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SMART AIR POLLUTION MONITORING SYSTEM USING IOT AND RASPBERRY PI

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Abstract
Today's air pollution is a major problem for both people and the environment. Many dangerous pollutants are released into the air or environment as a result of globalisation and the quick development of industry. Human life expectancy is decreased by dangerous or poisonous gases, which also cause serious health issues like asthma, brain stroke, eye irritation, eye discomfort, itching or dry skin, among others. Air pollution also threatens the environment and humankind's level of living worldwide. As a result, it's essential to create a real-time air pollution detection system that offers local ambient conditions as well as the different gas concentrations in parts per million (ppm). In the recently published research study, scientists suggested an IoT and Raspberry Pi-based smart air pollution monitoring system. We designed this system using these two platforms. A variety of commercial gas sensors, a Raspberry Pi, the Internet of Things, and other necessary hardware components make up the built system. Real-time data is stored and sent to the cloud using Thingspeak. The created system offers accurate real-time data. All connected devices had internet access, and the data was displayed on an LCD.

Keywords: Air pollution, Gas sensors, Human beings Thingspeak, Cloud, Raspberry pi.

I. Introduction:

Pollutants have a significant negative impact on every aspect of the ecosystem, including the air, water, soil, and noise. Air pollution is currently a big issue on a global scale. The environment's destruction and deterioration, which causes serious pollution, is the main noticeable effect. The bulk of air contaminants are primary and secondary in nature. The main pollutants that are emitted into the environment are hydrogen sulphide, ammonia, petrol vapours, diesel, kerosene, liquefied petroleum gas, dust particles, carbon dioxide, sulphur dioxide, nitric oxide, etc. [1]. Ozone, ketones, sulphuric acid, nitrogen dioxide, sulphur trioxide, and other secondary pollutants are produced as a result of chemical reactions between the primary pollutants in the atmosphere. Many hazardous, toxic, and combustible gases, such as Cl2, C2H5OH, CO2, H2S, NH3, H2, CO, and LPG, are released into the environment by industry. Together with industrial sources, a number of individual sources of air pollution, such as automobiles, home stoves, ovens, and other appliances, are significant contributors to the air pollution problem. Inflammable fuels and combustion play a large role in air pollution. Fuels are mostly made of carbon or carbon derivatives. These compounds release heat when they burn in the air, which pollutes the environment [1, 2].

Air is essential to life. Poor air quality puts all living things, including humans and plants, at risk for disease. The health of people is specifically impacted by all forms of air pollution, including ozone and particle pollution. Both irritate the respiratory system and make breathing difficult, but one of them may be more harmful to your health than the other. Ozone is created when sunlight interacts with pollution from cars, factories, and power plants. Ozone is a colourless petrol that makes up the majority of urban pollution. Particle pollution is the term used to describe several types of air particles [1-3]. The sources of air pollution are diverse. The bulk of tiny particles that can enter the lungs are produced by burning in factories, wildfires, power plants, and automobiles. Natural elements like dust or sea salt are frequently the source of coarse particles. Particle pollution may make heart and lung conditions worse. Many patients with heart and lung issues visit hospitals when particle pollution is extremely bad. People are more susceptible to respiratory issues due to air pollution, which is also connected to cardiac arrhythmias, breathing issues, and cardiovascular illness [2-4].

Innovation is required for quick, easy, secure monitoring and control of physical quantities in the age of automation. There is a need for more complex and delicate smart systems. To improve performance and the system's capabilities in monitoring detecting technologies, as well as to reduce cost, form, size, and weight, sensor units must be added to the input ports of domestic, industrial, and scientific instruments. These days, a system that can detect different gases, show their quantity in the air, and measure, display, and instantly fetch data to a particular host or authority is necessary [4, 5]. Several researchers presented their methods for detecting air pollution using various terminologies. Current systems may now simultaneously detect a large number of toxic or flammable gases or even a combination of both, previously the detectors were made to only detect a single signal gas. They function as a monitoring system as well as a warning system when a hazardous gas level is reached. This type of technology is crucial since many gases have the potential to be harmful to living things, including humans and animals [5].

The implementation of a smart system to monitor air pollution is covered in this research paper. It discusses how to detect and monitor the presence of hazardous gases in the air using commercial gas sensors, the Internet, Thingspeak, and the Raspberry Pi.

