Smart Air Quality Monitoring in Crowded Urban Spaces Using IOT

Hitesh Bachhav[1], Shantanu Ekhande[2], Shashikant Jadhav[3], Om More[4], Mr. S. N. Shinde[5], Prof. M. P. Bhandakkar[6]

[1,2,3,4] *Student, Department of Information Technology, Matoshri Aasarabai Institute of Technology and Research Centre, Eklahare, Nashik, MH 422105*

[5] *Lecturer, Department of Information Technology, Matoshri Aasarabai Institute of Technology and Research Centre, Eklahare, Nashik, MH 422105*

[6] *HOD, Department of Information Technology, Matoshri Aasarabai Institute of Technology and Research Centre, Eklahare, Nashik, MH 422105*

***Abstract*—Industrial environments often involve hazardous gases and unsafe working conditions that can cause serious accidents, environmental pollution, and financial losses. Continuous monitoring is essential to ensure workplace safety and regulatory compliance.This project proposes an IoT-Based Industrial Safety Monitoring and Compliance Dashboard that enables real-time gas detection and automated reporting. The system uses MQ-series gas sensors (MQ-2, MQ-7, MQ-8, MQ-135) connected to an Arduino UNO microcontroller to detect gases such as methane, carbon monoxide, hydrogen, ammonia, and other air pollutants. A GPS module provides location tracking, and the collected data is transmitted to a cloud-based dashboard using Wi-Fi/GSM connectivity.The dashboard provides role-based access for Admin, Regional Authority, Company Users, and End Users. Automated alerts and compliance reports are generated whenever gas levels exceed safe limits. The proposed system enhances safety, improves transparency, and reduces manual monitoring efforts.**

***Index Terms*—IoT, Industrial Safety, Gas Monitoring, Arduino UNO, Compliance Dashboard, Real-Time Monitoring**

I. INTRODUCTION

Industrial sectors such as chemical plants, refineries, and manufacturing units operate in environments where hazardous gases may be present. Gas leakage or improper monitoring can result in worker injuries, environmental damage, and economic losses.

Traditional safety monitoring methods rely on manual inspections and periodic audits. These systems lack real-time monitoring and centralized data access. As a result, emergency responses may be delayed.

To overcome these limitations, this project introduces an IoT-based monitoring system that continuously measures gas concentrations and updates the data to a cloud dashboard. This ensures proactive safety management and faster decision-making.

II.LITERATURE REVIEW

Sr no	Paper Title	Authors	Year	Technology / Method	Sensors Used	Key Findings	Limitations
1	IoT-Based Gas Leakage Detection System for Industrial Safety	S. Patil, R. Kulkarni	2022	IoT + Cloud Monitoring	MQ-2, MQ-7	Real-time detection and alert system improves response time	No compliance reporting or role-based dashboard
2	Real-Time Industrial Gas Monitoring	A. Sharma, P. Verma	2021	Arduino with IoT dashboard	MQ-135, MQ-8	Accurate monitoring of hazardous gases	Limited scalability and no authority access

	System Using IoT						
3	Cloud-Based Industrial Safety Monitoring Using IoT	T. Brown, E. Wilson	2021	Cloud dashboard visualization	Gas & Temperature Sensors	Centralized monitoring and historical data analysis	Focuses only on visualization
4	Smart Compliance Monitoring Framework for Industrial Safety	R. Singh, D. Patel	2023	Role-based access framework	—	Improves transparency and compliance tracking	No real-time hardware integration
5	Review of IoT-Based Industrial Safety and Compliance Systems	J. Smith, M. Anderson	2024	Comparative study	—	Identifies gaps in existing IoT safety systems	No experimental implementation

