

Air Quality and Hazardous Gas Detection using IoT for Household and Industrial Areas

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Abstract. The detection and monitoring of hazardous gases is essential for ensuring the safety of individuals in various settings, such as industrial environments and residential areas. gas detectors detect gases like LPG, NH₃, alcohol, NO_x, Benzene, CO₂, Alcohol, Propane, Hydrogen, Methane, Carbon Monoxide, and smoke in the area around them. In this study, we present a system for real-time detection and monitoring of hazardous gases using MQ135 and MQ2 sensors. The system consists of a monitor that is placed in a fixed location and a mobile device that can be carried by the user. The MQ135 sensor is used to detect gases such as ammonia, while the MQ2 sensor is used to detect gases such as carbon monoxide and hydrocarbons. Each of these gases is known through the Parts per Million (PPM) values and can be determined which gas it is. The system utilises a microcontroller to process the sensor data and display the gas concentrations on a user interface. The mobile device also has the capability to alert the user and send notifications through an accompanying App if the gas concentrations exceed a predetermined threshold. The system is reliable, accurate, and easy to use, making it an ideal solution for detecting and mitigating the risks associated with hazardous gases in various settings. The system was tested in various environments and was able to accurately detect and monitor the presence of hazardous gases and it is a reliable and convenient solution for detecting and monitoring hazardous gases in real-time.

1 Introduction

The Internet of Things (IoT) is a rapidly growing technology that enables devices to communicate with each other through the internet. It allows for the integration of physical devices and digital systems, creating a network of connected devices that can collect and share data. In the context of gas detection and monitoring, IoT can be used to enhance the

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capabilities of the system by enabling remote monitoring and control. For example, IoT devices can be used to transmit real-time data from the gas sensors to a cloud-based platform, where it can be analysed and used to generate alerts or trigger automated responses. Additionally, IoT can be used to connect the gas detection system to other devices or systems, such as fire alarms or ventilation systems, to create a more comprehensive safety network. The integration of IoT with gas detection and monitoring systems can improve the system's efficiency, accuracy, and responsiveness, making it an even more effective solution for detecting and mitigating the risks associated with hazardous gases.

Gas detection and monitoring are critical for ensuring the safety of individuals in various settings, such as industrial environments and residential areas. Several gases can pose a threat to human health and the environment, including carbon monoxide, methane, ammonia, and benzene. Therefore, detecting and monitoring these hazardous gases in real-time is essential for mitigating the associated risks. In this study, we present a system that utilises MQ135 and MQ2 sensors to detect and monitor hazardous gases' concentrations in real-time. The system consists of a monitor placed in a fixed location and a mobile device that can be carried by the user. The MQ135 sensor detects gases like ammonia, while the MQ2 sensor detects gases such as carbon monoxide and hydrocarbons. The system utilises a microcontroller to process the sensor data and display the gas concentrations on a user interface. Additionally, the mobile device has the capability to alert the user and send notifications through an accompanying app if the gas concentrations exceed a predetermined threshold. This study aims to present a reliable, accurate, and easy-to-use system that can detect and mitigate the risks associated with hazardous gases in various settings. Some examples of how Air Quality and Hazardous Gas Detection using IoT for Household and Industrial Areas might be used include:

- Household air quality monitoring: IoT-enabled air quality monitors can be installed in homes to monitor indoor air quality in real-time. The data collected by the sensors can be transmitted to a cloud-based platform where it can be analysed and used to generate alerts or trigger actions such as air purifier activation or opening windows to improve the air quality.
- Gas leak detection in industrial settings: IoT-enabled gas sensors can be deployed in industrial areas to detect gas leaks in real-time. The sensors can be connected to a cloud-based platform where the data can be analysed and used to generate alerts or trigger automated responses, such as shutting down equipment or evacuating workers.
- Air quality monitoring in public places: IoT-enabled air quality monitors can be installed in public places such as schools, hospitals, and shopping centres to monitor indoor air quality. The data collected can be used to generate alerts or trigger actions such as increasing ventilation or alerting the building management to take action to improve the air quality.
- Hazardous gas monitoring in mining areas: IoT-enabled gas sensors can be used in mining areas to detect hazardous gases such as methane and carbon monoxide. The sensors can be connected to a cloud-based platform where the data can be analysed and used to generate alerts or trigger actions such as activating ventilation systems or alerting workers to evacuate the area.
- Gas leak detection in commercial kitchens: IoT-enabled gas sensors can be used in commercial kitchens to detect gas leaks from equipment such as stoves and ovens. The sensors can be connected to a cloud-based platform where the data can be analysed and used to generate alerts or trigger actions such as shutting off the gas supply or alerting the kitchen staff to evacuate the area.

