

IoT - Toxic Gas Detection System in Sewage

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Abstract

The application of IoT and machine learning in gas detection systems for sewage offers an innovative approach to real-time gas detection and enhances environmental safety in industrial and urban environments. This system uses advanced technologies such as the Internet of Things (IoT), machine learning algorithms, and high-performance sensors like the MQ135 and the DHT11 to achieve the best results in the gas concentration measurement and collection. It identifies abnormalities and determines which emission control measures are most effective for specific release points and similar situations. The design of the device includes sensor nodes that are primarily responsible for data collection and a central microcontroller (MCU) that operates a machine learning algorithm for efficient anomaly detection and predictive maintenance. The system uses the IoT connection to regularly send data to cloud platform (Blynk), enabling real time monitoring of gas levels and environmental conditions. The system generates a visual image of the captured data that can be accessed online. Distinctive attributes like accurate gas detection, continuous monitoring, predictive maintenance, remote assessment, and comprehensive data visualization, all contribute to smart decision-making for environmental safety.

Keywords: Gas Monitoring System, IoT, Machine Learning Algorithms, MQ135 Sensor, Environmental Safety.

1. Introduction

The gas detection system using IoT and Machine Learning is an innovative solution for real-time gas detection and environmental safety in industrial and urban settings. IoT, machine

learning algorithms, and high-performance sensors like the MQ135 and DHT11 are combined in this system to enhance gas monitoring accuracy, anomaly detection, and pollution control. Anomaly detection, predictive maintenance, and accurate gas monitoring are among the benefits of the system, which integrates cutting-edge IoT, machine learning, and high-performance sensors. Sensor nodes collect the data and transmits to a central unit that uses the machine learning algorithms that are programmed with the predefined threshold values to reveal the anomalies and help to predict the necessary maintenance. The collected data and detected anomalies are sent to the cloud platform (Blynk), enabling remote monitoring, control, and visualization. The proposed system's capability to collect accurate readings, perform continuous monitoring, enable predictive maintenance, and provide remote accessibility ensures a smart, safe, and secure environment. This proposed work is specifically devised for the sewage system in order to minimize the human involvement.

2. Literature Review

This research investigates the application of the MQ-6 sensor for a gas leakage detection system, aiming to enhance safety in indoor environments [1]. This study likely discusses the rising significance of IoT in safety applications, particularly gas detection systems. It may assess existing systems, emphasizing the need for enhanced security and efficiency in gas leak detection [2]. The research focusses on IoT-based gas leakage detection systems, emphasizing the integration of real-time alerts through Pushbullet notifications. It highlights advancements, existing methodologies, and the importance of timely alerts in mitigating risks associated with gas leaks. The research explores the development of multiple gas analyzers, focusing on their capability to detect and analyze various gasses simultaneously. It discusses current technologies, sensor efficiency, and the significance of precise gas monitoring in industrial applications. The industrial safety, highlighting advancements in sensor technology, real-time monitoring, and automated alert mechanisms for the sewage system is the major focus of this study. It emphasizes the critical role of these systems in hazards situation. Existing research focuses on enhancing sewage worker safety through systems that utilize sensors to alert workers to high concentrations of harmful gases [5,6]. Research highlighted in [7] emphasizes the importance of real-time monitoring of wastewater using sensors. Additionally, [8] emphasizes the necessity for implementing sludge treatment to

meet societal needs. Studies [9-11] emphasize the capability of these techniques to identify gas leaks and send alerts to prevent fatalities.

Based on the existing literature, the proposed sewage monitoring system utilizes sensors and microcontrollers for data collection. It also integrates machine learning to detect anomalies and predict necessary maintenance.

3. Materials and Methods

The gas detection system using IoT and Machine Learning technologies, integrates components such as NodeMCU, and high pH value sensors like MQ 135 and DHT 11 for monitoring ferrous oxide and carbon dioxide concentrations. Arduino IDE is used for interfacing and calibrating the sensors, enabling real-time data collection across various industries and city locations. The NodeMCU is the CPU of the whole system, which uses the IoT technology to connect with different sensors and the cloud-based services. The sensor nodes consist of the MQ135 sensor to detect pollution and DHT11 sensor to sense weather conditions. The setup is calibrated and then the sensors are connected to NodeMCU which is responsible for data collection, processing, and transmission, providing real-time environmental information.

