment for patient care. . This system aims to monitor the gas pipeline

network, detect any abnormalities or leaks, and provide timely alerts to prevent potential hazards and ensure uninterrupted gas supply.

1.2 PURPOSE

Here are some key purposes and benefits of a gas pipeline monitoring system for hospitals:

1. **SAFETY**: Gas leaks can pose a significant risk to patients, staff, and the overall infrastructure of the hospital. Monitoring systems can detect such issues in real time and trigger alarms to alert relevant personnel, allowing them to take immediate action and prevent potential accidents or health hazards

2. **RELIABILITY**: Hospitals rely heavily on a continuous and uninterrupted supply of gases for critical medical operations. A monitoring system ensures that the gas pipelines are functioning properly, providing a reliable and consistent supply of gases to medical devices, operating rooms, intensive care units, and other areas where they are needed. By constantly monitoring the system's performance, hospitals can proactively address any maintenance or operational issues before they lead to disruptions or equipment failures.

3. **EFFICIENCY**: Gas pipeline monitoring systems help optimize the usage and distribution of gases within hospitals, promoting efficient operations. By monitoring the flow rates and pressures, hospital administrators can identify areas of excess consumption or potential bottlenecks. This information can be used to fine-tune gas distribution, minimize wastage, and allocate resources effectively, leading to cost savings and improved overall efficiency.

4. **COMPLIANCE**: A monitoring system helps hospitals meet these compliance standards by providing accurate and real-time data on gas usage, pressure levels, and leak detection. This information can be used for documentation, audits, and regulatory reporting purposes, ensuring that the hospital remains in compliance with applicable regulations and guidelines

2. IDEATION AND PROPOSED SOLUTION

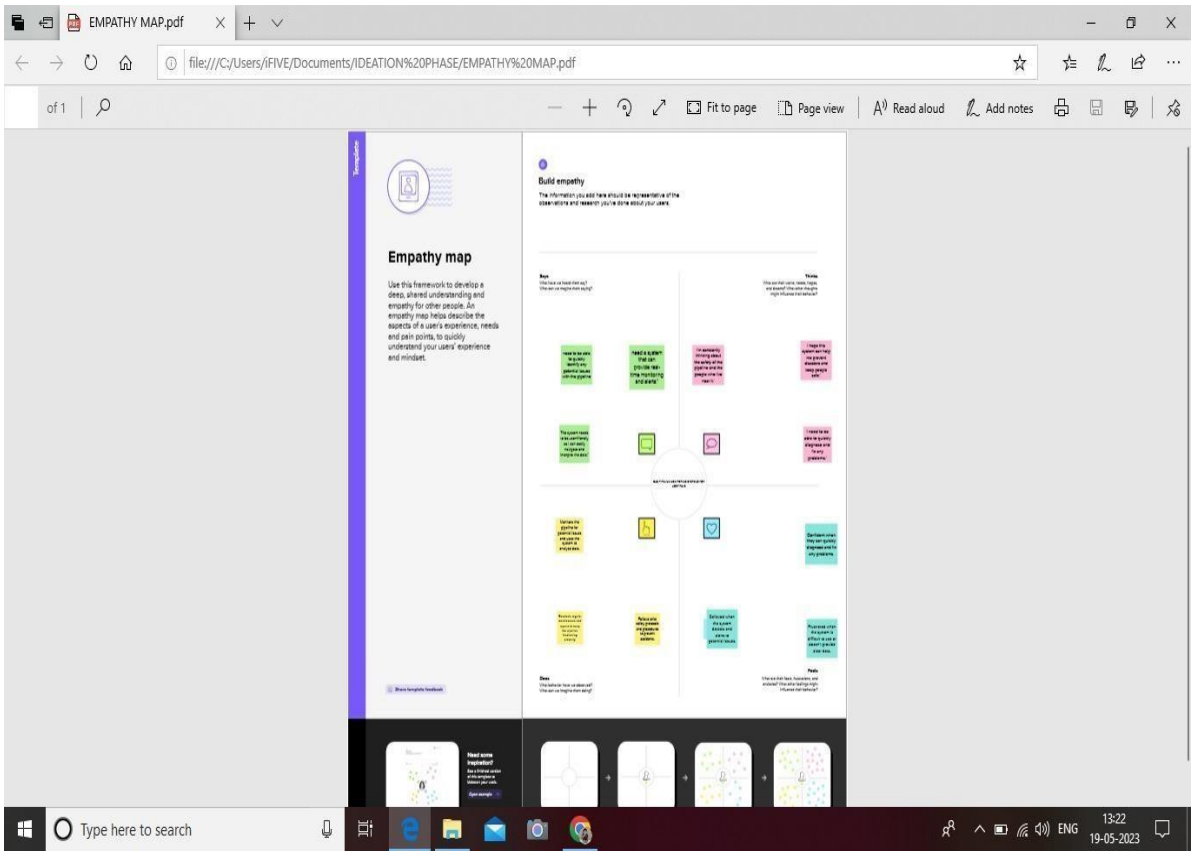
2.1 PROBLEM STATEMENT

The problem statement for a gas pipeline monitoring system for hospitals is to develop a reliable and efficient solution that ensures the continuous monitoring and safety of gas pipelines within hospital premises. The current lack of a dedicated monitoring system poses significant risks, as gas leaks can lead to potential hazards such as fires, explosions, or health issues for patients, staff, and visitors. The solution should provide real-time monitoring of gas pressure, temperature, and flow rates, promptly detecting any anomalies or leaks. It should also include automated alarm systems and notification mechanisms to alert relevant personnel in case of emergencies, enabling swift response and preventive measures. The gas pipeline monitoring system should be designed to integrate seamlessly with existing hospital infrastructure, ensuring minimal disruption to daily operations while prioritizing the safety and well-being of all individuals within the healthcare facility.