2 Existing methods

Debnath and his team members built a low-cost system that detects and alerts the user about the leakage. To develop a model that is Low-cost gas detection system sensors and Alert users through phone call and also graphical alert on web server. To apply machine learning to know accuracy of the sensor's stakeholders [1].

Gagan Parmar, Sagar Lakhani, and Manju K. Chattopadhyay, which was published in October 2017. In this paper, the authors proposed a low-cost air pollution monitoring system that utilizes an IoT-based approach to monitor and detect the concentration of various gases in the air. The system consists of a network of low-cost gas sensors that are deployed in various locations to monitor the air quality. The sensor data is then transmitted to a cloud-based platform through the Internet, where it can be processed and analyzed in real-time. The authors also developed a user-friendly mobile application that allows users to view the air quality data and receive alerts if the concentration of any harmful gases exceeds a certain threshold [2].

Anand Jayakumar, Praviss Yesyand T K, Venkstesh Prashanth K K, and Ramkumar K, which was published in March 2021. In this paper, the authors proposed an IoT-based air pollution monitoring system that allows users to monitor the pollution levels from anywhere using their computer or mobile device. The system consists of a network of low-cost air quality sensors that are deployed in various locations to monitor the pollution levels. The sensor data is then transmitted to a cloud-based platform through the Internet, where it can be processed and analyzed in real-time. The authors also developed a user-friendly web application that allows users to view the air pollution data and receive alerts if the pollution levels exceed a certain threshold [3].

3 Proposed method

3.1 Problem statement

The human body is sensitive to a variety of harmful gasses and dangerous chemicals or compounds found in the atmosphere. If the level of such gasses surpasses the human body's tolerance limit, a person may be in danger or perhaps perish if the quantity is sufficiently high relative to sustainability. The quantity of dangerous gases in regions where people live, such as industrial areas, near gas wells, and also houses, must be detected and measured by a gas detection and measurement system in order to deal with this kind of problem. Different harmful and hazardous gasses, like natural gas (CH₄) common in household kitchen stoves or Lpg in cylinders, various types of burning fuels, etc. are everywhere around us. Because there are more poisonous gasses present in manufacturing environments, there is a higher chance that one of those gasses will cause an accident. As a result, numerous types of gasses, including CH₄ (Methane), CO (Carbon Monoxide), and fuels for burning, are present in these locations as exhaust gasses while manufacturing. So it is essential to have such a monitoring system as to properly safeguard human life.

At the moment, accidents are happening more frequently as a result of the increased usage of gasses and fuels in both domestic and industrial settings. The frequency of gas leakage-related explosion-related accidents is rising alarmingly quickly in Bangladesh. According to a survey conducted by Titas Gas Transmission Company Ltd., Bangladesh, the number of gas leakage-related explosions was estimated to be 3,819 in 2013–2014 and 5,123 in 2014–2015. These disasters were caused by gas cylinders and pipelines. The most hazardous explosions are those caused by gas cylinders. One may argue that storing a gas

cylinder inside a house without the necessary security and upkeep is equivalent to keeping a live bomb inside the house and residing with it.

