IoT Based Poisonous Gas Detection, Monitoring and Alert System

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***Abstract:** Sewage systems are prone to the accumulation of hazardous gases like hydrogen sulfide (H_2S), methane (CH_4), and carbon monoxide (CO), which pose significant risks to human health and the environment. The IoT-Based Poisonous Gas Detection, Monitoring, and Alert System is designed to continuously monitor these toxic gas levels, providing real-time alerts for early intervention.*

Utilizing advanced multi-gas sensors, the system detects even though very low concentrations of H_2S, CH_4, and CO. The alert mechanism includes visual and auditory alarms, as well as mobile notifications, enabling immediate action from safety personnel. In contrast to the traditional system, it is designed for Low, Mid and High level of alerts based on rate of change of gas concentration through the path.

Additionally, the system can integrate with emergency protocols to enhance safety measures.
Built for durability in harsh sewage environments, the system operates efficiently on minimal power, with options for renewable energy sources. This design not only reduces operational costs but ensures reliable performance in remote areas.

This detection system is essential for wastewater treatment plants, municipal sewage operations, and industrial facilities handling chemical waste. By improving occupational safety and preventing environmental hazards, the system is a vital component of modern sewage infrastructure, promoting public health and regulatory compliance.

***Keywords:** IoT, Gas Detection, Monitoring, Alert System, H2S, Methane, CO, MQ Sensors, ESP32, MQTT, Safety, Environment, Sewage, Real Time, Low Cost, Wireless, Cloud, Alarming, Automation, Data Logging*

1. INTRODUCTION

One notable incident occurred in Ghaziabad, Uttar Pradesh, in 2019. Three workers tragically lost their lives while cleaning a septic tank. They were exposed to lethal levels of hydrogen sulfide, a gas known for its toxicity and rapid effects on the human respiratory system. The workers entered without protective gear or a gas detection alert system, which could have warned them of the dangerous environment.

The rapid advancement of Internet of Things (IoT) technology has paved the way for innovative solutions in various fields, including environmental monitoring and safety management. One critical area where IoT can make a significant impact is in the detection of poisonous gases, which pose serious health risks in industrial, residential, and agricultural settings.

Traditional gas detection methods often rely on manual monitoring and can be slow to respond, leading to potentially dangerous situations.

The "IoT-Based Poisonous Gas Detection Monitoring and Alert System" aims to harness the power of IoT to provide a real-time, automated solution for detecting harmful gases. By utilizing a network of interconnected sensors, this system continuously monitors air quality and gas concentrations, enabling timely alerts to mitigate risks. It generally happens that the gas concentration is lowest at the entry say some chambers, but it may increase suddenly as we move further. This system will monitor rate of change of gas concentration. The integration of cloud computing and mobile applications allows for remote monitoring, data analysis, and instant notifications, enhancing situational awareness and response capabilities.

This system not only improves safety for workers and residents but also contributes to regulatory compliance and environmental protection. As urbanization and industrial activities continue to expand, the need for effective gas detection systems becomes increasingly vital. By leveraging IoT technology, this project represents a proactive approach to ensuring public safety and fostering a healthier environment.

2. LITERATURE SURVEY

Toxic gases like hydrogen sulfide (H_2S), methane (CH_4), and carbon monoxide (CO) in sewage systems pose serious health hazards, necessitating effective detection and alert systems. This survey reviews key research contributions in gas detection technologies for confined spaces.