II. Literature review:

The term "gas sensor" refers to a piece of equipment that detects physical parameters, such as molecules or gas analytes, and then transforms them into electrical (current/voltage) form. The discovery of the first commercial sensor served as the foundation for the development of the gas sensing or detection system. In order to identify methane in deep mining locations, Sir Humphry Davy built the flame safety lamp, the first gas detector utilised in the industrial period, in 1815 [6, 7]. Following that, other systems to detect gases in the environment were created using commercial sensors and analog electronic circuits. However, such devices have some drawbacks, such as sensing only one petrol analyte, requiring more processing time, taking more time, being unreliable, and not storing data. Subsequently, following the introduction of the microprocessor (p) or microcontroller (c), the term automation was created. Because in the realm of automation, both are quite important. Automation offers accuracy, portability, reusability, and reliability. This section gives background and overview of the field of developing petrol-detecting devices. Figure 1 depicts the development of air pollution monitoring systems using embedded system platforms, communication protocols, and integrated circuits (ICs) [8–10]

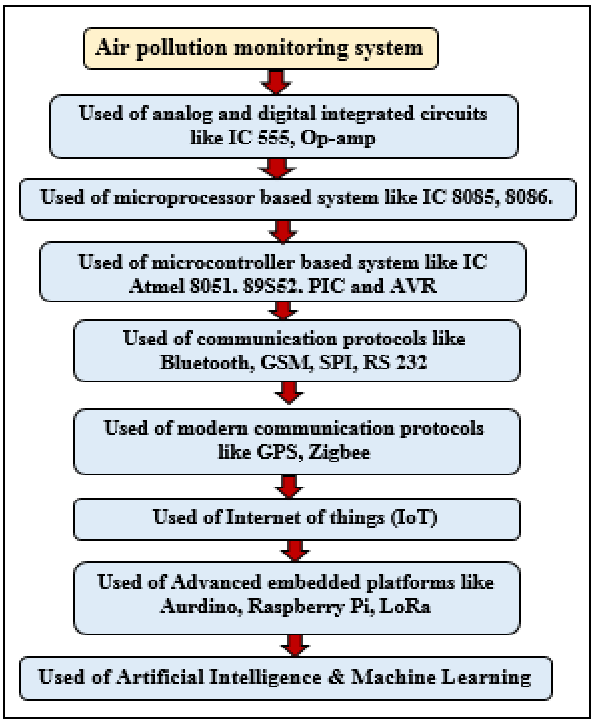

Figure 1: Evolution of terminologies in air pollution monitoring system

Gupta, et al. [11] Design and development of an Internet of Things-based air quality monitoring system for smart cities. Real-time data on air quality may be accessed via smart devices, and this data is then analyzed to discover how it affects city dwellers. In addition to temperature, moisture, carbon monoxide, liquid petroleum gas, smoke, and other hazardous gases, the smart devices can monitor airborne hazardous air pollutants concentrations including PM2.5 and PM10 as well as other environmental variables. Any users across the world can access the acquired data via an Android application.
Telagam, et al. [12] A real-time, wireless mesh network-based, inexpensive, and simple air quality monitoring system that monitors carbon monoxide, nitrogen dioxide, and methane gas was presented by researchers. By using this approach, we may take steps to lessen pollution in public areas and create new opportunities to do so. The authors used MQ7, MQ4, MQ 135, and MQ-4 gas sensors in the current setup. In addition, the writers collected data on a laptop via serial transmission using LabVIEW and VISA driver software. Liquid crystal displays are a type of display used in digital watches and many portable computers. The data is transmitted to the serial port, where it is read by the read buffer and displayed on the LCD screen.
An overview of the acute effects surveillance system for the Mexico City metropolitan area is provided by Sánchez-Carrillo, et al. [13]. Epidemiological research has connected air pollution to short-term health effects. Reports from industrialised nations have discussed the use of geographic data or monitoring systems for the examination of the effects of air pollution on health, most of them focused on hospitals and medical services. There aren't many instances of health monitoring systems in developing countries that offer systematic pollution and health data collecting, are adapted to local environmental conditions, and make efficient use of limited resources.
An air pollution and monitoring strategy that employs a data mining technique to identify air pollution is recommended by Raipure, et al. [14]. The sensor grid is used to identify sensor signals from several

gas sensors. Through a microcontroller, the values are transmitted from the Analog to Digital Convertor (ADC) to the server. Data mining is used to calculate pollution from various sources. The ID3 algorithm is used to determine the values based on likelihood. A Bluetooth module connects the controller and client, and the client communicates with the server using web services. Wireless sensors are used to calculate the number of hazardous gases present in the air, which ultimately results in a pollution reductionin pollution.

Our system not only identifies the airborne toxins, but it also predicts future pollution so that we may stop it and possibly warn the particular affected region. Wireless sensors are used to calculate the percentage of harmful gases that are present in the air, which ultimately helps to reduce pollution. Our device not only identifies the airborne toxins, but it also predicts future pollution so that we may stop it and possibly warn the particular affected region.