The methodological approach involves establishing sensor nodes and configuring data collection and transmission protocols. Sensor nodes are calibrated for precision and programmed to relay data to the NodeMCU unit at regular intervals. NodeMCU processes the data using a machine learning algorithm (Isolation Forest) to identify abnormalities and predict maintenance needs. The data collected is transmitted to cloud platform (Blynk) using the inbuilt Wi-Fi capabilities of the NodeMCU. NodeMCU's integration with IoT facilitates remote monitoring and real-time visualization of gas levels and environmental conditions.

The gas detection system represents a significant advancement in gas monitoring technology. It provides precise data, detects anomalies, and can even forecast future issues. By integrating NodeMCU, IoT connectivity, and machine learning algorithms, this system effectively addresses both safety and environmental concerns. The Table 1 shows the hardware and the software components used.

Table 1. Hardware and Software Components

Hardware	Software
NodeMCU	Arduino IDE
Gas Sensor (MQ-135)	Blynk (Cloud Platform)
Temperature Sensor (DHT-11)	
Buzzer	

4. Proposed System

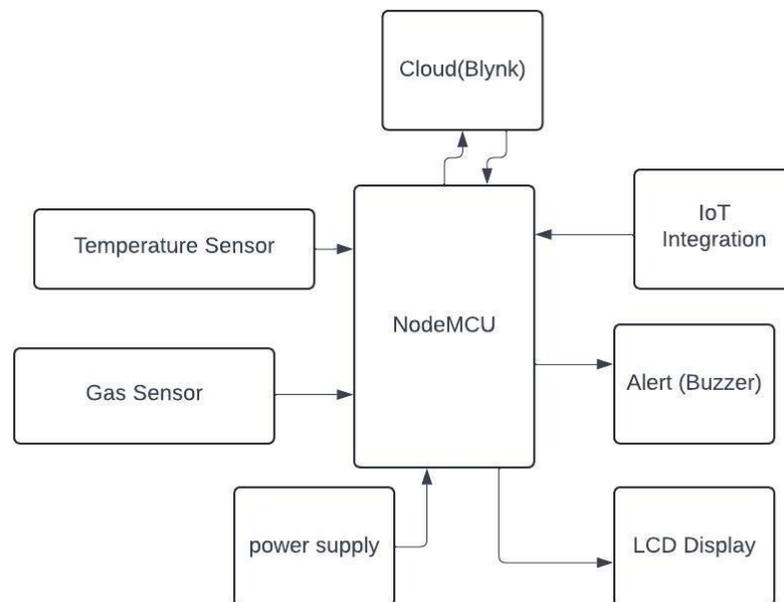


Figure 1. Block Diagram

Figure 1 shows the block diagram of the proposed system, which includes an MQ-135 gas sensor for real-time gas level monitoring and leak detection, and a DHT11 sensor for ambient condition monitoring. A central processing unit, NodeMCU, collects and processes the data. When anomalies are detected, alerts are forwarded to users through buzzers.

The IoT module enables NodeMCU to transmit the collected data to the cloud platforms Blynk for remote control and visualization. The proposed sewage system, unlike existing systems, incorporates a machine learning algorithm (Isolation Forest) configured with

predefined threshold values to detect anomalies and predict necessary measures. The Table .2 below shows the specification and the uses of the hardware components.

Table 2. Components Specification and Its uses

Components	Specification	Use in Proposed Work
Gas Sensor (MQ-135)	Detects all types of gasses in the environment.	Provides real-time data on gas levels to identify leaks.
Temperature Sensor (DHT-11)	Measures temperature range from 0-50°C with $\pm 2^\circ\text{C}$ accuracy.	Monitors environmental conditions that might influence gas leakage.
Node MCU (ESP8266)	32-bit processor, Wi-Fi enabled, with GPIO pins.	Acts as the control unit to process sensor data and communicate with the cloud.
Power Supply (12 V)	Provides stable 12V DC power output.	Ensures all components receive the required voltage for operation.
Cloud Service (Blynk Cloud)	IoT platform capable of handling data streams.	Stores and manages sensor data for real-time and historical analysis.
Alert System	Services that can send instant notifications to users.	Delivers alerts to notify personnel of a gas leak promptly.
LCD Display	16 characters wide, 2 rows, 5x7 pixel matrix per character.	Displays real-time sensor data and system status for local monitoring

5. Working Principle

The proposed gas detection system uses an MQ-135 gas sensor for monitoring hazardous gas levels and a DHT-11 temperature sensor for tracking ambient temperature fluctuations. These sensors are continuously active, ensuring real-time data collection. The NodeMCU (ESP8266) processes the sensor data and transmits it wirelessly to the main computing unit. The system connects to the internet through IoT technology, allowing data transfer to the Blynk Cloud for remote access and historical analysis.