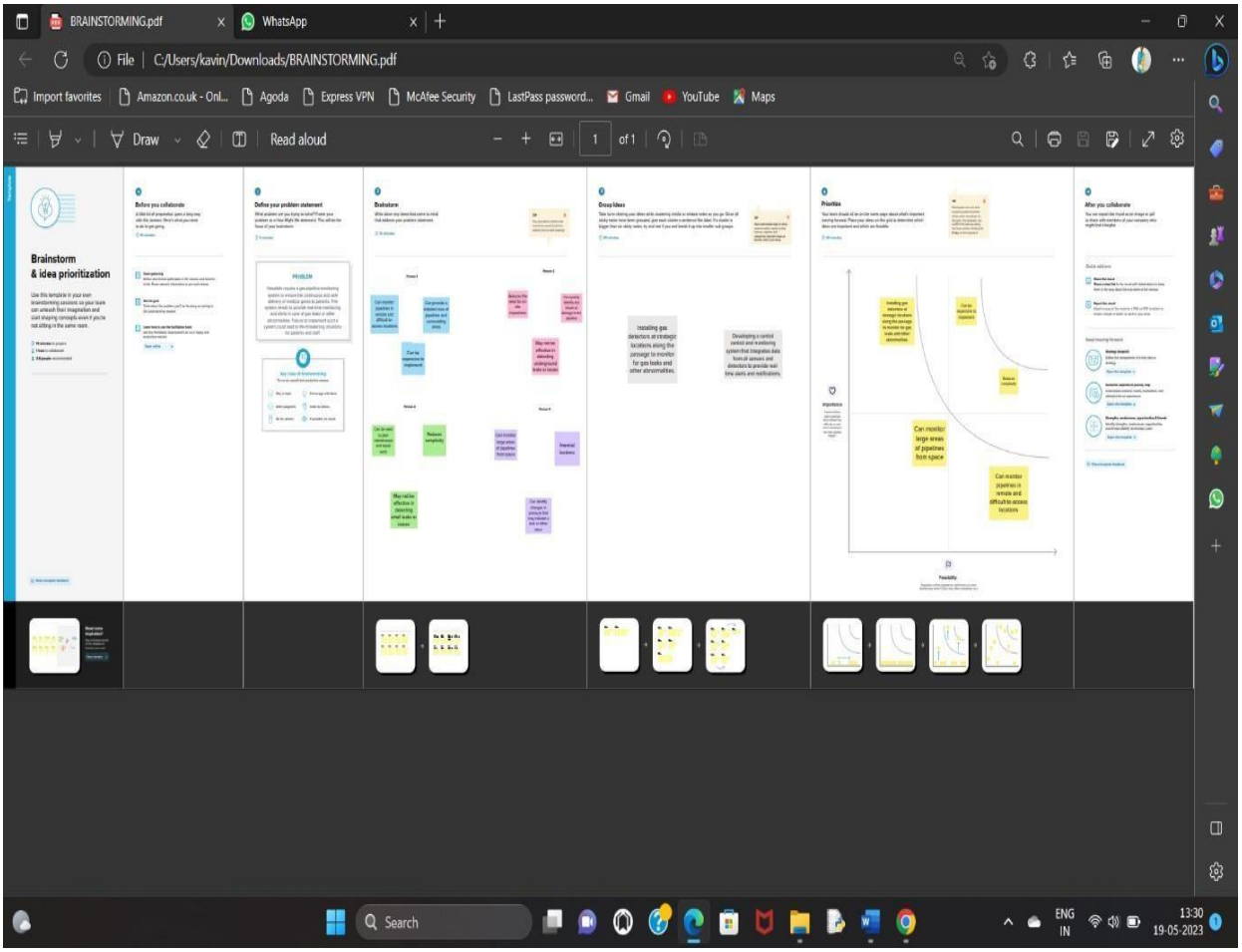
DESCRIPTION

A gas pipeline monitoring system for hospitals is a crucial safety designed to ensure the safe and efficient distribution of medical gases throughout healthcare facilities. This system employs advanced sensors and monitoring technologies to constantly track the pressure, flow rate, and composition of gases, such as oxygen, nitrogen, and nitrous oxide, within the hospital's pipeline network. It provides real-time data and alerts to facility staff, enabling them to promptly detect and address any abnormalities, leakages, or potential hazards in the gas distribution system. This monitoring system plays a vital role in safeguarding patient care by minimizing the risk of gas supply disruptions, ensuring uninterrupted access to critical medical gases, and maintaining a secure environment for both patients and healthcare professionals.

2.2 EMPATHY MAP CANVAS



2.3 IDEATION & BRAINSTORMING



2.4 PROPOSED SOLUTON

A proposed solution for a gas pipeline monitoring system for hospitals would involve the implementation of a comprehensive sensor network and an advanced monitoring platform. The sensor network would be strategically installed along the gas pipelines throughout the hospital infrastructure to continuously monitor gas flow, pressure levels, and potential leaks.

These sensors would provide real-time data that is transmitted to a centralized monitoring platform. The monitoring platform would employ intelligent algorithms and analytics to detect anomalies, such as sudden pressure drops or abnormal gas flow patterns, and trigger immediate alerts to hospital staff.

KEY FEATURES OF THE SOLUTION

1. REAL-TIME MONITORING

The system continuously monitors gas pipelines in real-time, capturing data on parameters such as pressure, flow rates, and gas composition. This allows for immediate detection of leaks, pressure fluctuations, or other abnormalities, ensuring prompt action and mitigating potential risks.

2. CENTRALIZED MONITORING AND VISUALIZATION

The system provides a centralized monitoring platform where all gas pipeline data is collected, analysed, and visualized. This allows hospital staff to have a comprehensive view of the gas network's performance, enabling proactive maintenance, resource optimization, and efficient decision-making.

BENEFITS OF PROPOSED SOLUTION

The proposed solution for a gas pipeline monitoring system in hospitals offers several significant benefits. Firstly, it enhances safety by continuously monitoring the gas pipelines and detecting any leaks or abnormalities in real-time. This proactive approach ensures that any potential gas leaks are promptly identified and addressed, minimizing the risk of accidents, fires, or gas-related incidents within the hospital premises.

Secondly, the system improves operational efficiency by automating the monitoring process. Rather than relying on manual inspections, the system utilizes advanced sensors and intelligent algorithms to monitor the gas pipelines continuously. This automation reduces the need for human intervention and allows hospital staff to focus on their core responsibilities, ultimately leading to improved productivity and resource allocation.

Furthermore, the proposed solution provides comprehensive data collection and analysis capabilities. It can gather and analyze data on gas flow rates, pressure levels, temperature variations, and other relevant parameters. This information can be utilized to optimize gas usage, identify potential maintenance issues, and make informed decisions regarding system upgrades or expansions.

Overall, implementing the proposed gas pipeline monitoring system in hospitals not only enhances safety but also streamlines operations and provides valuable insights for better management of the gas infrastructure. It ensures a secure environment for patients, staff, and visitors while optimizing resources and improving the overall efficiency of the hospital's gas distribution system.