Maisonneuve, et al. [15] recommended and deployed outdoor technology for tracking urban noise pollution is the Noise Tube. Even though it is not a surveillance system for urban air pollution, the system architecture and operation are relatively similar. Each sensor node is a standalone smartphone. The microphone's built-in recorder captures the noise data and identifies it with GPS location information. The captured data is uploaded to the server through the cellular network. The public can access authorized noise pollution statistics via specialized websites and mobile apps.

The design of air pollution motioning systems has been seen to incorporate several commercial sensors, wires, wireless communication protocols, integrated circuits, advanced embedded platforms, WiFi, IoT, and other terminologies.

III. Methodology:

The Raspberry Pi 4, commercial sensors MQ 2, MQ 5, MQ 7, MQ 9, MQ 135, TGS 825, and DHT 22, a liquid crystal display (16x 2-LCD), the cloud service ThingSpeak, a laptop, a power source (+5VDC), and other required parts were used to design the system. The raspberry pi 4's GPIO pins are general-purpose input/output connectors that can be connected to external devices and input sensors. The sensor array, raspberry pi model, power supply, Display, and Thingspeak are included in the major components. The MQ 2, MQ 5, MQ 7, MQ 9, MQ 135, and TGS 825 sensors are utilised in the current system to detect LPG, CO, CH_4, CO_2, and H_2S gases, respectively.

The ambient temperature and humidity are measured using the DHT 22 sensor. The Raspberry Pi Foundation created the Raspberry Pi 4, a small single-board computer with two displays. The Raspberry Pi 4 comes with a built-in Wi-Fi module, USD, OS, memory, internet, GIOP, and a quad-core processor. A +5 VDC power supply was needed for the entire system. On a 16 x 2 screen, a liquid crystal display shows real-time data information. Online real-time data flows can be gathered, visualised, and examined with the use of the IoT platform service ThingSpeak. We can instantaneously visualise real-time data, upload data from your devices to ThingSpeak, and send notifications via web services. Fig. 2 displays a block diagram of the proposed smart air pollution monitoring system.

III. Working Principle of the proposed Model:

Fig. 2 graphically depicts the intended system's operating principle. The system's functional block diagram is shown in Fig. 2.