Gas leakage from a cylinder's body or valves may happen throughout the entire kitchen, room, or area if it is not properly maintained or monitored. Thus, a tiny spark might start a fire that spreads quickly, like a storm, and result in a huge explosion. As a result, there may even be important lives lost in casualties. The fifth of March 2019 saw a recent event in Gazipur that claimed the life of a worker. Therefore, regular maintenance and monitoring are essential to preventing this kind of tragic tragedy. Because of this, a technical monitoring system must be put in place. Through this monitoring system, anyone may assess an area's toxicity or hazard and take the appropriate action. Particularly wireless surveillance is more efficient because users may see around without coming close. A poisonous and harmful gasses monitoring system is therefore absolutely important.

3.2 Objectives

- Wireless Detection and Monitoring of Gases present in the environment is considered as the main objective of this project. To do so,
- The main objective of the project is wireless detection and monitoring of gases present in the environment.
 - Blynk application is used to display the Parts per Million (PPM) values of the gases present around.
 - The data is collected from MQ2 and MQ135 sensors and transmitted using an ESP32 Node MCU through WiFi.
 - The application file displays a list of toxics and combustible materials according to their PPM values.
 - Two gas measurement sensors are used because they have different core features for detecting gases.
 - The system provides awareness of the pollution present around, enabling people to take health measurements accordingly and potentially reduce polluting materials.

3.3 Architecture diagram

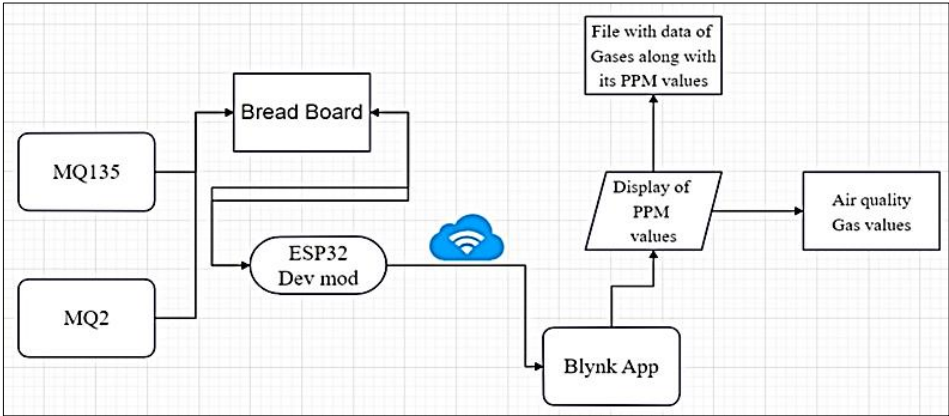


Fig. 1. Architecture diagram for proposed method.

The above Figure 1, architecture diagram depicts the connections between sensors and the flow of the process of the proposed method. The flow of the project is as follows;

Step - 1: Connection of the sensors, Esp32 dev kit to the Breadboard and execution of code that connects to the mobile application.

Step - 2: Reading of the Gasses, that is their ppm values are displayed and are monitored.

Step - 3: PPM and the gasses data file is referred to in the mobile application itself and learn the gasses present around.

Note: The Detecting system is measured continuously, so as to train the sensor to give accurate measurements with the data that it inculcates.

The MQ135 and MQ2 sensors are connected to the breadboard along with the Node MCU i.e ESP32 and the data is transferred through this wifi module to the Blynk Mobile application. The values are then compared to the data file containing the list of gasses.

3.4 Modules - connectivity diagram

The modules-connectivity diagram is a visual representation of how the various components are connected in the air pollution monitoring system. It shows how the MQ135 and MQ2 gas sensors are connected to the breadboard, which is in turn connected to the ESP32 Node MCU microcontroller. The microcontroller is connected to the internet through Wi-Fi, enabling it to transmit data to the Blynk application. The Blynk application then displays the gas concentrations in Parts Per Million (PPM) on the user interface, allowing users to monitor pollution levels from anywhere using a computer or mobile device that has the Blynk application installed. If the gas concentrations exceed a predetermined threshold, the Blynk application can alert the user and send notifications to their device. The modules-connectivity diagram is an essential reference for understanding the system's architecture and for troubleshooting connectivity issues that may arise during the development or deployment of the system. It provides a clear visual representation of how the different components are interconnected in the system, making it easier to understand and maintain the system.