3. REQUIREMENT ANALYSIS

3.1FUNCTIONAL REQUIREMENT

FR NO.	FUNCTIONAL REQUIREMENT (EPIC)	SUB REQUIREMENT (STORY/ SUB- TASK)
FR- 1	real time monitoring	Monitoring gas flow rates Monitoring pressure levels Monitoring temperature and gas composition.
FR- 2	User friendly interface	Real time updates Visualization of data Customizable dashboard
FR-3	Remote access and control	Web based Mobile based Data analysis
FR-4	Leak detection and alerting	Sensor integration Threshold setting Immediate alerts

3.2 NON- FUNCTIONAL REQUIREMENTS

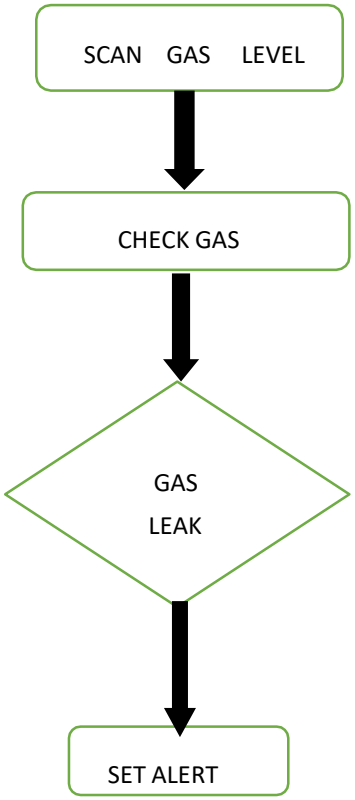
NFR NO	NON FUNCTIONAL REQUIREMENTS	SUB REQUIREMENTS
NFR 1	Reliability	The system should be highly reliable, ensuring continuous monitoring of the gas pipelines to detect any leaks or abnormalities promptly. It should have built-in redundancy and fault-tolerance mechanisms to minimize system downtime.
NFR 2	Safety	The system must adhere to strict safety standards to prevent gas leaks or any hazardous situations. It should incorporate fail-safe mechanisms to automatically shut off gas supply in the event of a leak or abnormal gas pressure.
NFR 3	Security	The system should incorporate robust security measures to protect sensitive data and prevent unauthorized access.
NFR 4	Performance	The system should have low latency and high performance to provide real-time monitoring and quick response to any gas pipeline issues. It should be capable of handling a large volume of data and process it efficiently.

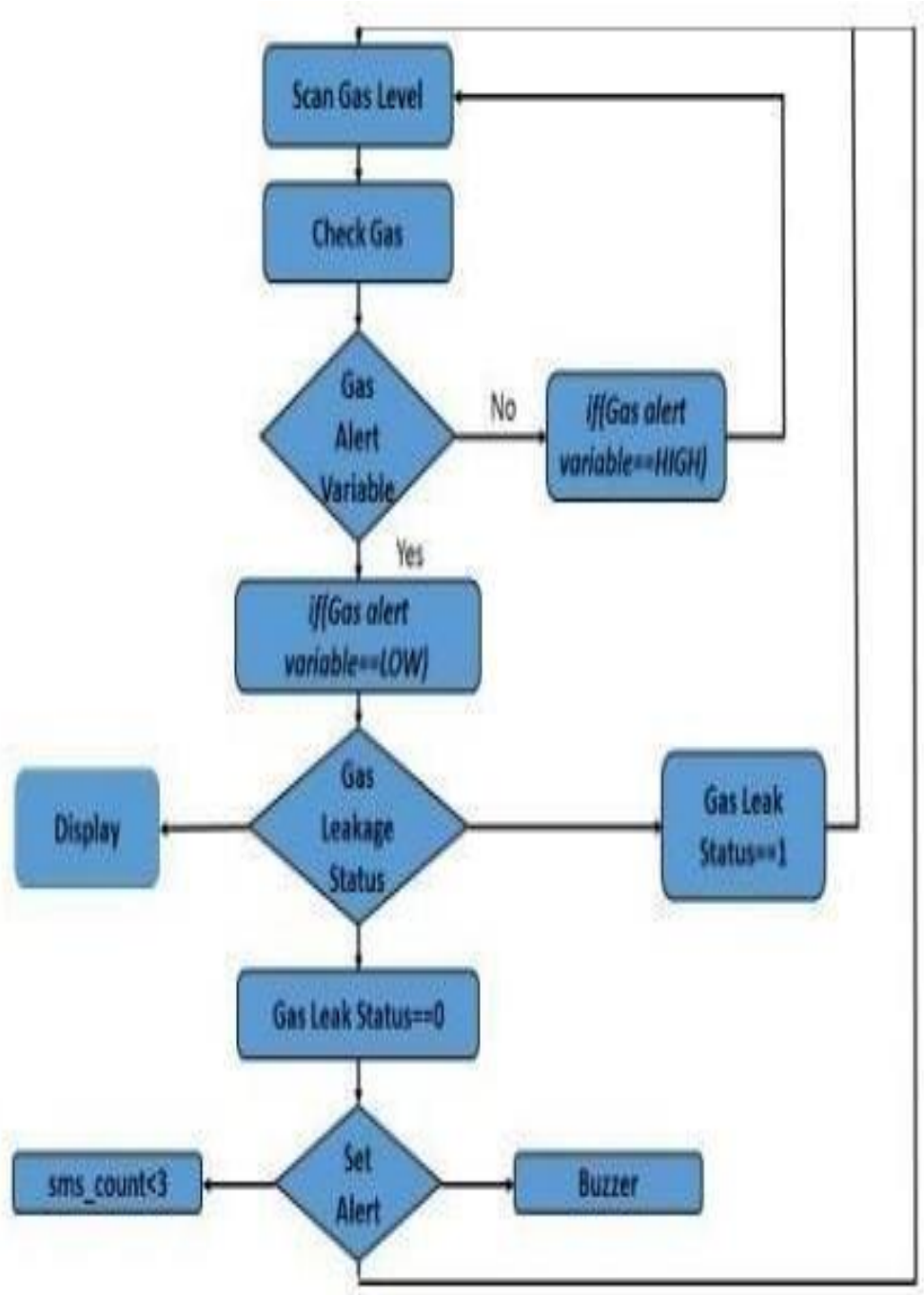
4. PROJECT DESIGN

4.1 DATA FLOW DIAGRAM

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

Example: **(Simplified)**




Scan Gas Level
Check Gas
Gas Alert Variable
No
if(Gas alert variable==HIGH)
Yes
if(Gas alert variable==LOW)
Gas Leakage Status
Display
Gas Leak Status==1
Gas Leak Status==0
Set Alert
sms_count<3
Buzzer

4.2 SOLUTION AND TECHNICAL ARCHITECTURE

SOLUTION

A gas pipeline monitoring system for hospitals is essential to ensure the safety and reliability of gas supply to critical areas such as operating rooms, laboratories, and patient rooms. Here's a solution and technical architecture that can be implemented for a gas pipeline monitoring system in hospitals

1. GAS SENSORS

Gas sensors should be capable of detecting different types of gases commonly used in hospitals, such as oxygen, nitrous oxide, and anesthetic gases.