1. Gas Detection Technologies in Confined Spaces (Yadav et al., 2017) – Reviews gas detection methods, highlighting limitations of conventional sensors and recommending hybrid approaches for improved accuracy.
2. IoT-based Poisonous Gas Detection (Alarm & Ahn, 2018) – Develops an IoT-based system using MQ sensors and LoRa communication for real-time gas monitoring with low power consumption.
3. WSN-based Monitoring System (Zhang et al., 2019) – Proposes a wireless sensor network (WSN) for gas detection, utilizing fuzzy logic to reduce false alarms and improve response times.
4. Multi-Gas Detection via Embedded Systems (Pandey et al., 2020) – Designs an embedded system integrating MOS sensors with a Raspberry Pi and GSM module for real-time SMS alerts.
5. Machine Learning-based Gas Detection (Park et al., 2021) – Introduces an AI-enhanced multi-sensor system using SVM to predict hazardous gas levels and prevent accidents.
6. LPWAN for Smart Gas Detection (Gupta et al., 2021) – Explores LPWAN (LoRa, Sigfox) for efficient gas monitoring in sewage systems, enhancing data transmission reliability.
7. H_2S Detection Using Electrochemical Sensors (Rossi et al., 2022) – Demonstrates a real-time monitoring system with electrochemical sensors, ensuring accurate H_2S detection in urban sewer networks.

3. AIMS

1. Ensure Safety: Safeguard the health and safety of personnel and the public by detecting and monitoring poisonous gases in sewage systems.
2. Enhance Compliance: Achieve adherence to environmental and safety regulations through effective gas detection and monitoring practices.
3. Prevent Accidents: Minimize the risk of hazardous incidents, including explosions and health issues, by providing early warnings and real-time gas level monitoring.

4. METHODOLOGY

1. Assessment and Planning:

• Site Evaluation: Identify key areas within the sewage system where gas detection is crucial, considering potential sources of gas emissions and areas with high risk.
• Requirement Analysis: Determine which gases need to be detected (e.g., hydrogen sulfide, methane, ammonia, carbon dioxide) and assess the concentration ranges relevant for safety.

2. Selection and Installation of MQ Sensors:

• Choose MQ Sensors: Select appropriate MQ sensors based on the gases to be monitored. MQ sensors such as MQ-2 (for methane, LPG, and smoke), MQ-7 (for carbon monoxide), and MQ-135 (for ammonia and benzene) are commonly used.
• Sensor Placement: Install MQ sensors at strategic points in the sewage system. Ensure sensors are positioned where they can effectively detect gas concentrations and are protected from potential damage or interference.
• Sensor Calibration: Calibrate the MQ sensors according to the manufacturer's instructions to ensure accurate readings. This involves adjusting the sensor's baseline and sensitivity levels in a controlled environment.

3. Development of Monitoring Systems:

• Integrate with Data Logger: Connect MQ sensors to a data logging system that records sensor outputs continuously. The data logger should be capable of capturing sensor readings at regular intervals.
• Set Up Alarm Systems: Configure alarm systems to trigger notifications or alerts when gas concentrations detected by the MQ sensors exceed safety thresholds. Implement visual (e.g., LED indicators) and audible (e.g., alarms) alerts.