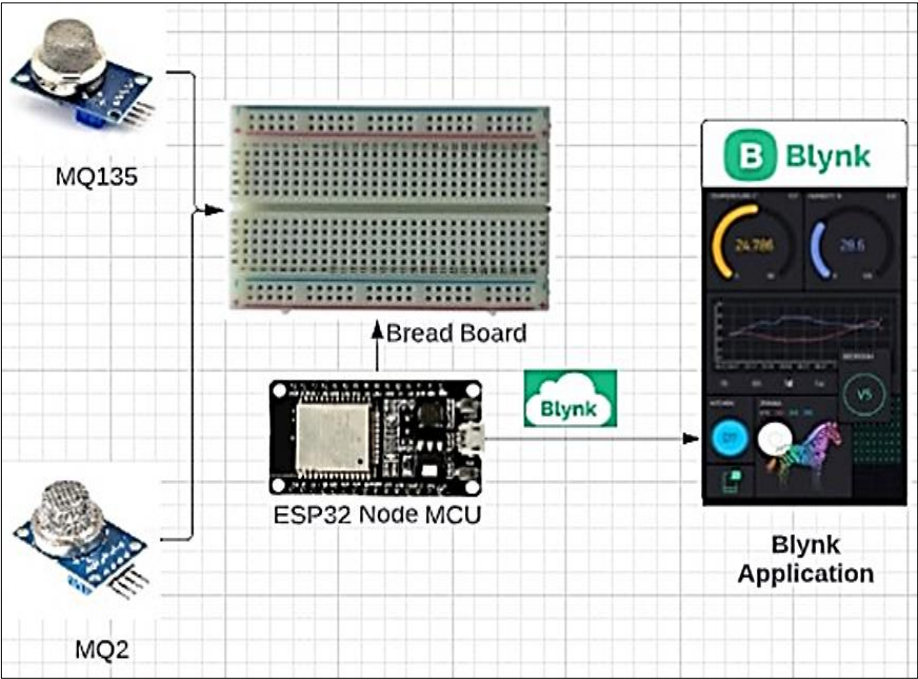


Fig. 2. Connectivity diagram of the proposed system.

MQ135 and MQ2 are gas sensors that detect the presence of hazardous gases in the environment. The sensors provide analog output, which is fed to the analog input pins of the ESP32 Node MCU. The ESP32 Node MCU is a microcontroller board that acts as the brain of the system. It reads the analog output from the gas sensors, processes it, and transmits the data to the Blynk application through WiFi. The Breadboard is a prototyping board that is used to connect various electronic components in the system. It provides a convenient platform for wiring and testing the system before it is deployed in the field. Blynk is a mobile application that allows users to control and monitor IoT devices from their smartphones. It provides an intuitive interface that displays real-time data from the gas sensors and enables users to set thresholds and receive alerts when the gas concentrations exceed predefined limits. The Blynk application communicates with the ESP32 Node MCU through WiFi and provides a user-friendly interface for monitoring and controlling the system. In summary, the connectivity between the MQ135 and MQ2 gas sensors, the Breadboard, the ESP32 Node MCU, and the Blynk application plays a crucial role in enabling the system to detect and monitor hazardous gases in real-time. The robust and reliable connectivity between these components ensures that the system operates smoothly and provides accurate and timely data to the end-users.

3.6 Modules and description

3.6.1 Module 1: Collection of data

- The MQ135 and MQ2 sensors are used to detect the concentration of various gases in the air. The sensors work by measuring the electrical conductivity of the air, which changes in the presence of certain gases.
- The data that is collected from these sensors is typically reported in units of parts per million (PPM), which is a measure of the concentration of a particular gas in the air.
- The data from the MQ135 and MQ2 sensors will be displayed in real time on a mobile application called "Quickstart Device." This means that the readings will be continuously updating as long as the system is turned on and the sensors are functioning properly.
- The "Quickstart Device" mobile application will store the data from the sensors, allowing users to access the readings at any time. This can be useful for monitoring the air quality in a particular location and detecting any changes or trends over time.

