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IoT-BASED INDUSTRIAL EMISSION MONITORING SYSTEM

Dr. B. Mannan Professor, Department of E.C.E, GATES Institute of Technology, Gooty.
Vulligadla Yasmeen[2], K. Supriya[3], K. Susmitha[4], V. Vandana[5], S. Vamsi Vardhan Reddy[6]
UG student, Department of E.C.E, GATES Institute of Technology, Gooty.

Abstract:
The need to industrialize to compete with global standards is a complete requisite to realize a booming economy. However, it has wreaked havoc on the environment and caused emissions of dangerous chemicals. This study aimed to create a system that monitors the emission of the gases such as Methane, Butane, and Carbon Di-Oxide, held in a manufacturing company anytime, anywhere using IoT as a system of physical things embedded with different sensors, software, electronics and connectivity to allow it to perform better by exchanging information with other connected devices. An alert is produced instantly if the level of the gases goes above the normal level means indication through the internet-specific receiver section. The emission level is also displayed and stored in the database of an owner. When the owner ignores it, the report will be sent to the Government officials with the entire details. The entire system is controlled by an ESP32 microcontroller.

Keywords: MQ2, MQ4, MQ6 Gas sensors, ESP32 microcontroller, Cloud

1. Introduction

Nowadays, intelligent monitoring systems play a major role in present day-to-day life. IoT plays a vital role in designing smart and intelligent systems in industrial and information technology applications. IoT is a combination of embedded and communications systems which interconnects hardware devices to the internet. In this paper, an IoT application was implemented to monitor several common parameters used in industrial applications such as smoke, gas, fire, humidity and machine control using IoT. In this proposed system, the ESP32 Wi-Fi module is used for collecting data from equipment and transferring it to a wireless internet, parameters are uploaded to the cloud and continuously monitored by the user either mobile using mobile application tool kits or internet using data clouds. ESP32 is the most advanced integrated circuit with a Wi-Fi module in the industry, it consists of an inbuilt microcontroller and antenna with less expense. Hence this helps to transfer data, statistics, logs and various other parameters information among various devices to improve the performance of the system. The industrial monitoring system consists of applications such as machine control, and harmful gas level monitoring.

The Internet of Things (IoT) is a system that allows devices to be connected and remotely monitored across the Internet. In the last years, the IoT concept has had a strong evolution, being currently used in various domains such as smart homes, telemedicine, industrial environments, etc. [1]. Wireless sensor network technologies integrated into the IoT enable a global interconnection of smart devices with advanced functionalities [2]. A wireless home automation network, composed of sensors and actuators that share resources and are interconnected to each other, is the key technology to making intelligent homes. A “smart home” is a part of the IoT paradigm and aims to integrate home automation. Allowing objects and devices in a home to be connected to the Internet enables users to remotely monitor and control them [3]. These include light switches that can be turned on and off by using a smartphone or by voice command, thermostats that will adjust the indoor temperatures and generate reports about energy usage, or smart irrigation systems that will start at a specific time of a day, on a custom monthly schedule, and thus will control water waste. Smart home and industrial solutions have become very popular in the last few years. One of the greatest advantages of home automation systems is their easy management and control using different devices, including smartphones, laptops and desktops, tablets, smartwatches, or voice assistants. Home automation systems offer a series of benefits; they add safety through appliance and lighting control, secure the

home through automated door locks, increase awareness through security cameras, increase convenience through temperature adjustment, save precious time, give control, and save money.

By now, there is a mature market for such kind of surveillance system and its cost is relatively high. However, it can't meet the surveillance needs for movable or places which have not have strict needs on performance and reliability. In fact, such kind of needs is becoming more and more intense to some instant. With the development of 3G technology, wireless bandwidth is larger, which makes it possible to develop more content rich. For this system, the input is taken from the sensors. These sensors will provide the analogue as well as digital data. In this system, PIC 18F4550 is used which supports both input data. Monitoring is done on mobile or desktop (using chrome explorer). As per the application or environment, the sensors can be added or removed. Applications for mobile phones such as video, audio and digital data provide a basement for the realization of wireless smart surveillance systems at the same time. Android is an open-source phone operating system based on the Linux platform and it's truly open and complete mobile software for mobile terminals. To solve the shortcomings of traditional surveillance systems, this project proposed a surveillance scheme based on an Android smartphone, which makes it possible to monitor the target site in anywhere and anytime via an Android smartphone under the coverage of a wireless network. This project proposed a monitoring scheme prototype based on an Android smartphone terminal. By collecting and processing data at a server and, sending data a to smartphone terminal via web services, it reaches the purpose of monitoring the target site anywhere and anytime under the coverage of a wireless network and enhances the edibility of the surveillance system greatly.