2. DATA ACQUISITION

The data acquisition system collects and processes the gas sensor data in real time. It should be capable of handling a large number of sensor inputs and provide accurate readings.

3. DATA PROCESSING AND ANALYSIS

Implement a data processing and analysis module to interpret the sensor data received from the data acquisition system. This module should include algorithms to detect gas leaks, analyse gas concentration levels, and trigger appropriate actions when abnormal gas levels are detected.

4. ALERTING SYSTEM

Integrate an alerting system that can notify relevant personnel when a gas leak or abnormal gas concentration is detected. This can beachieved through various means such as audible alarms, visual indicators, email notifications, or SMS alerts. The alerting system should have configurable escalation levels to ensure timely response and proper incident management.

5. REAL TIME MONITORING

- Monitoring gas flow rates
- Monitoring pressure levels
- Monitoring temperature and
- Gas composition.

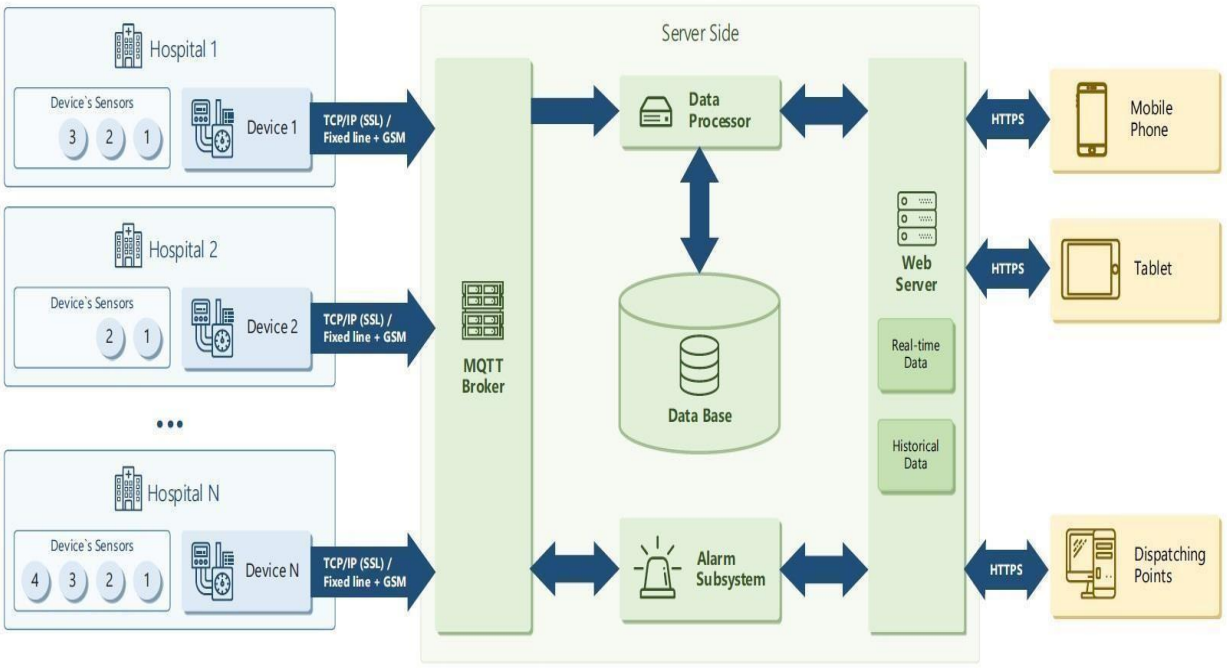
6. LEAK DETECTION AND ALERTING

- Sensor integration
- Threshold setting
- Immediate alerts

TECHNICAL ARCHITECUTURE

Technical Architecture:

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2



GUIDELINES

Safety regulations

Ensure compliance with relevant safety regulations, such as those provided by local authorities or industry standards.

System design

Design a comprehensive monitoring system that covers the entire gas pipeline network within the hospital premises.

Gas sensors

Install appropriate gas sensors strategically at critical points, including gas storage areas, distribution pipes, and patient care areas. These sensors should detect gases such as oxygen, nitrogen, carbon dioxide, and anesthetic gases.

Alarm system

Integrate the gas sensors with an alarm system that provides immediate alerts in case of gas leaks or abnormal gas levels. The alarms should be audible and visible to alert personnel promptly.

Monitoring and control center

Establish a centralized monitoring and control center where gas levels and alarms are continuously monitored by trained personnel. This center should have access to real-time data and historical trends.

Data logging and analysis

Implement a data logging system to record gas levels and alarms over time. Analyse this data to identify patterns, potential issues, and areas for improvement.

Backup Power

Ensure that the gas pipeline monitoring system has backup power sources, such as uninterruptible power supplies (UPS) or generators, to maintain functionality during power outages.

Maintenance and testing

Establish a regular maintenance schedule for the gas sensors, alarm system, and other components. Perform routine testing to verify their accuracy and reliability.

Staff training

Provide comprehensive training to hospital staff regarding the gas pipeline monitoring system. Educate them about the potential hazards, alarm procedures, and appropriate response protocols.

Emergency response plan

Develop an emergency response plan in collaboration with relevant departments, such as maintenance, engineering, and safety. Clearly define roles, responsibilities, and steps to be taken in case of a gas leak or other emergency situations.

Emergency Shutdown

Install emergency shutdown valves that can be activated in case of a gas leak or other hazardous situations. These valves should be easily accessible and operable to ensure swift response and isolation of affected sections.

Remote Monitoring

Enable remote monitoring capabilities to allow hospital staff to monitor the gas pipeline system from a central control room. This provides real-time visibility and facilitates timely decision-making.

Regular Inspections and Maintenance

Schedule regular inspections and maintenance of the gas pipeline system to ensure its integrity and proper functioning. This includes checking for any signs of corrosion, loose connections, or worn-out components.

Remember to consult with experts in gas pipeline monitoring systems and adhere to local regulations and industry standards specific to your region.