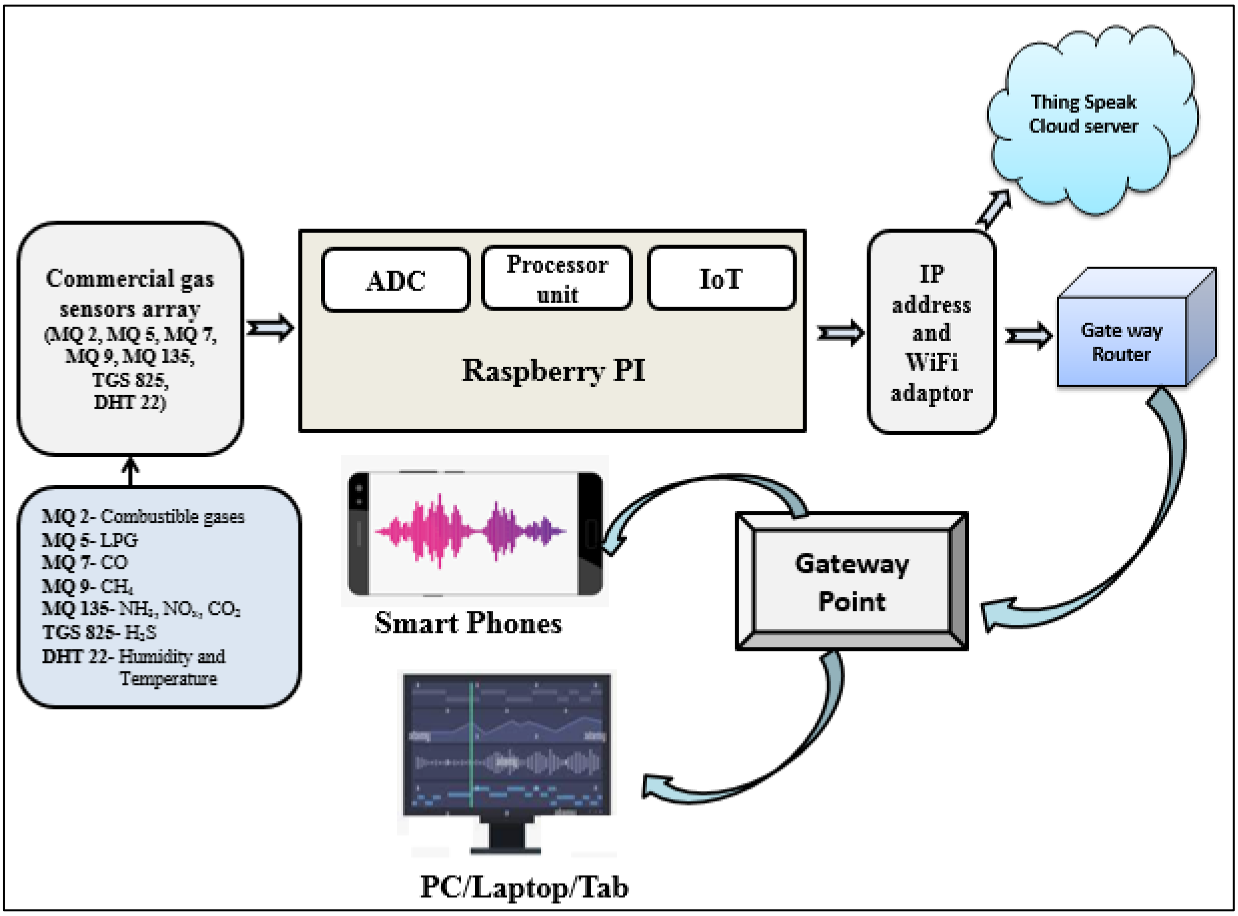

Figure 2: Block diagram of smart air pollution monitoring system

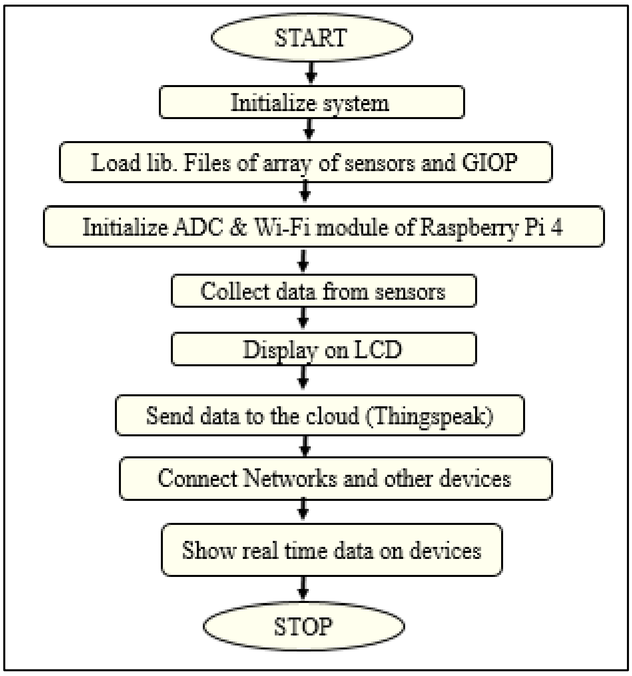

Figure 3: Flow chart of the proposed system

The system is initially given the necessary power supply. All sensors detected the surrounding gases, converted them to electrical form, and then supplied them to the Raspberry Pi's general input and output ports. All of this analogue data is converted to digital by the Raspberry Pi's ADC before being sent to the processing unit. After that, actions are conducted in accordance with the threshold valve's setting for periodicity of sensitivity, timing, and space, and data is sent to the LCD screen for display purposes. Following that, as seen in Figs. 2 and 3, real-time data will be sent on the ThingSpeak IoT platform. The user is the system's final component. Users can access the system using a smartphone, laptop, or desktop computer by properly logging in with their ThingSpeak accounts.

IV. Result and Discussion:

The system is first given the necessary power supply. The general input and output pins of the Raspberry Pi are provided with data from all sensors after they have converted the sensed gases into electrical form. All analog data is converted to digital by the raspberry pi's ADC before being sent to the processing unit. Thereafter, periodicity of sensitivity, time, and space action is performed in accordance with the threshold valve's setting, and data is supplied to the LCD screen for display purposes. Real-time data will then be transmitted to the ThingSpeak IoT platform, as seen in Fig. 2 and flowchart Fig. 3. The user is the final component of the system.

Figure 4: Obtained results of the proposed system

V. Conclusion:

This study recommended implementing a sophisticated air pollution monitoring system that continuously checks the quality of the air in a particular location and displays the results on an LCD screen. Moreover, it sends measurement data to the platform for "Thing talk." The method helps one become more aware of the air they are currently breathing. This monitoring tool can offer real-time air performance indicators.

VI. Acknowledgment:

The authors express gratitude to the management for offering all forms of assistance for the ongoing study project.

VII. Declaration of Competing Interest:

The authors affirm that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research presented in this study.

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