3.6.2 Module 2: Notify/prompt the user

- The data displayed into the mobile app has two LCD screens.
- The first screen displays the data from the MQ135 sensor.
- The second screen displays the data from the MQ2 sensor.
- Now the status of both the screens is constantly changing according to the environment and it is monitored, observed and recorded.
- The user can view the gasses present based on the ppm values in the mobile application itself.
- Blynk application has the data file that has the gasses and its ppm values along with this, it also has the brief description of what ppm values is and how it is calculated.
- The data file contains the health measurements that user can practice so as to be healthy and get well from the inhalation of the hazardous gasses.

4 Results and discussions

4.1 Description about dataset

MQ135 and MQ2 sensors are connected to the microcontroller, that is ESP32 and the readings of the gases from surroundings are taken using the sensor. With these two gas sensors, the ppm values of gases and the quality of the air is known. Using Arduino IDE, we can see the output in the serial monitor. The data is then displayed in the mobile application, The values from both the sensors are displayed in different screens. One with the ‘Air Quality’ are the values from the MQ135 and the ‘Gas value’ are the values from the MQ2 sensor. There is a button at the bottom ‘click here’, which takes to a data file containing the details of all the gasses along with its ppm values.

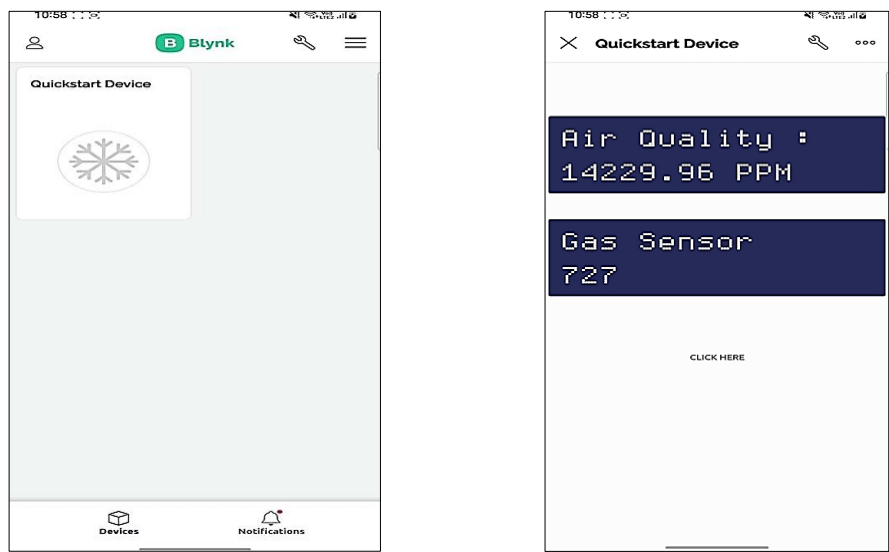


Fig. 3. Display of gas value and air quality in Blynk application.

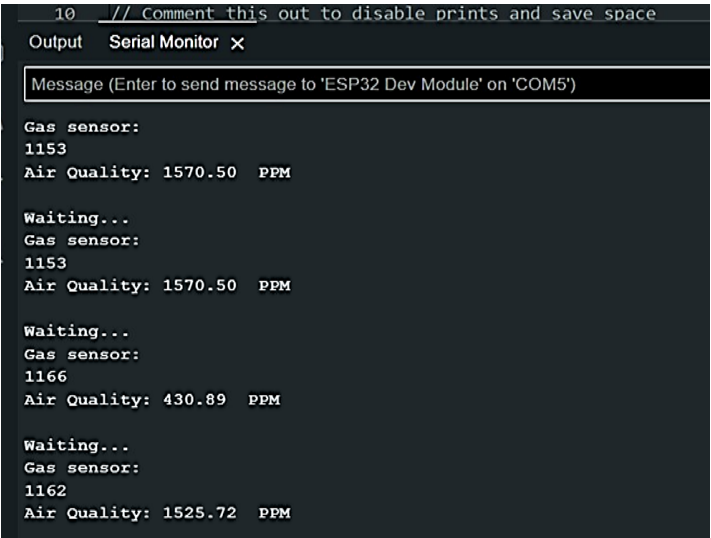


Fig. 4. Readings from the sensors in serial monitor.

