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AIR MONITORING SYSTEM

[1]Prof. S.Jadhav , [2]V.M. Ghodake, [3]J.D. Deokar, [4]S.R. Pawar

[1]Assistant Professor, E & TC Engineering Department, S. B. Patil College of Engineering, Indapur (MH), India.

[2 3 4] Student, E & TC Engineering Department, S. B. Patil College of Engineering, Indapur (MH), India.

Email: jadhav.shilpa1606@gmail.com, vghodake7364@gmail.com, Jayajadhav2129@gmail.com, swatu9201@gmail.com

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Abstract

This paper talks about a system designed to monitor air quality using two sensors — MQ135 for detecting general air pollutants and MQ7 for measuring carbon monoxide (CO) levels. Keeping track of air quality is important because it helps people understand pollution and encourages healthier living, especially for future generations. The system supports environmental efforts like those of the Indian government, which has taken steps such as banning highly polluting motorcycles. This project uses IoT platforms like Thing Speak and Cayenne to show real-time pollution data on public dashboards. This lets anyone easily check the air quality in specific areas. Compared to older systems, this one offers better sensor calibration, gives more accurate pollution readings (in PPM), and is cheaper to build thanks to the use of affordable components. Overall, it's a cost-effective and easy-to-use solution for monitoring the environment and spreading awareness about air pollution.

Introduction

Air pollution is one of the biggest problems in today's world. It has increased because of fast industrial growth, more people living in cities, growing population, and too many vehicles on the roads. Harmful gases, chemicals, and tiny particles released into the air can seriously affect our health and the environment (1)(2).

Pollutants like carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen oxides (NO_x), ozone (O_3), methane, and dust particles are the main reasons for bad air quality. According to the World Health Organization (WHO), breathing in these substances can cause asthma, lung problems, heart diseases, and other serious health issues (3).

Traditional systems used to measure air quality are often very expensive, complicated, and only available in certain government or industrial locations. They can't monitor large areas or provide real-time data. So, there is a strong need for cheaper, real-time, and easy-to-use air pollution monitoring systems (4).

Thanks to the Internet of Things (IoT) technology, we can now build smart, portable, and affordable systems to check air quality. Devices like the Node MCU ESP8266 can detect pollutants and send data over Wi-Fi. This allows people to check air quality from their phone or computer, anytime and anywhere. These systems show the amount of pollution in parts per million (PPM) on a website, making it easy to understand the data (7)(8).

These IoT-based systems can detect harmful gases like LPG, methane, and carbon monoxide, and also give early warnings if levels become dangerous. For example, if CO levels go above 100 ppm, it can cause dizziness, nausea, or even death in a few minutes. Real-time monitoring helps people and authorities take quick action to stay safe (5).

This project uses IoT to support environmental protection by fixing the problems of older monitoring systems. It helps collect data, share it remotely, and can be used in many places to check pollutants like O_3, SO_2, CO, and dust particles. In the end, this system is a simple, low-cost, and effective way to protect people's health and reduce the harmful effects of air pollution.

Literature Survey

Many researchers have created air pollution monitoring systems using IoT (Internet of Things) technology to help deal with the growing problem of poor air quality.

One system used a Node MCU Arduino board to detect harmful gases like CO_2, smoke, alcohol, benzene, and ammonia (NH_3). It showed the air quality levels in parts per million (PPM) on an LCD screen and a webpage. If pollution levels became too high, an alarm would go off. People could also check the air quality from their phone or computer (1).

Another team made a similar system and talked about how air pollution can lead to serious health problems like bronchitis, asthma, pneumonia, and heart disease. Their system used several gas sensors (CO_2, smoke, alcohol, benzene, NH_3, LPG, and NOx) to give more accurate readings. Like the first system, it showed data on a webpage and gave warnings when pollution levels were high. This study also pointed out that air pollution causes millions of early deaths around the world every year (2).

A different project focused on air quality in cities and industrial areas. It used gas sensors for CO and NO_2 and sent the data through a Wireless Sensor Network (WSN). This allowed for real-time, low-cost data transfer to a main server, which helped in short- and long-term planning. However, the system had some issues. The sensors weren't properly calibrated, so the readings weren't very accurate. Also, using many sensors caused power problems, so extra power sources were needed (3).