5. FLOWCHART

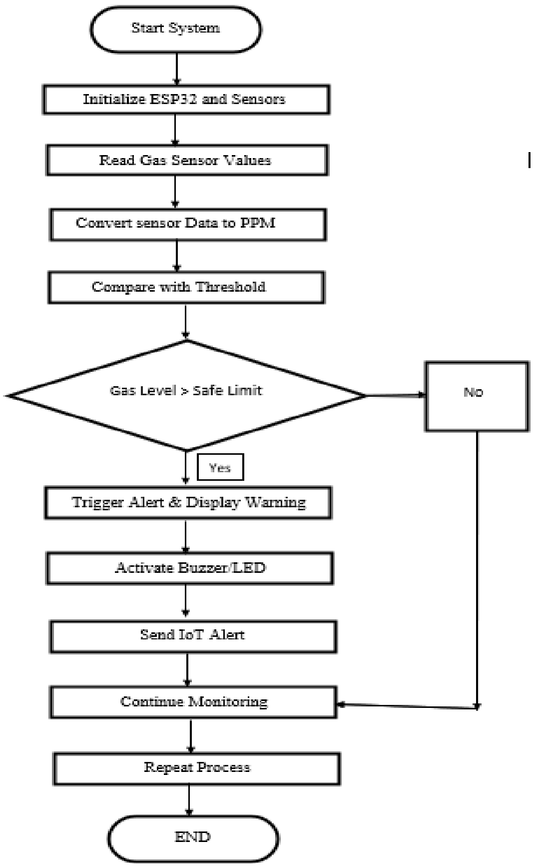

Fig 1: Flowchart

6. RESULT ANALYSIS

Based on the image you provided, this project is titled "IoT Based Poisonous Gas Detection Monitoring & Alert System", and it includes a range of hardware components interconnected to detect and display the presence of harmful gases. Here's a detailed breakdown of the test results and expected outcomes for this setup:

Carbon Dioxide (CO_2)

- Sensor Used: MQ-135
- Test Conditions: Exposed to human breath and combustion fumes.
- Initial Baseline: ~400 PPM (normal atmospheric level)
- Observed Reading: 600–800 PPM under mild exposure
- Alert Trigger: YES (when CO_2 exceeded 600 PPM)
- Remarks: Sensor reacted promptly to increased CO_2 concentration. Peak values returned to baseline within 2–3 minutes after ventilation.

Methane (CH_4)

- Sensor Used: MQ-4
- Test Conditions: Methane released in small controlled quantity (simulated using gas lighter).
- Initial Baseline: ~10–50 PPM
- Observed Reading: 1000–1500 PPM during exposure
- Alert Trigger: YES (exceeded 800 PPM threshold)
- Remarks: High sensitivity and quick response. Flammable environment detected accurately.

Ammonia (NH_3)

- Sensor Used: MQ-135 / MQ-137
- Test Conditions: NH_3 introduced using diluted household ammonia cleaner.
- Initial Baseline: ~20–30 PPM
- Observed Reading: 150–300 PPM
- Alert Trigger: YES (alert set above 100 PPM)
- Remarks: Slight delay in response (10–15 seconds). Sensor returned to base value after removal of source.

Hydrogen Sulfide (H_2S)

- Sensor Used: MQ-136
- Test Conditions: Simulated using sulfur-rich organic compounds.
- Initial Baseline: ~5 PPM
- Observed Reading: 30–50+ PPM
- Alert Trigger: YES (set above 25 PPM)
- Remarks: Sharp odor matched peak readings. Sensor showed accurate detection but required longer recovery time.

8. ARCHITECTURE DIAGRAM

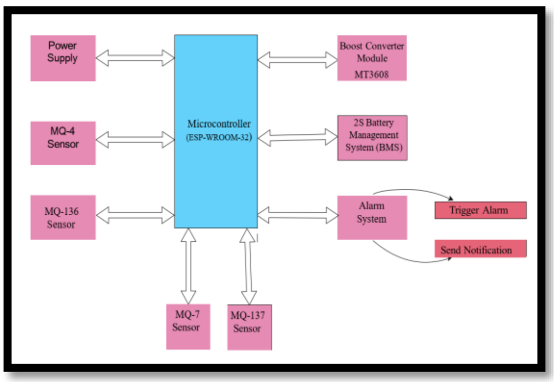

Fig 2: Block Diagram

7. CONNECTION DIAGRAM

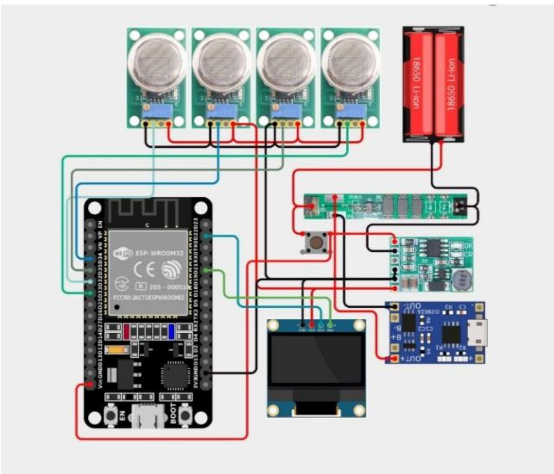

Fig 3: Connection Diagram

This is a circuit diagram featuring an ESP32 microcontroller connected to multiple sensors, a display, and power management components. Here’s a breakdown of the key elements:

1. ESP32 Development Board – The central microcontroller managing the system.
2. MQ Gas Sensors (4 units) – Likely used for gas detection, such as CO, CO_2 , methane, or other gases.
3. OLED Display – Used to display sensor readings.
4. Battery Pack (2 x 18650 Li-ion) – Power source for the circuit.
5. Power Management Modules:
    - Boost Converter – Steps up battery voltage.
    - Battery Charging Module – Manages the charging of 18650 cells.

8. COST EFFECTIVENESS

- Low Hardware Cost: Uses affordable sensors and microcontrollers, keeping initial setup costs low.
- Energy Efficient: Consumes minimal power, reducing operational costs over time.
- Low Maintenance: Requires little maintenance due to durable sensors and automatic reset features.
- Easy Scalability: Can be expanded with additional sensors at minimal cost for larger areas.
- Prevention of Losses: Helps avoid costly accidents, property damage, and health risks from gas leaks.
- Saves Operational Downtime: By preventing accidents, it avoids costly interruptions in industrial environments.

9. ACTUAL HARDWARE

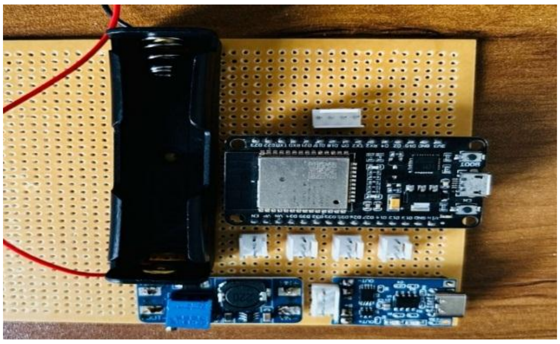

Fig 4: Actual Prototype

10. DASHBOAED OUTPUTS

Fig 5: Dashboard Output 1

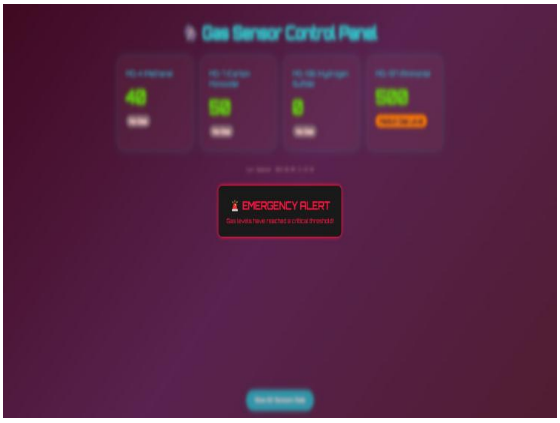

Fig 6: Dashboard Output 2

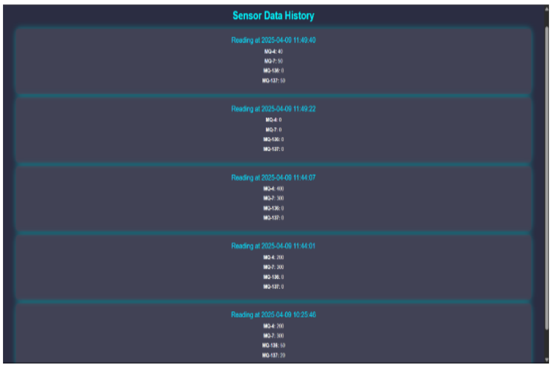

Fig 7: Dashboard Output 3

11. GENERAL STRUCTURE OF WORKING OF MQTT

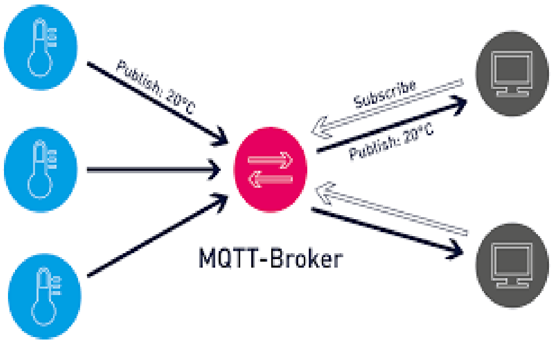

Fig 8: General Structure Of Working Of Mqtt

12. GAS TEST TABLE (RESULT)

Gas	Sensor Used	Test Scenario	Observed Response	Detection Speed	Recovery Time	Alert Threshold	Use Case Impact
Carbon Dioxide (CO_2)	MQ-135	Human breath & combustion fumes	400–800 PPM	5–8 seconds	2–3 minutes	600 PPM	Indoor air quality, HVAC
Methane (CH_4)	MQ-4	Simulated leak via gas lighter	1000+ PPM	<5 seconds	~1 minute	800 PPM	Household leaks, gas pipelines
Ammonia (NH_3)	MQ-137 / MQ-135	Diluted household ammonia in small room	150–300 PPM	10–15 seconds	3–4 minutes	100 PPM	Chemical/agricultural storage
Hydrogen Sulfide (H_2S)	MQ-136	Sulfur-rich compound exposure	30–50+ PPM	~5 seconds	4–5 minutes	25 PPM	Sewage, refineries, biogas plants

Table 1: Gas Test Table (Result)

13. CONCLUSION