Arduino IDE software is used for interfacing and calibrating the sensors. The NodeMCU integrates sensor readings and processes the data to detect gas leaks and temperature anomalies. The processed data is analyzed using an isolation forest algorithm programmed with predefined threshold values to identify anomalies. The calibration, data collection, data processing, and data analysis using Isolation Forest are programmed in C++ and loaded onto the NodeMCU.

The alert system triggers when gas levels exceed 120 ppm, ensuring timely responses to potential hazards. The system's continuous monitoring capability allows it to detect new anomalies and respond promptly, enhancing overall safety. The power supply unit (12V) ensures the system operates reliably around the clock, maintaining constant vigilance and quick response to gas leaks. Additionally, an LCD display provides real-time data visualization. The Figure 2 shows the work flow of the proposed.

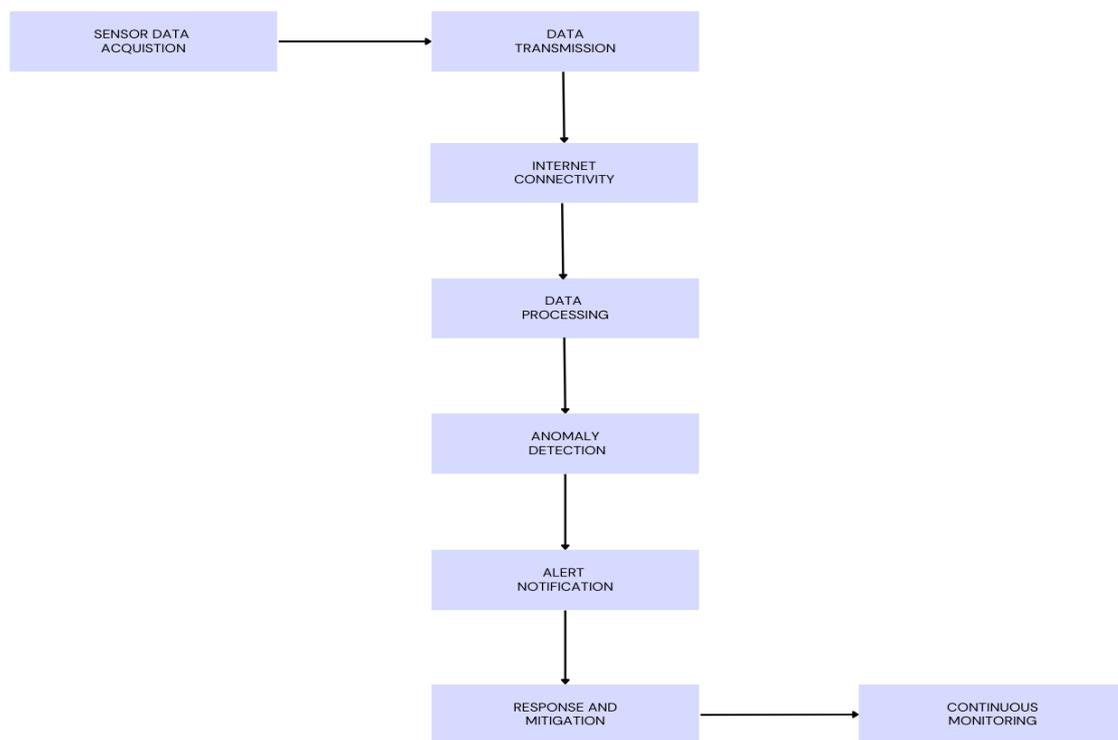


Figure 2. Flowchart

6. Results

Figure 3 shows the hardware prototype of the proposed toxic gas detection system in sewage. The hardware setup can be fixed to sewage tanks or pipes to monitor gas leakage and increased gas concentrations that could lead to hazardous situations.