Table-1 : Components & Technologies

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g. Web , Mobile	HTML, CSS, JavaScript
2.	Application Logic-1	Logic for a process in the application	Java / Python
3.	Application Logic-2	Logic for a process in the application	IBM Watson STT service
4.	Application Logic-3	Logic for a process in the application	IBM Watson Assistant
5.	Database	Data Type, Configurations etc.	MySQL, NoSQL, etc.
6.	Data processor	Collects , analyses and stores data	IBM DB2, IBM Cloudant etc.
7.	Web server	Facilitate the communication and interaction between the user interface, backend systems	IBM Block Storage or Other Storage Service or Local File system
8.	External API-1	Purpose of External API used in the application	IBM Weather API, etc.
9.	External API-2	Purpose of External API used in the application	Aadhar API, etc.
10.	MQTT	MQTT is well-suited for remote monitoring and control applications due to its low bandwidth and low power consumption characteristics.	Object Recognition Model, etc.
11.	HTTPS	Protects sensitive data	Public key infrastructure(PKI)

Table-2: Application Characteristics

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	List the open-source frameworks used	Technology of Open source framework
2.	Security Implementations	Strong authentication protocols, encrypted communication channels, and regular security audits to identify and address potential vulnerabilities	e.g. SHA-256, Encryptions, IAM Controls, OWASP etc.
3.	Scalable Architecture	Justify the scalability of architecture (3 – tier, Micro-services)	Technology used
4.	Availability	These systems are typically designed to meet the specific requirements of hospitals and can be done through authorized dealers, system integrators, or directly from manufacturers.	Technology used
5.	Performance	System design ,implementation quality maintenance practices	Technology used

4.3 USERS STORIES

1. As a hospital administrator,I want to receive immediate alerts and notifications in case of a gas leak or abnormal gas concentration, so that I can take prompt action to ensure the safety of patients and staff.

2. As a maintenance technician, I want to easily identify the location of a gas leak within the hospital **premises,** so that I can quickly respond and fix the issue to prevent any potential harm.

3. As a compliance officer, I want to generate reports on gas pipeline monitoring activities and incidents, so that I can ensure that the hospital is meeting regulatory requirements and maintain a record of compliance.

4. As a hospital administrator, I want to have access to historical data and analytics on gas consumption and pressure levels, so that I can make informed decisions about maintenance and optimize resource usage.

5. As a hospital staff member, I want to have a user-friendly interface to report any suspected gas leaks, so that the maintenance team can investigate and resolve the issue promptly.

6. As a maintenance staff member, I want to be able to remotely control and monitor gas valves and regulators, so that I can efficiently manage the gas supply and respond to emergencies without delay.

7. As a hospital administrator, I want the system to generate detailed reports and logs of gas pipeline events, including leak incidents, maintenance activities, and repairs, for compliance and audit purposes.

8. As a hospital administrator, I want the system to integrate with our existing building management system (BMS), so that we can have a centralized view of all critical infrastructure systems.

9. As a maintenance staff member, I want the system to provide predictive maintenance capabilities, notifying me of potential equipment failures or maintenance needs based on data analysis and patterns.

10. As a hospital staff member, I want to receive training and documentation on how to use the gas pipeline monitoring system effectively and safely, so that I can respond appropriately in case of an emergency.

5. CODING AND SOLUTIONING (EXPLAIN THE FEATURES ADDED IN THE PROJECT ALONG WITH CODE)

To develop a gas pipeline monitoring system for hospitals, you would typically need to consider the following steps:

1. Requirements Gathering: Understand the specific requirements and objectives of the gas pipeline monitoring system in the hospital. Determine the desired features, such as real-time monitoring, leak detection, data analysis, and reporting.

2. Sensor Installation: Install appropriate sensors along the gas pipelines to capture relevant data, such as pressure, flow rate, and temperature. These sensors can be connected to a central monitoring system.

3. Data Acquisition: Set up a data acquisition system to collect data from the installed sensors. This can involve using microcontrollers or IoT devices to gather data at regular intervals or in real-time.

4. Data Transmission: Establish a reliable communication system to transmit the acquired data from the sensors to the central monitoring system. This can be

achieved using wired or wireless communication protocols such as Ethernet, WiFi, or Bluetooth.

5. Central Monitoring System: Develop a central monitoring system that receives and processes the data from the sensors. This system should have a user-friendly interface for visualizing the data, displaying alerts, and generating reports. It should also include algorithms for analyzing the data and detecting any abnormalities or potential leaks.

6. Alerting and Notification: Implement an alerting mechanism to notify relevant personnel when a gas leak or anomaly is detected. This can involve sending realtime alerts through email, SMS, or push notifications to authorized individuals responsible for gas pipeline maintenance or safety.

7. Data Analysis and Reporting: Utilize data analysis techniques to derive insights from the collected data. This can involve identifying trends, detecting patterns, and generating reports on gas consumption, leak incidents, or system performance. These reports can help in decision-making, maintenance planning, and system optimization.

8. Maintenance and Upgrades: Implement a system for regular maintenance, including sensor calibration, software updates, and periodic inspections. Additionally, consider incorporating scalability and flexibility in the solution to accommodate future expansions or upgrades.

It's important to note that the implementation details and technologies used may vary depending on specific requirements, existing infrastructure, and available resources. Consulting with domain experts, including gas pipeline engineers and hospital staff, can provide valuable insights to ensure a robust and tailored solution

5.1 FEATURE 1

1. **REAL-TIME MONITORING**

   Real-time monitoring is essential to detect any anomalies or leaks in the gas pipeline system promptly. This can be achieved by implementing sensors and integrating them with the monitoring software. Here's an example code snippet to demonstrate real-time monitoring using Python:

Python code

```
import sensor_library

def monitor_gas_pipeline():

    while True:

        sensor_data = sensor_library.get_sensor_data()
if sensor_data['gas_level'] > threshold:
            send_alert_email()

        # Perform other monitoring tasks

def send_alert_email():

    # Code to send alert email to the hospital staff
    Pass
```

5.2 FEATURE 2

2. **THRESHOLD BASED ALERTS:** Setting thresholds for gas levels can help trigger alerts when the gas concentration exceeds the safe limit. The following code snippet shows how to incorporate threshold-based alerts:

Python code

```
threshold = 5.0  # Example threshold value in ppm

def monitor_gas_pipeline():
while True:

    sensor_data = sensor_library.get_sensor_data()

    if sensor_data['gas_level'] > threshold:

        send_alert_email()

    # Perform other monitoring tasks

def send_alert_email():

  # Code to send alert email to the hospital staff
  Pass
```