2. Related Works

The implementation of Industrial Emission Monitoring Systems using IoT has gained significant attention in recent years due to the increasing concern over the impact of industrial emissions on the environment and public health. In this section, we discuss some of the recent research works that have focused on developing IoT-based systems for monitoring and controlling industrial emissions.

One of the studies conducted by Omar et al. (2019) proposed an IoT-based system for monitoring air pollution in industrial areas. The authors designed a low-cost system that utilized sensors to collect data on air quality and a cloud-based platform for data storage and analysis. The results of the study demonstrated that the proposed system was effective in detecting the presence of air pollutants and could provide real-time information on air quality.

Another study by Dole and Kulkarni (2019) described the design and implementation of an IoT-based system for monitoring and controlling industrial emissions. The system used sensors to measure emissions levels, and a cloud-based platform for data analysis and visualization. The authors demonstrated that the proposed system was effective in detecting emissions and could provide real-time feedback to users, thereby facilitating the control of emissions in industrial processes.

Ali et al. (2019) presented a wireless sensor network (WSN)-based system for monitoring industrial emissions. The system used low-cost sensors and ZigBee wireless communication to transmit data to a central server for analysis. The results of the study showed that the proposed system was effective in detecting the presence of emissions and could provide real-time information on emissions levels.

In another study, Ferdous et al. (2018) proposed an IoT-based system for monitoring air pollution in industrial areas. The authors designed a system that utilized sensor nodes, a gateway, and a cloud-based data management system. The results of the study demonstrated that the proposed system was effective in detecting the presence of air pollutants and could provide realtime information on air quality.

Karunakaran et al. (2020) presented an IoT-based system for monitoring and controlling industrial emissions. The system used sensors to measure the concentration of pollutants and a cloud-based platform for data analysis and visualization. The authors demonstrated that the proposed system was effective in detecting emissions and could provide real-time feedback to users, thereby facilitating the control of emissions in industrial processes.

Finally, Aziz et al. (2021) proposed an IoT-based system for monitoring greenhouse gas emissions in industrial processes. The system used a combination of sensors, wireless communication, and cloud-based data analytics to monitor emissions and provide real-time feedback to users. The results of the study showed that the proposed system was effective in detecting the presence of greenhouse gases and could provide real-time information on emissions levels.

In conclusion, the above-mentioned studies highlight the growing interest in IoT-based systems for monitoring and controlling industrial emissions. The proposed systems have demonstrated their effectiveness in detecting the presence of emissions and providing real-time feedback to users, thereby facilitating the control of emissions in industrial processes

3. PROPOSED SYSTEM

This system is fully automatic it doesn't need any human interaction. This system receives the toxic gases range parameters values, and location of the industry and sends SMS automatically after a manually set period. And it works continuously. It displays the ppm values on LCD and also through the application or website in Android. ThingsSpeak which is an open-source IoT platform that is used for the graphical representation of the gases emitted in the industry, can be accessed through a web interface or mobile application, making it convenient for users and owner of industry to monitor this IoT-based system from anywhere. If the owner ignores the harmful ranges monitoring, Government authorities will be given a message or they can view at the website and take necessary actions..
By using the wifi module ,data will be uploaded into the Thing speak server.

3.1.1 Working

The conceptual diagram shows the concept of the proposed method, this is shown in Figure 1. The block diagram shows two important areas in industries they are Plant premises, Office premises. In plant premises, the sensors are placed where the toxic gases are expected to evolve, in the occurrences of the gases their concentration is calculated in the form of voltages, and ppm values. The sensor converts the physical quantity into voltages, when concentration increases the input voltage to the microcontroller through the sensor also simultaneously increases. In office premises, the concentration of each gas is monitored on the website. The government sectors and health organizations having the authority of analyzing the industrial status can also have a note on the website information.

This project performs three main functions. The first one is industrial emission monitoring; the second one is to give alerts by a message which is using GSM technology. With the help of this project, we can find out the location of the industry where the toxic gases are released and at the same time, we can monitor threshold values. These parameters are ppm values of the toxic gases such as CO2, CH4, and Butane readings.

A text SMS containing the location and values of all the sensors is sent to an owner's mobile. Or we can send this text SMS to any authorized person in Industry. Then that person can intimate about location and gases emission. By using these parameters, an owner can do the necessary preparation for controlling emissions.
Initially turned on the power supply and wait until the GSM module is connected to the network and GPS connected to the satellites

When the LED on the GPS module blinks then the module is connected to the satellite and the output of the GPS is given to the ESP32. And the reading of the toxic gas rate is taken from the sensor and given to the microcontroller.