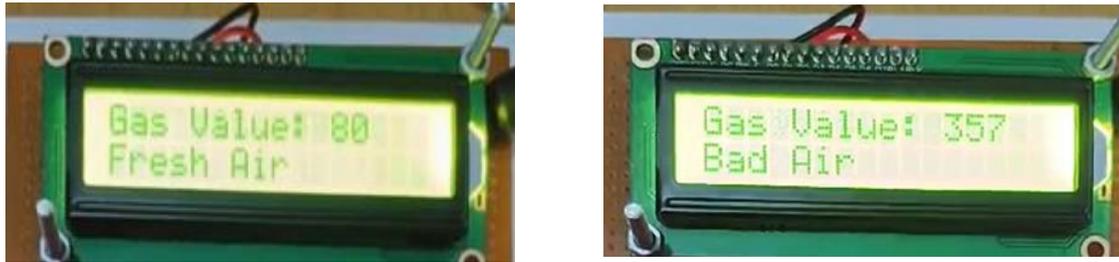


Figure 3. Product Design



Figure 4. Temperature Value

The data collected from the MQ135 and DHT11 sensors is forwarded to the NodeMCU, which processes the data and transmits it to the cloud as well as to the connected LCD display. The DHT11 sensor is used for environmental monitoring. The Arduino sketches enable Blynk data visualization on the display and can also be used with gas-anomaly alert mechanisms for environmental monitoring. Hence, the sensors provide on-the-spot gas concentration data and environmental readings. Figure 4 shows the LCD display of the temperature value, and Figure 5 shows the LCD display indicating fresh and bad air quality.



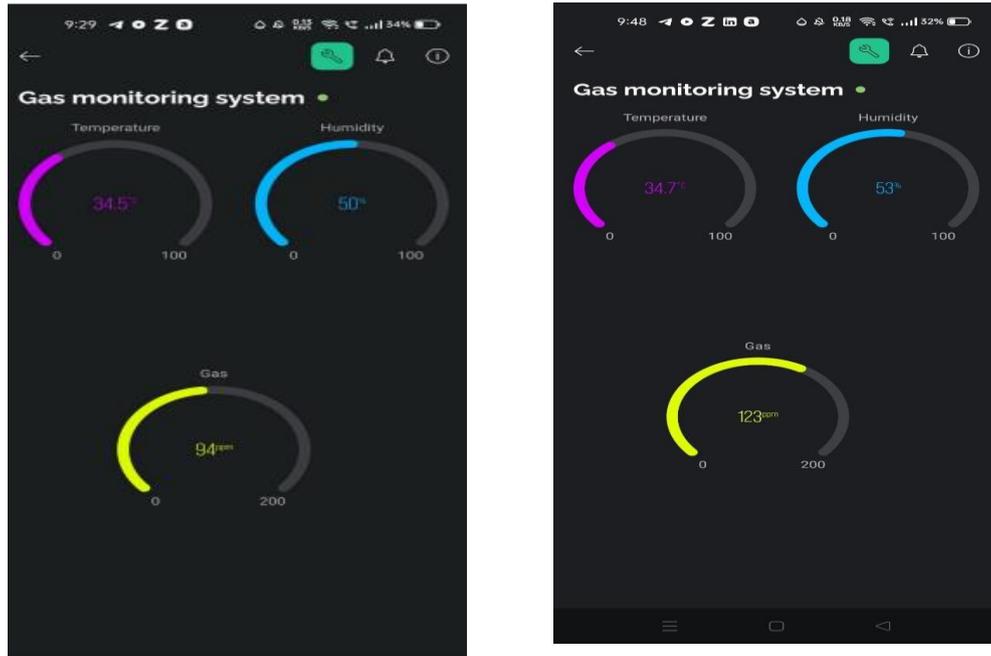
(a) Fresh Air

(b) Bad Air

Figure 5. LCD Display Value of (a) Fresh Air and (b) Bad Air

The Figure 6 shows the Blynk platform image for the gas values from the MQ135 sensor which has two sections showing normal and abnormal levels of gas detected. This image uses IoT technology to show changes in gas concentration in real time hence indicating safe and toxic zones.

The output observed show a highly developed gas monitoring system that uses Internet of Things (IoT) and machine learning technologies. This system combines MQ135 and DHT11 sensors, Blynk IoT platform as well as LCD displays and Blynk interfaces for live data visualization. A complete environmental monitoring solution, the system also detects anomalies and incorporates warning mechanisms to increase gas detection accuracy for better pollution control. Together they demonstrate a modern gas monitoring system based on IoT and machine learning.