a. IoT-Based Gas Leakage Detection System for Industrial Safety – S. Patil, R. Kulkarni (2022). This study used IoT with cloud monitoring and MQ-2, MQ-7 sensors for real-time gas detection and alert systems, improving response time. However, it lacks compliance reporting and a role-based dashboard.
b. Real-Time Industrial Gas Monitoring System Using IoT – A. Sharma, P. Verma (2021). This system used Arduino with an IoT dashboard and MQ-135, MQ-8 sensors for accurate hazardous gas monitoring. The limitation is limited scalability and absence of authority-based access.
c. Cloud-Based Industrial Safety Monitoring Using IoT – T. Brown, E. Wilson (2021). The study focused on cloud dashboard visualization using gas and temperature sensors for centralized monitoring and historical data analysis, but it mainly concentrates on visualization without deeper system integration.
d. Smart Compliance Monitoring Framework for Industrial Safety – R. Singh, D. Patel (2023). This framework introduced role-based access to improve transparency and compliance tracking, though it does not include real-time hardware integration.
e. Review of IoT-Based Industrial Safety and Compliance Systems – J. Smith, M. Anderson (2024). This comparative study identified research gaps in existing IoT-based safety systems; however, it did not include any experimental implementation.

III. EXISTING SYSTEM

- In current industrial setups:
- Gas detection is often manual or standalone.
- Reports are maintained in physical registers.
- No centralized real-time dashboard exists.
- No automated compliance reporting system is available.
- Hardware location tracking is absent.
- These limitations make safety management inefficient and reactive.

Limitations of Existing System

- Depends on manual inspection
- Delayed response to emergencies
- No automatic alert system
- Limited transparency
- No centralized data storage
- No automatic alert or notification mechanism

IV. PROPOSED METHODOLOGY

A. Arduino UNO:

The Arduino is an open source hardware and software that can make a user to do effective operation in it. The Arduino is a microcontroller. These microcontroller

devices help in sensing and controlling the objects in the real-time situations and environment. These boards are available cheaper in the market. There are a number of inventions performed in it and still it is going on. A developer can send a set of instructions to the microcontroller. All Arduino boards are open-source, empowering users to build them independently, and ultimately adapt them to their particular needs. Arduino/Genuine Uno board consists of an ATmega328P microcontroller chip. It has 14 digital input-output pins, 6 analogy inputs, a 16 MHz quartz crystal, a USB connection, a power jack, and a reset button. The ATmega328 on the Arduino Uno comes programmed with a bootloader that allows uploading new code.

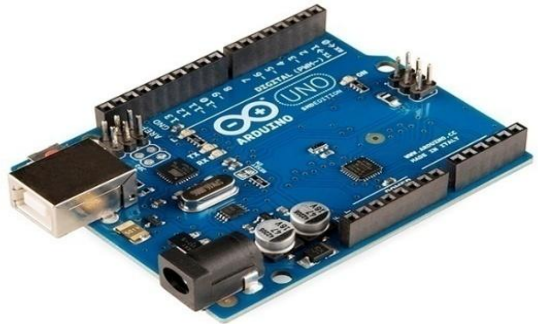


Figure: Arduino UNO

B. Gas Sensors (MQ Series):

The system employs multiple MQ-series sensors—MQ-2, MQ-7, MQ-8, and MQ-135—to detect a wide range of hazardous gases such as methane, propane, hydrogen, carbon dioxide, ammonia, and nitrogen oxides. These sensors are highly sensitive, capable of detecting gas concentrations in parts per million (ppm), and provide real-time inputs to the Arduino. This allows for early detection of leaks and harmful emissions to prevent accidents.

C. GPS Module:

The GPS module is integrated into the system to provide accurate location tracking of the industrial unit or monitoring site. In case of a detected gas leak or safety violation, the GPS data is sent along with sensor readings to the central dashboard. This ensures that regulatory authorities and companies can pinpoint the exact location of incidents and respond quickly, thereby reducing risks and ensuring accountability.

D. LCD Display:

The LCD module is used for local visualization of real-time sensor readings. Workers and operators on-site can

immediately check the levels of gases without relying solely on the cloud dashboard. This feature improves on-ground safety awareness and ensures that any unusual readings can be noticed and acted upon instantly, even before automated alerts are triggered.