When readings go higher or lower than certain values then the GSM module will get activated and send the message to the owner.

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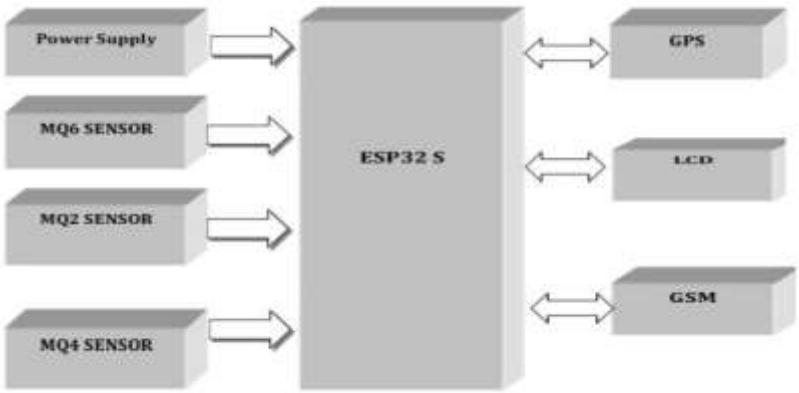

Fig 1: Block diagram of the proposed method

CASE 1:

Real-time monitoring in an industrial setting: The system is installed in a manufacturing plant, and the gas sensors detect a sudden increase in methane levels. The system sends an alert message to the Android device of the plant manager, who can take appropriate action to prevent any harm to human life and the environment.

CASE 2:

Historical data analysis and graphical representation: The system uploads the gas emission data to the Thing Speak cloud IoT platform, which provides a graphical representation of the data. The plant manager can use this data to analyse historical trends and identify any patterns of gas emissions. This can help in planning preventive measures and improving the overall safety of the plant.

CASE 3:

Display of gas emission levels on an LCD screen: The system is equipped with an LCD screen that displays real-time gas emission levels. This provides an easy-to-understand visual representation of the gas levels, allowing the plant manager to take quick action in case of any abnormalities.

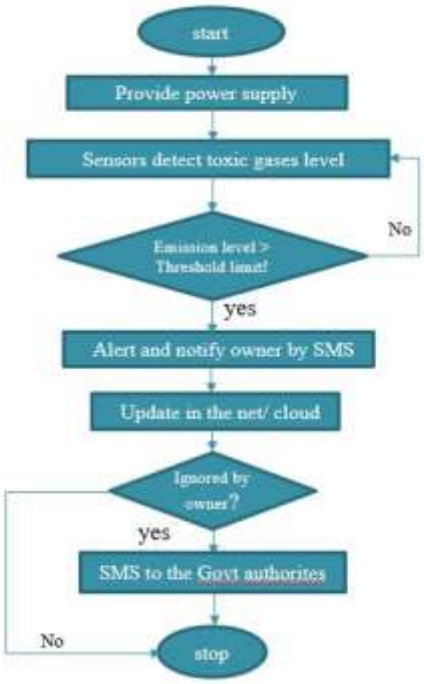

Fig 2. Algorithm

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4. Results and Discussion

Display has been re-enacted by utilizing by Arduino Software to screen the harmful gas and radiation location utilizing distinctive sensors. The adjustment in, carbon monoxide, smelling salts, radiation, and methane will be recognized by separate sensors and can be resolved.

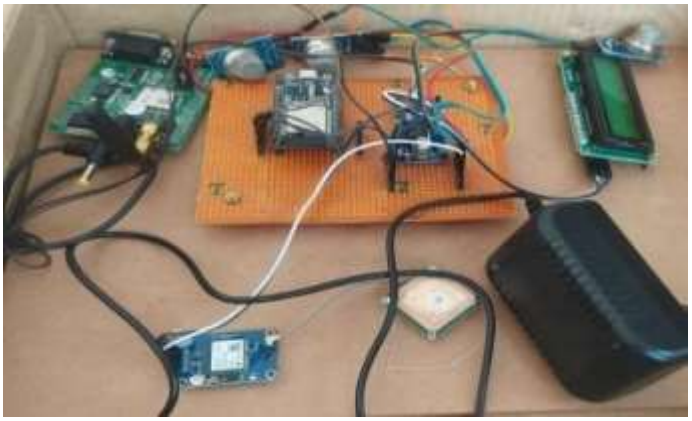

Fig 4.1. Hardware set up of project

Figure 4.1 shows the prototype for the system design. figure 4.2 shows the SMS notification when harmful gas levels have been raised from normal level to harmful levels.