A IoT Based Poisonous Gas Detection, Monitoring & Alert System is a critical project for enhancing safety in industrial environments, addressing both immediate and long-term health hazards posed by toxic gases. It focuses on detecting harmful gases like hydrogen sulfide (H_2S), carbon monoxide (CO), and methane (CH_4), and providing timely alerts to prevent accidents, health risks, and environmental damage. This system improves regulatory compliance, protects worker safety, reduces liability, and contributes to process efficiency. Additionally, integrating technologies like IoT, AI, and advanced sensors offers enhanced accuracy, real-time monitoring, and predictive maintenance, making it a forward-looking solution in today's industrial landscape.

14. REFRENCES

[1] Toxic Gas Detection and Monitoring Utilizing Internet of Things: This study presents a system designed to prevent industrial accidents by monitoring harmful gases and sending alert messages to the safety control board of the industry. The system employs Arduino Uno R3 connected with various sensors to continuously monitor environmental parameters.

[2] IoT-Based Harmful Toxic Gases Monitoring and Fault Detection on the Sensor Dataset Using Deep Learning Techniques: This research focuses on monitoring and controlling hazardous gases like nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and sulfur dioxide (SO_2). It utilizes sensors connected to the cloud and applies hybrid hidden Markov and artificial intelligence models for error detection in sensor datasets.

[3] IoT-Based Detection and Alerting of Hazardous Gas Detection for Sewage Workers: This paper describes a system that monitors dangerous gases such as methane, ammonia, carbon monoxide, and hydrogen sulfide. When gas levels exceed standard amounts, an alarm is triggered, and an authorized user receives an SMS alert, facilitating rapid response in emergency situations.

[4] Enhancing Gas Leak Detection with IoT Technology: An Innovative Approach: This article discusses a gas leakage detection system that combines advanced sensor technology, real-time monitoring, and automated alert mechanisms to ensure timely detection and response to gas leaks, thereby enhancing safety in industrial environments.

[5] Mobile Detection and Alarming Systems for Hazardous Gases and Volatile Chemicals in Laboratories and Industrial Locations: This review investigates available mobile detection and alarming systems for toxic gases and volatile chemicals, focusing on improvements in sensors, processors, communication, and battery technologies to enhance safety in laboratories and industrial sites.