5.3 DATABASE SCHEMA (IF APPLICABLE)

A gas pipeline monitoring system requires a database to store and manage data related to gas levels, sensor readings, alarms, and other relevant information. Here's an example of a possible database schema for a gas pipeline monitoring system in a hospital:

Table: Hospitals

Columns: hospital_id (Primary Key), name, address, contact_info

Table: GasSensors

Columns: sensor_id (Primary Key), hospital_id (Foreign Key), location, installation_date

Table: GasReadings

Columns: reading_id (Primary Key), sensor_id (Foreign Key), reading_timestamp, gas_level

Table: Alarms

Columns: alarm_id (Primary Key), sensor_id (Foreign Key), alarm_timestamp, description

This schema consists of four tables: Hospitals, GasSensors, GasReadings, and Alarms. Let's go through each table in more detail:

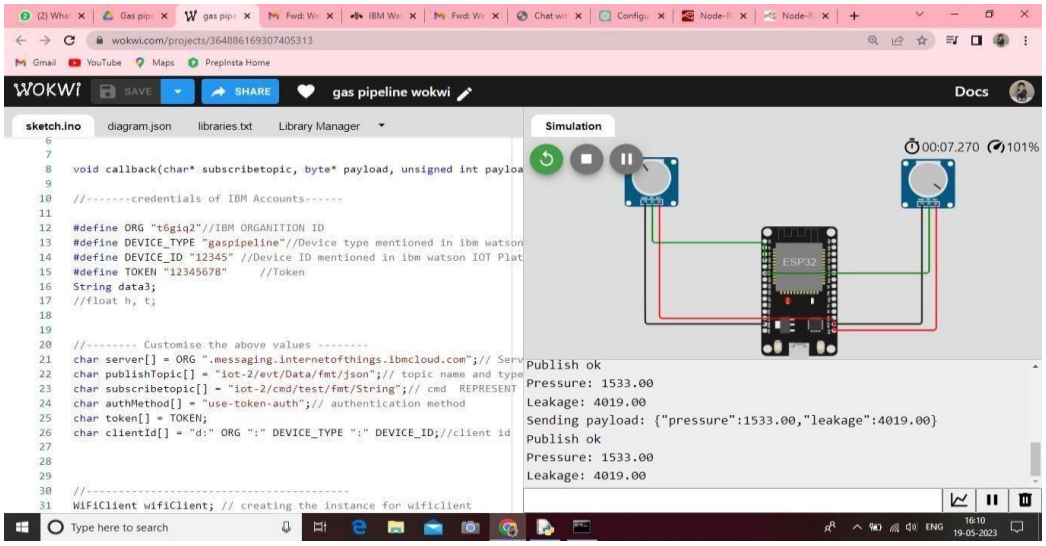
Hospitals: This table stores information about the hospitals using the gas pipeline monitoring system. Each hospital is identified by a unique hospital_id.

hospital_id: Unique identifier for each hospital.

name: Name of the hospital. address:

Address of the hospital.

6. RESULTS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SAVE
SHARE
gas pipeline wokwi
Docs
sketch.ino
diagram.json
libraries.txt
Library Manager
void callback(char* subscribetopic, byte* payload, unsigned int payloa
//-------credentials of IBM Accounts------
#define ORG "t6giq2"//IBM ORGANITION ID
#define DEVICE_TYPE "gaspipeline"//Device type mentioned in ibm watson
#define DEVICE_ID "12345" //Device ID mentioned in ibm watson IOT Plat
#define TOKEN "12345678" //Token
String data3;
//float h, t;
//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Serv
char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type
char subscribetopic[] = "iot-2/cmd/test/fmt/String";// cmd REPRESENT
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id
//-------------------------------------
WiFiClient wifiClient; // creating the instance for wificlient
Simulation
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101%
ESP32
Publish ok
Pressure: 1533.00
Leakage: 4019.00
Sending payload: {"pressure":1533.00,"leakage":4019.00}
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Leakage: 4019.00
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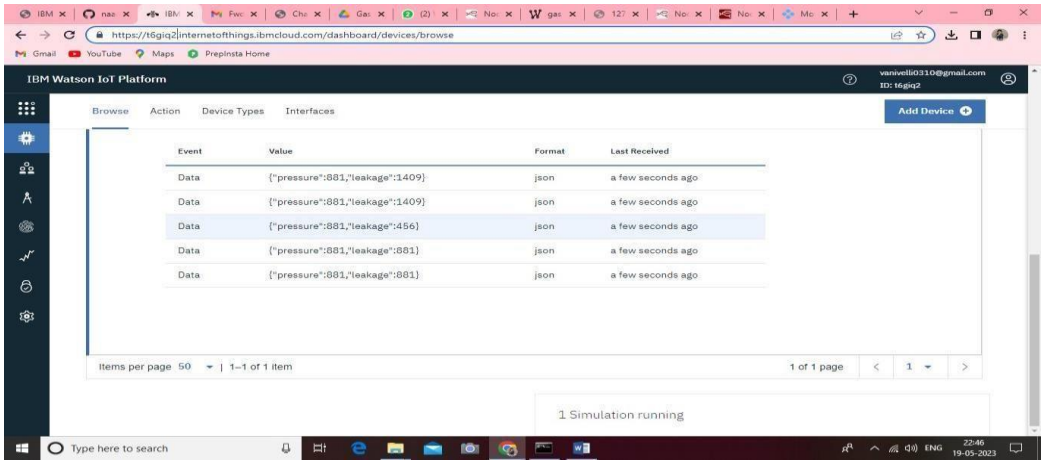
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IBM Watson IoT Platform
vanivelli0310@gmail.com
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Interfaces
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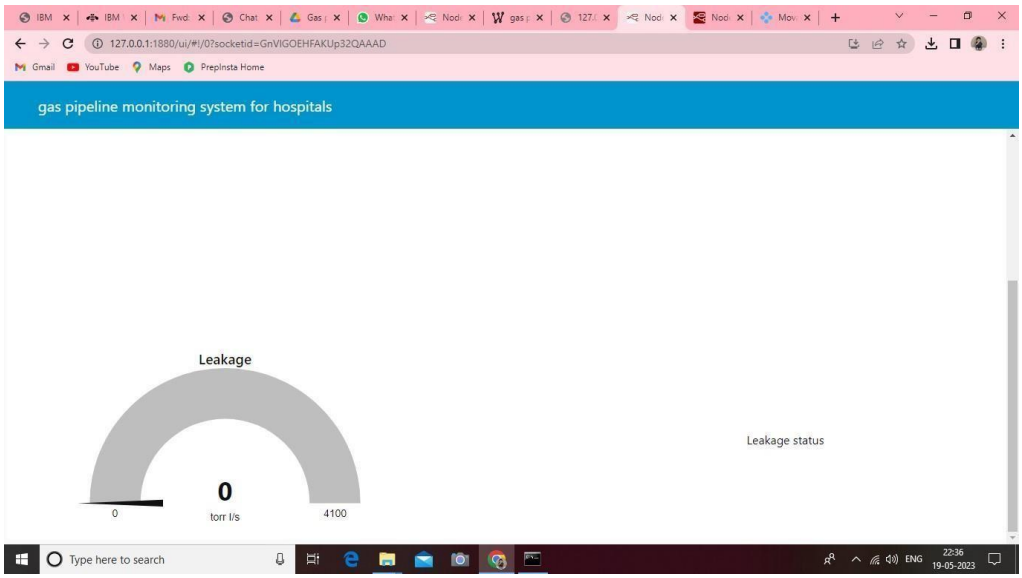
19-05-2023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gas pipeline monitoring system for hospitals
Leakage
0
torr l/s
0
4100
Leakage status
Type here to search
ENG
22:36
19-05-2023