(a) Safe Notification

(b) Alert Notification

Figure 6. Interface Gas Values for (a) and (b)

7. Discussion

Gas monitoring systems have advanced significantly with the integration of IoT and machine learning (ML) technologies, enhancing safety and environmental care through real-time data collection, anomaly detection, and early warning mechanisms. IoT enables interconnection of various sensors for hazard detection, while ML algorithms like Isolation Forest improves accuracy and efficiency in identifying gas leaks and environmental risks. The Table 3 below shows the features of the traditional and the proposed method.

Table 3. Comparison chart of Traditional and Proposed Method

Features	Traditional Method	Proposed Method
Detection Method	It is manual or basic automated detection	It is an Advanced automated detection using IoT and ML
Real-Time Monitoring	Limited, often periodic	Continuous, real-time monitoring
Anomaly Detection	It has only Basic threshold-based detection	But it has Advanced ML algorithms (Isolation Forest) for anomalies

Data Communication	Wired, limited communication	It's Wireless, seamless information exchange via IoT
Response Time	It's slower, delayed due to periodic checks	Much faster, immediate alerts and responses

8. Conclusion

It is important to note that the integration of IoT and ML within gas detection systems represents a huge leap in environmental protection and operational efficiency. With instantaneous data collection, remote surveillance capabilities and precise anomaly detection, the system becomes capable of quickly recognizing and addressing gas leaks or any other environmental danger. This model not only avoid health and environmental dangerous but also affirms regulatory standards compliance and efficient operations. Promoting gradual improvements in gas monitoring procedures through machine learning, the IoT, therefore, enables balance between protection of nature and security of the public. The future work of the research will involve comparing different machine learning models using the real-time data collected.

References

- [1] Tommy, Alexander. "Implementation of a Gas Leakage Detection System Using the MQ-6 Sensor." *Brilliance: Research of Artificial Intelligence* 2, no. 1 (2022): 17-21.
- [2] Woishe, Methila Farzana, Nila Sultana, Tamanna Zaman Bristy, Nafiza Anjum Khan, and MD Taimur Ahad. "A Secured Model of IoT-based Smart Gas Detecting and Automatic Alarm System." *International Journal of Computer and Information System (IJCIS)* 3, no. 2 (2022): 45-50.
- [3] Begum, Aklima, Md Abdullah Al Mamun, Md Atiar Rahman, Sabiha Sattar, Mist Toma Khatun, Hasina Akhter, and Mohaimina Begum. "Toxic and Non-Toxic Gas Detection System for Septic Tank." *Australian Journal of Engineering and Innovative Technology* 3, no. 2 (2021): 26-33.
- [4] Subramanian, M. Athish, Naveen Selvam, S. Rajkumar, R. Mahalakshmi, and J. Ramprabhakar. "Gas Leakage Detection System using IoT with integrated notifications

using Pushbullet-A Review." In 2020 Fourth International Conference on Inventive Systems and Control (ICISC), Coimbatore, India, IEEE, 2020.pp. 359-362.

- [5] S. Lavanya Devi, N. Prabu, S. Ramesh, G. Keerthana, E. Vasupradha. "Intelligent Remote Safety Monitoring of Sewage Workers." International Journal of Scientific Research in Science, Engineering and Technology 10(1) 2023, pp. 90-96.
- [6] N. Asthana and R. Bahl. "IoT Device For Sewage Gas Monitoring And Alert System." 1st International Conference on Innovations in Information and Communication Technology (ICIICT), Chennai, India, 2019, pp. 1-7.
- [7] Wilfrid Bourgeois, Joanna E Burgess, Richard M Stuetz. "On-line monitoring of wastewater quality: a review" Journal of Chemical Technology and Biotechnology 76, no. 04 (2001), pp. 337-348.
- [8] Eriksson, Eva, Nina Christensen, Jens Ejbye Schmidt, and Anna Ledin. "Potential priority pollutants in sewage sludge." Desalination 226, no. 1-3 (2008): 371-388.
- [9] Murvay, Pal-Stefan, and Ioan Silea. "A survey on gas leak detection and localization techniques." Journal of Loss Prevention in the Process Industries 25, no. 6 (2012): 966-973.
- [10] Ramya, V., and B. Palaniappan. "Embedded system for Hazardous Gas detection and Alerting." International Journal of Distributed and Parallel Systems (IJDPS) 3, no. 3 (2012): 287-300.
- [11] Huang, Hesong, Hongning Bian, Shuchuan Zhu, and Jibo Jin. "A greenhouse remote monitoring system based on GSM." In 2011 international conference on information management, innovation management and industrial engineering, Shenzhen, China, vol. 2, IEEE, 2011.pp. 357-360.