Fig .4.2 : Different gases ppm display on the LCD display

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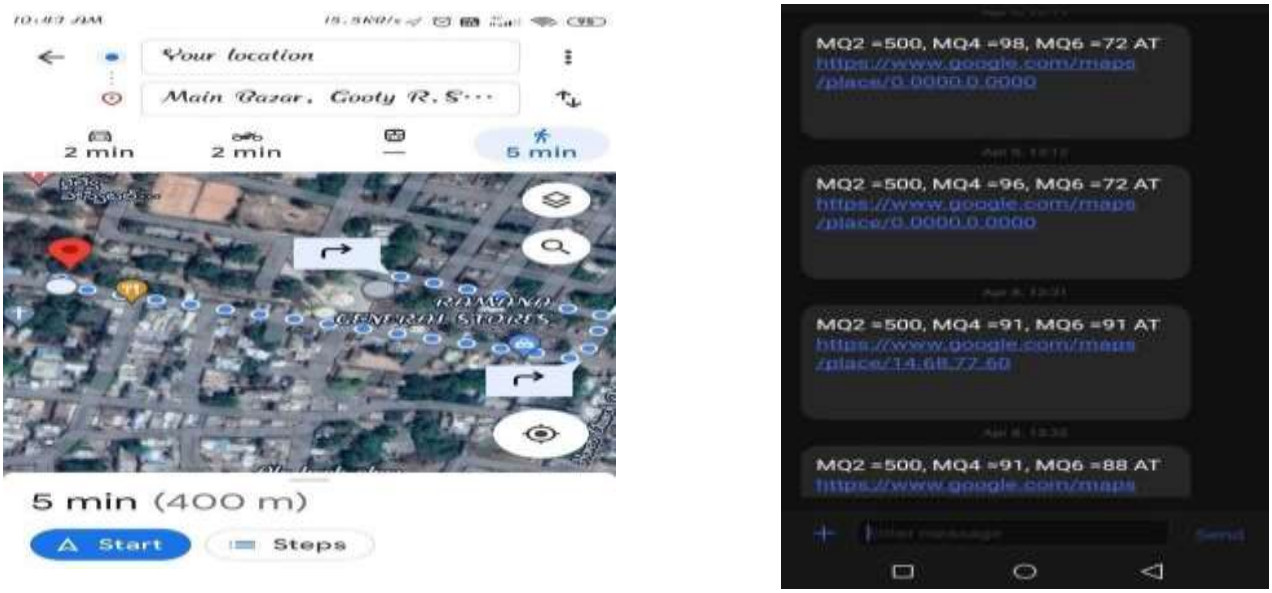

Fig. 4.3: SMS send to the mobile with location

Fig. 7. Graph of gas leakage detection.

Fig. 4.4 Graphical Representation of Gases Emission

5. Conclusion

In this work a novel framework for toxic gas and radiation discovery checking cautioning has been created to defeat the drawback looked at more established techniques by utilizing the Wi-Fi module and the Internet of things. Consequently, the utilization of serial correspondence makes the framework with ESP32 and IoT. The IoT associate remote sensor connects with the web, guaranteeing the operation of the gas observing framework. We can create an application additionally utilized for checking gas and radiation in Android portable. It can be extended by Artificial Intelligence and Machine Learning

Future Scope:

The IoT-based gas emission monitoring system has enormous potential for future applications and developments. Here are some possible future scope areas for this technology

- Integration with AI and Machine Learning: The system can be integrated with AI and machine learning algorithms to enable predictive analysis of gas emissions. This can help in identifying any potential hazards and taking corrective actions before any harm is caused.
- Smart Cities: The system can be deployed in smart cities to monitor gas emissions from various sources such as transportation, waste management, and industrial activities. This can help in reducing air pollution and improving the overall quality of life in the city.
- Integration with Blockchain: The system can be integrated with blockchain technology to provide a tamper-proof record of gas emissions. This can help in ensuring transparency and accountability in environmental management.
- Cloud-based Analytics: The system can be integrated with cloud-based analytics tools to enable real-time data analysis and reporting. This can help in identifying any anomalies and taking immediate action to prevent any harm.
- Mobile App Integration: The system can be integrated with a mobile app that can provide real-time notifications and alerts to the users. This can help in improving the overall safety of the users and reducing the potential for any accidents.

Overall, the future scope for the IoT-based gas emission monitoring system is vast and varied, with potential applications in industries, smart cities, and environmental management. With continued research and development, this technology has the potential to significantly improve public health and safety while minimizing the impact of hazardous gas emissions on the environment.

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