Some projects used Arduino boards for weather monitoring instead of air pollution. These systems used sensors to measure things like temperature, humidity, light, dew point, and heat index. The data was shown on a screen and saved for later analysis. While not directly related to pollution, these projects showed how useful Arduino is for tracking the environment (4).

Another air pollution monitoring system used the MQ135 sensor to detect many harmful gases. But the study made a mistake by saying that high PPM values meant the air was clean, which is incorrect. The sensors were not calibrated properly, and the data was only available on a local computer, not over the internet. Better systems use cloud platforms or open-source tools to safely store and share data with users worldwide (5).

Proposed Methodology

This project uses IoT technology to create an affordable and reliable air quality monitoring system. It collects data from different sensors and sends it to the cloud for real-time analysis and display. The Thing Speak platform is used to store the data and show it clearly, with proper calibration to get accurate pollution levels measured in parts per million (PPM). Sending data directly to the cloud removes the need for extra hardware like LCD screens, which helps lower costs. Other IoT platforms like Thinger.io and Cayenne also offer easy-to-use dashboards and allow users to download data for further study.

For internet connection, Wi-Fi is chosen over GSM or GPRS because it is cheaper and easier to use with cloud services. Unlike some previous studies that didn't calibrate sensors correctly, this system follows UN guidelines for safe and moderate pollution levels, using Delhi's high pollution level as a reference for testing. The hardware includes two gas sensors, MQ-7 and MQ-135, which need more power because of their built-in heating parts. To keep readings stable, the MQ-7 sensor is powered by a separate 9V battery with a voltage regulator, while the MQ-135 runs from the Arduino board.

The system is based on an Arduino Uno board with an ESP-01 Wi-Fi module for wireless data transfer to the Thing Speak cloud. It uses sensors like MQ-7 to measure carbon monoxide (CO) and MQ-131 for ozone (O_3) detection. These sensors work by changing their output voltage depending on gas concentration, which is then calibrated to give accurate PPM readings. The system shows real-time air quality monitoring and can be used in real environments. It continuously sends live data to a server, which anyone can access from a webpage or mobile device. Overall, the system can track multiple pollutants such as ozone (O_3) and sulphur dioxide (SO_2), making it a useful tool for monitoring air pollution

1. Sensors and Inputs

MQ-135 (Air Quality Sensor): Detects gases such as NH_3, CO_2, alcohol, benzene, and smoke.

MQ-7 (Carbon Monoxide Sensor): Specially calibrated for monitoring CO levels.

DHT22 (Temperature & Humidity Sensor): Monitors environmental temperature and relative humidity for complete air quality assessment.

Power Supply (5V/3.3V regulated): Ensures stable voltage supply for STM32 and sensors.

2. Output Devices and Communication

LCD/OLED Display: Shows real-time sensor readings including CO, CO_2, PM2.5, temperature, and humidity.

IoT Module (ESP8266/ESP32): Transmits data to a cloud server using MQTT protocol for remote monitoring and storage.

GSM Module: Sends SMS alerts to the user's mobile phone when pollution levels cross safe limits.

Buzzer and Indicators: Provide local audio-visual alerts to immediately warn individuals in the monitored area.

[1]Poonam Paul, Ritik Gupta, Sanjana Tiwari, Ashutosh Sharma, "IoT based Air Pollution Monitoring System with Arduino", IJART, May 2005.

Area: Embedded systems and microcontroller-based sensing (Arduino)

Application: Indoor air quality monitoring (rooms, offices)

Limitation: may only measure a few gases (CO, smoke, NH3, etc.) and not all pollutants (e.g. PM2.5, PM10, NO_2, O_3).

[2]Abdullah Kadri, Elias Yaacoub, Mohammed Mushtaha, And Adnan Abu-Dayya "Wireless Sensor Network For Real-Time Air Pollution Monitoring" IEEE Forum On Strategic Technology -2013.

Area: Ambient / environmental air quality monitoring.

Application: Public information – letting citizens know current air pollution levels via apps/web so **people can take protective action.**

Limitation: Limited number of stations: The pilot deployment uses only four solar-powered monitoring stations over $\sim 1\,km^2$. So spatial resolution is limited.

[3] Yeji Ma, Mark Richards, Moustafa Ghanem ,Yike Guo ,And John Hassard, "Air Pollution Monitoring And Mining Based On Sensor Grid In London" Sensor 2008

Area: Urban environmental monitoring, especially air pollution from road traffic.