6.1 PERFORMANCE METRICES

Performance metrics or matrices for a gas pipeline monitoring system can help evaluate its effectiveness, efficiency, and reliability. Here are some commonly used performance metrics for a gas pipeline monitoring system:

- **RESPONSE TIME**: Response time measures how quickly the system can detect and respond to anomalies or alarms. It is typically measured as the time elapsed between the occurrence of an event (e.g., gas leak) and the system's response (e.g., triggering an alarm or notifying relevant personnel).
- **ACCURACY**: Accuracy measures the system's ability to accurately detect gas leaks or abnormal gas levels. It is usually calculated by comparing the system's detected anomalies or alarms with the ground truth (e.g., verified gas leak incidents). The accuracy metric can help assess the system's reliability and effectiveness in identifying actual gas pipeline issues.
- **FALSE POSITIVE RATE**: The false positive rate quantifies the percentage of false alarms or alerts triggered by the system when no actual gas leak or anomaly is present. Minimizing the false positive rate is crucial to avoid unnecessary disruptions and alarm fatigue among hospital staff.
- **FALSE NEGATIVE RATE**: The false negative rate represents the percentage of missed gas leaks or anomalies that the system fails to detect. A high false negative rate indicates a potential risk of undetected gas leaks, compromising the safety of the gas pipeline system. Minimizing the false negative rate is essential to ensure the system's effectiveness in detecting actual incidents.
- **MEAN TIME TO REPAIR (MTTR)**: MTTR measures the average time taken to repair or resolve issues identified by the system. It includes the time required to investigate, diagnose, and fix the problem in the gas pipeline system. Minimizing MTTR helps ensure timely response and reduces the potential impact of gas leaks or abnormalities.
- **AVAILABILITY**: Availability refers to the percentage of time that the gas pipeline monitoring system is operational and accessible. High availability ensures that the system is consistently monitoring the gas

pipeline, reducing the risk of undetected incidents due to system downtime.

- **DATA INTEGRITY**: Data integrity ensures the accuracy, consistency, and reliability of the data stored in the system. It involves measures to prevent data corruption, loss, or unauthorized access. Maintaining data integrity is essential for making informed decisions based on reliable data.
- **SYSTEM STABILITY**: System stability refers to the overall reliability and robustness of the gas pipeline monitoring system. It involves monitoring and minimizing system crashes, software bugs, or other technical issues that can disrupt the system's continuous operation.

These performance metrics can be measured and evaluated over time to assess the gas pipeline monitoring system's effectiveness, efficiency, and reliability. Regular monitoring and analysis of these metrics can help identify areas for improvement and ensure the system's optimal performance.

7. ADVANTAGES AND DISADVANTAGES

Advantages of Gas Pipeline Monitoring System in Hospitals:

- **SAFETY**: A gas pipeline monitoring system helps ensure the safety of patients, staff, and the hospital infrastructure by continuously monitoring gas levels and detecting any anomalies or leaks promptly. Early detection enables quick response and preventive actions to mitigate potential hazards.
- **RAPID RESPONSE**: The system provides real-time monitoring and immediate alerts in case of gas leaks or abnormal gas levels. This allows hospital staff to respond quickly, evacuate affected areas if necessary, and take appropriate measures to minimize risks
- **ENHANCED EFFICIENCY**: Gas pipeline monitoring systems automate the monitoring process, reducing the need for manual checks and inspections. This improves operational efficiency by saving time and resources, allowing hospital staff to focus on other critical tasks.
- **DATA-DRIVEN INSIGHTS**: The system collects and stores data on gas levels, readings, and alarms, providing valuable insights for analysis and decision-making. Analyzing historical data can help

identify patterns, optimize gas usage, and improve the overall gas pipeline infrastructure in hospitals.

- **REMOTE MONITORING AND CONTROL**: Many gas pipeline monitoring systems offer remote access capabilities, enabling authorized personnel to monitor and control the system from anywhere. This allows for quick response and intervention, even when staff members are not physically present on-site.

7. DISADVANTAGES OF GAS PIPELINE MONITORING SYSTEM

- **COST**: Implementing a gas pipeline monitoring system can involve significant upfront costs, including the installation of sensors, infrastructure, and software. Additionally, there may be ongoing expenses for maintenance, upgrades, and system monitoring.
- **COMPLEXITY**: Gas pipeline monitoring systems can be complex to design, implement, and maintain. They require expertise in sensor technology, data analysis, and system integration. Adequate training and support are essential to ensure proper utilization of the system.
- **FALSE ALARMS**: Gas pipeline monitoring systems may occasionally generate false alarms due to sensor malfunctions, environmental factors, or transient gas fluctuations. False alarms can lead to staff complacency or alarm fatigue if they occur frequently, potentially impacting the system's effectiveness.
- **DATA SECURITY AND PRIVACY**: Gas pipeline monitoring systems collect and store sensitive data about gas levels and infrastructure. Ensuring the security and privacy of this data is crucial to prevent unauthorized access or misuse. Adequate security measures and compliance with data protection regulations are essential.
- **DEPENDENCY ON TECHNOLOGY:** Gas pipeline monitoring systems heavily rely on technology infrastructure, including sensors, software, and network connectivity. Any technical issues, such as power outages, system failures, or network disruptions, can temporarily render the system non-operational, potentially impacting patient safety.