Power Supply & Connectivity:

A stable power supply is provided to ensure uninterrupted functioning of the sensors and Arduino. Additionally, Wi-Fi or GSM connectivity modules are integrated to enable communication between the hardware unit and the cloud dashboard. This connectivity ensures that real-time data is continuously transmitted to stakeholders, making the system efficient and reliable for industrial safety monitoring

System Modules

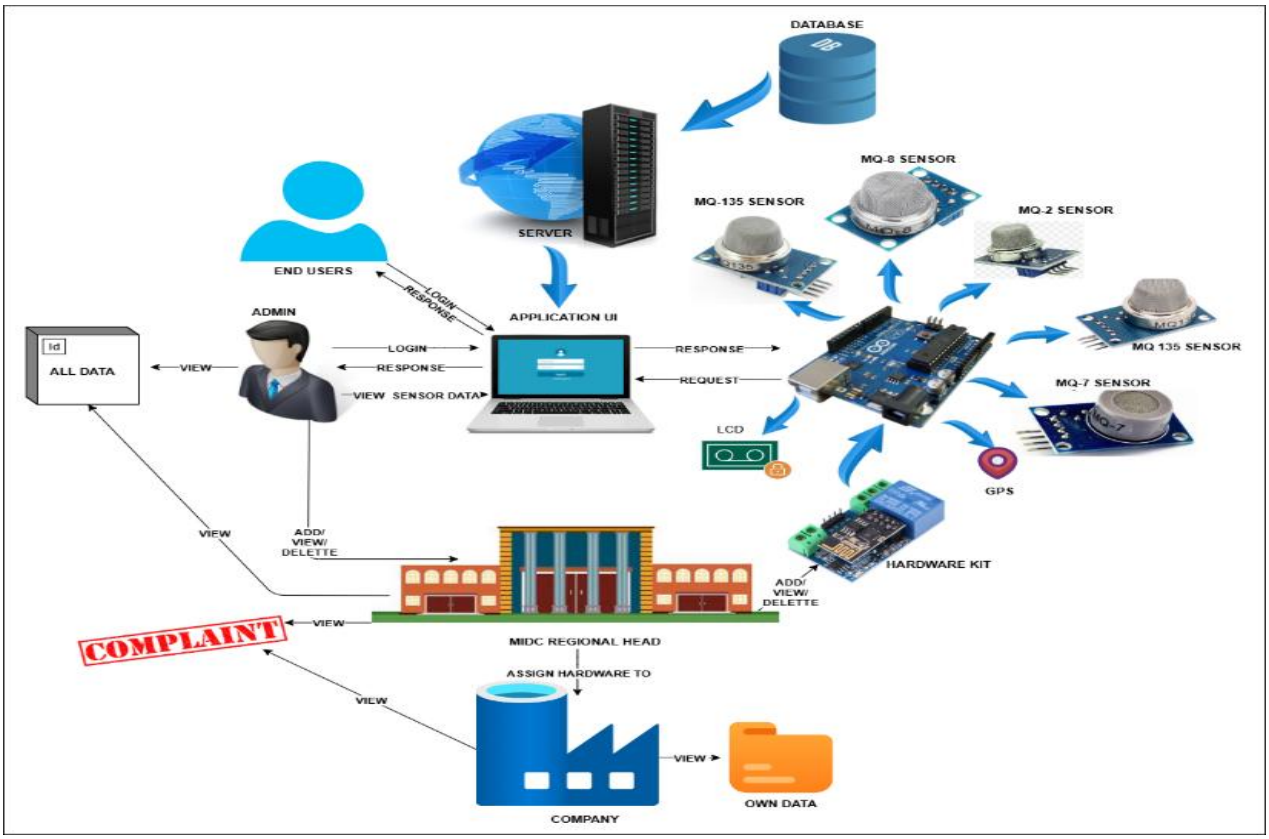
1) Admin:
- Login
- Add/view/delete
- View all data
- Responses

2) MIDC Regional Head
- Login
- Add/view/delete
- Add/view/delete → kits, hardware
- Assign hardware to company
- View all reports
- View complaints (auto generated)

3) End User
- Register
- Login
- View all reports

4) Comaapany
- Login
- View own data
- View complains

quality crosses predefined thresholds.



System Architecture

Advantages of Proposed System:

- Real-time monitoring
- Automatic alert generation
- Improved industrial safety
- Role-based secure access
- Reduced manual effort

V. CONCLUSION

The IoT-Based Industrial Safety Monitoring and Compliance Dashboard provides a smart and automated approach to monitor hazardous gases in industrial environments. By integrating sensors, GPS tracking, and cloud-based reporting, the system ensures real-time detection and immediate response. This solution enhances workplace safety, ensures regulatory compliance, and reduces reliance on manual monitoring systems. It is efficient, scalable, and suitable for modern industries.

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