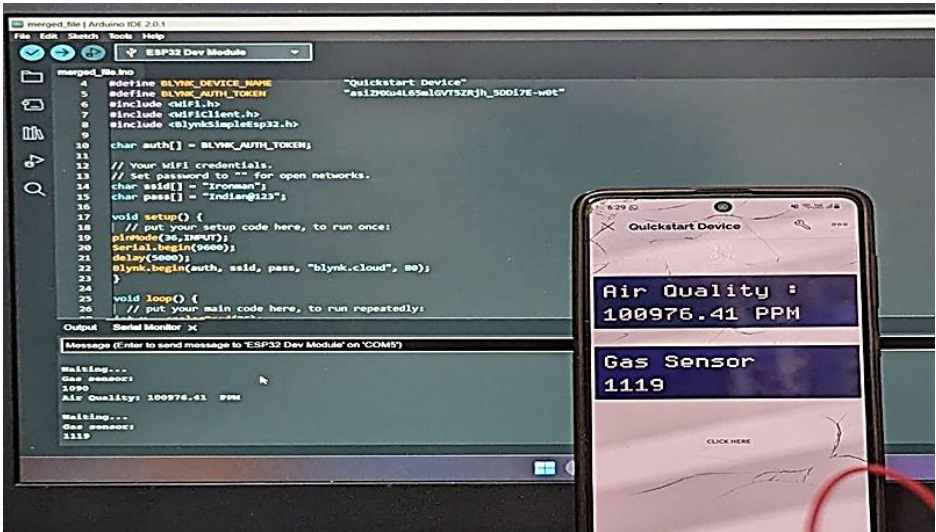


Fig. 5. Display of the project execution in monitor and mobile.

4.2 Significance of proposed method with advantages

The proposed method of wireless detection and monitoring of gases using the Blynk application and MQ2 and MQ135 sensors has several significant advantages. Firstly, the system allows for real-time monitoring of gas concentrations in the environment, providing continuous updates on the presence of hazardous gases. Secondly, the use of the Blynk application allows for remote monitoring of the gas concentrations through a mobile device or computer, which enhances convenience and accessibility. Additionally, the inclusion of a file that displays the gases according to their PPM values allows for easy interpretation of the data and identification of toxic and combustible materials. The use of two gas measurement sensors is also a key advantage as they measure different gases and have unique features for detecting them. This allows for more accurate and comprehensive monitoring of the environment. Ultimately, the proposed method can significantly increase awareness of pollution levels in the environment, enabling individuals to take health precautions and contribute to the reduction of polluting materials.

5 Conclusion

It is important to have systems in place to detect and monitor hazardous gases in various settings, as these gases can pose a risk to the health and safety of individuals. The system described in this study utilises MQ135 and MQ2 sensors to detect and monitor gases such as ammonia, carbon monoxide, and hydrocarbons in real-time. The system consists of a fixed monitor and a mobile device that can be carried by the user, and utilises a microcontroller to process the sensor data and display it on a user interface. The mobile device also has the ability to alert the user and send notifications through an accompanying app if the gas concentrations exceed a predetermined threshold. Overall, the system appears to be reliable, accurate, and easy to use, making it an effective solution for detecting and mitigating the risks associated with hazardous gases in various settings. Hazardous gases can pose serious risks to individuals in various settings, including industrial environments and residential areas. It is essential to have systems in place to detect and monitor these gases to ensure the

safety of people in these areas. In this study, we present a system for real-time detection and monitoring of hazardous gases using MQ135 and MQ2 sensors. Overall, the system described in this study provides a reliable and convenient solution for detecting and monitoring hazardous gases in real-time. Its ability to detect a wide range of gases, as well as its accuracy and ease of use, make it an invaluable tool for ensuring the safety of individuals in industrial and residential settings.

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