It is important to carefully evaluate the advantages and disadvantages of a gas pipeline monitoring system in the context of a specific hospital's needs, budget.

8. CONCLUSION

In conclusion, a gas pipeline monitoring system plays a crucial role in ensuring the safety and efficiency of gas distribution in hospitals. By continuously monitoring gas levels, detecting anomalies, and providing real-time alerts, the system helps mitigate potential risks and enables rapid response to gas leaks or abnormalities. The system offers several advantages, including enhanced safety, rapid response, improved efficiency, data-driven insights, and remote monitoring capabilities.

However, there are also considerations and potential disadvantages to keep in mind. Implementing a gas pipeline monitoring system involves upfront costs, complexity in design and maintenance, the possibility of false alarms, data security and privacy concerns, and dependency on technology infrastructure.

Overall, the decision to implement a gas pipeline monitoring system in hospitals should be based on a careful evaluation of the specific needs, resources, and constraints of the institution. When properly designed, implemented, and maintained, a gas pipeline monitoring system can significantly contribute to the safety and efficiency of gas distribution in hospitals, providing peace of mind to patients, staff, and stakeholders.

9. FUTURE SCOPE

The future scope for a gas pipeline monitoring system in hospitals can involve the following potential enhancements and advancements:

ADVANCED SENSOR TECHNOLOGY: Integration of advanced sensor technologies such as IoT (Internet of Things) devices, wireless sensors, and smart meters can enhance the accuracy and efficiency of gas level monitoring. These sensors can provide real-time data, enable better anomaly detection, and offer more precise measurements.

PREDICTIVE ANALYTICS: Implementing predictive analytics algorithms can help identify patterns and trends in gas level data. By analyzing historical data and combining it with other variables such as weather conditions or occupancy rates, the system can predict potential gas pipeline issues or identify opportunities for preventive maintenance.

INTEGRATION WITH BUILDING MANAGEMENT SYSTEMS (BMS): Integrating the gas pipeline monitoring system with the hospital's BMS allows for centralized control and monitoring of multiple systems. This integration enables seamless coordination with HVAC (Heating, Ventilation, and Air Conditioning) systems, fire alarms, and other infrastructure, ensuring comprehensive safety management.

MOBILE APPLICATIONS: Developing mobile applications for gas pipeline monitoring systems allows authorized personnel to access real-time data, receive alerts, and remotely control the system. Mobile apps can enhance flexibility and provide on-the-go monitoring and control capabilities, improving overall system efficiency and response times.

AUTOMATED SHUT-OFF VALVES: Integrating the gas pipeline monitoring system with automated shut-off valves enables immediate isolation of affected sections in the event of a gas leak. This feature helps minimize the risk of gas spreading throughout the hospital and enhances safety measures.

10. APPENDIX

10.1 SOURCE CODE

```
#include <WiFi.h>//library for wifi

#include <PubSubClient.h>//library for MQtt float pressure; float leakage; void

callback(char* subscribetopic, byte* payload, unsigned int payloadLength);

//-------credentials of IBM Accounts------

#define ORG "t6giq2"//IBM ORGANITION ID

#define DEVICE_TYPE "gaspipeline"//Device type mentioned in ibm watson IOT Platform

#define DEVICE_ID "12345" //Device ID mentioned in ibm watson IOT Platform

#define TOKEN "12345678"      //Token

String data3;

//float h, t;

//-------- Customise the above values --------

char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Server Name

char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type of event perform and format in which data to be send

char subscribetopic[] = "iot-2/cmd/test/fmt/String";// cmd REPRESENT command type AND COMMAND IS TEST OF FORMAT STRING

char authMethod[] = "use-token-auth";// authentication method char

token[] = TOKEN; char clientId[] = "d:" ORG ":" DEVICE_TYPE ":"

DEVICE_ID;//client id

//_____

WiFiClient wifiClient; // creating the instance for wificlient
```

PubSubClient client(server, 1883, callback ,wifiClient); //calling the predefined client id by passing parameter like server id,portand wificredential void setup()// configureing the ESP32

```
{
  Serial.begin(115200);
delay(10);
Serial.println();
wificonnect();
mqttconnect();
}
void loop()// Recursive Function
{
pressure=analogRead(34);
leakage=analogRead(32);
Serial.print("Pressure: ");
Serial.println(pressure);
Serial.print("Leakage: ");
Serial.println(leakage);
delay(1000);
PublishData(pressure,leakage);
delay(1000);
  if            (!client.loop())            {
mqttconnect();
  }
}
```

```
/.....retrieving to Cloud..... /
void PublishData(float pressure,float leakage) {
mqttconnect();//function call for connecting to ibm
 /*  creating the String in in form JSon to update the data to ibm
cloud
 */
 String payload = "{\"pressure\":";
payload += pressure;  payload +=
"," "\"leakage\":";  payload +=
leakage;  payload += "}";
Serial.print("Sending payload: ");
Serial.println(payload);  if (client.publish(publishTopic,
(char*) payload.c_str())) {
  Serial.println("Publish ok");// if it sucessfully upload data on the cloud then it
will print publish ok in Serial monitor or else it will print publish failed  } else
{
  Serial.println("Publish failed");
 } }
void mqttconnect() {
 if (!client.connected()) {
  Serial.print("Reconnecting client to ");
Serial.println(server);  while (!!!client.connect(clientId,
authMethod, token)) {  Serial.print(".");
delay(500);
  }
```

```
    initManagedDevice();
    Serial.println();
  } }
void wificonnect() //function defination for wificonnect
{
  Serial.println();
  Serial.print("Connecting to ");
  WiFi.begin("Wokwi-GUEST", "", 6);//passing the wifi credentials to establish the connection   while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}
void initManagedDevice() {
  if (client.subscribe(subscribetopic)) {
    Serial.println((subscribetopic));
    Serial.println("subscribe to cmd OK");
  } else {
    Serial.println("subscribe to cmd FAILED");
  } }
```

```
void callback(char* subscribetopic, byte* payload, unsigned int payloadLength)
{
  Serial.print("callback invoked for topic:
");   Serial.println(subscribetopic);    for (int
i = 0; i < payloadLength; i++) {
//Serial.print((char)payload[i]);     data3 +=
(char)payload[i];
  }
 Serial.println("data: "+ data3);     data3="";
}
```

10.2 GITHUB AND PROJECT VIDEO DEMO LINK

WOKWI LINK

https://wokwi.com/projects/364886169307405313

DEMO LINK

https://drive.google.com/file/d/1qEMQhmO7XZGcyqTQp5UPn9kPnK2MhIl/view?usp=sharing