Application: Identifying pollution "hot spots" in time (morning rush, afternoon, evening) and space (roads vs residential or near industrial areas).

Limitation: Scalability — scaling in area (wider urban area), more sensors leads to more complexity in data fusion, storage, processing. There is also trade-off between coverage and cost

[4] Bhatta Chariya, S., Sridevi, S. and Pitahaya, R., 2012, December. Monitoring of indoor environmental quality using a WSN. In 2012 Sixth International Conference on Sensing Technology (ICST) (pp. 422-427). IEEE.

Area: Indoor Environmental / Indoor Air Quality (IAQ) monitoring.

Application: Health & comfort management — reducing exposure to harmful pollutants indoors (dust, VOCs, gases).

Limitation: Sensor accuracy & calibration — sensors for gaseous pollutants, particulates may drift or have cross-sensitivity, needing calibration over time.

[5] Al-Ali, A. R.; Zulkarnaen, I.; Aloul, F., "A Mobile GPRS Sensors Array For Air Pollution Monitoring," Sensors Journal, IEEE, Vol.10, No.10, Pp.1666, 1671, Oct. 2010

Area: Mobile environmental monitoring (air quality) using sensor systems.

Application: Urban / city air quality monitoring—measuring pollution across different roads, zones, during mobility.

Limitation: Sensor accuracy / calibration / drift — low-cost sensors may face precision issues, cross sensitivity, drift over time (implicitly a risk in mobile sensing systems).

APPLICATIONS

1. Indoor Air Quality Monitoring

This system can be set up in places like homes, offices, schools, and hospitals to regularly check the air for harmful pollutants such as carbon dioxide (CO_2), carbon monoxide (CO), and dust particles (PM). It helps make sure the indoor air stays clean and safe for everyone.

2. Outdoor/Smart City Monitoring

This system is a good fit for smart city projects because it can monitor air pollution in real time using wireless sensors. The collected data can be shared with city authorities and added to their dashboards to help with planning and making the city environment healthier.

3. Traffic and Roadside Pollution Analysis

This system is helpful for checking pollution levels in areas with heavy traffic. It measures harmful gases from vehicles and gives live updates, so people traveling through those areas can stay informed about the air quality.

4. Health and Safety Applications

This system is helpful for people with asthma, older adults, and anyone with breathing problems. It lets them see real-time air pollution levels so they can avoid polluted areas and choose cleaner, healthier routes when going out.

5. Industrial Monitoring

This system can be used in factories and industrial areas to check pollution levels and detect harmful gases. It helps ensure that industries follow environmental safety rules and keep the air clean.

6. Research and Environmental Studies

This system helps researchers gather air pollution data over a long period of time. They can use this information to study patterns, predict future pollution levels, and create better rules and policies to protect the environment.

7. Mobile/Portable Monitoring

Because the device is small and inexpensive, it can be made into a portable tool. This lets people carry it around to check air pollution in different places easily.

8. Cloud and Web-based Applications

The data collected by the system is saved on the cloud, so you can check it anytime from websites or mobile apps. It can also be connected with Google Maps to show pollution hotspots in real time, making it easy to see where the air is most polluted.

CONCLUSION

The air quality monitoring system we created is a smart and affordable way to track pollution in real time. Unlike traditional monitoring stations that need big, expensive setups, our system is small, uses less power, and is easy to set up anywhere. It uses special gas sensors that react quickly, don't need much maintenance, and can monitor air continuously. By using wireless sensor networks and cloud platforms, the system lets people check pollution data remotely and easily. Older systems used costly technology like WASP or GSM, but ours keeps costs low without losing accuracy. The data is sent to the cloud and shown on a website, so users can see air quality information whenever they want. Another great thing is that more sensors can be added to cover larger areas, making the system flexible and scalable. It also uses efficient communication methods to save resources. Compared to traditional setups, this system fits well into smart city plans and can be expanded easily. In the future, we plan to add web dashboards and connect with Google Maps so people can see pollution levels live and find cleaner routes to avoid bad air, which is especially helpful for people with asthma or breathing problems. Overall, this system is a smart, portable, and eco-friendly solution that works better than older methods in cost, flexibility, and efficiency.

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E-mail: ramikrawal@gmail.com

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