Outdoor Air Quality Monitoring System Using Iot

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***Abstract*—**Air pollution is a major environmental concern that can have significant impacts on public health. In recent years, advances in the Internet of Things (IoT) technology have enabled the development of outdoor air quality monitoring systems that can provide real-time data on air pollution levels. This paper presents an outdoor air quality monitoring system that uses IoT to collect and analyze air quality data. The proposed system consists of sensors that are deployed in various locations to measure air quality parameters such as particulate matter (PM), carbon monoxide (CO), and nitrogen dioxide(NO2)and alert us with the help of an alarm system.

The sensors are connected to a central hub that collects and processes the data. The data is then transmitted to a cloud-based server where it is analyzed and visualized in real time. The system can also be integrated with other IoT applications, such as weather monitoring, to provide a more comprehensive view of environmental conditions. In conclusion, the proposed outdoor air quality monitoring system using IoT has the potential to be an effective tool for addressing air pollution and improving public health.

Keywords*—*IoT, Air Quality, Outdoor Monitoring, Sensors, Environmental Pollution.

I. I. INTRODUCTION

In recent years, air pollution has become a major concern for public health, and outdoor air quality monitoring has become an essential task for environmental agencies. With the advent of Internet of Things (IoT) technology, it has become easier to monitor air quality in real-time and analyze the data to

understand the impact of air pollution on human health and the environment[1,3].An IoT-based outdoor air quality monitoring system can provide accurate and reliable data on various air pollutants such as particulate matter, nitrogen oxides, sulfur dioxide, and ozone[15]. The system consists of multiple sensors deployed strategically, connected to a cloud-based platform through wireless communication networks[13]. The platform collects and processes the data from the sensors, analyzes it using machine learning algorithms[7,9], and presents the information in an easy-to-understand format for end-users.The benefits of such a system are numerous, including early warning of high-pollution events, identification of pollution sources, and evaluation of the effectiveness of pollution control measuring[11]. This paper aims to provide an overview of the design, implementation, and evaluation of an IoT-based outdoor air quality monitoring system, highlighting the challenges and opportunities in deploying such systems in real-world environments.

II. II. SYSTEM DESIGN AND IMPLEMENTATION

A. *Hardware Requirements:*

1) Arduino Uno: The Arduino UNO is a microcontroller that has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or a battery to get started. The Arduino UNO can be powered via a USB connection or with an external power supply. The power source is selected automatically.

Fig. 1. Arduino Uno

2) MQ135 Sensor: Ammonia (NH_3), sulfur (S), Benzene (C_6H_6), CO_2, and other harmful gasses and smoke can all be detected by the MQ-135 Gas sensor. This gas sensor also has a digital and analog output pin, like other MQ series sensors. At the point when the level of these gasses goes past an edge limit in the air the computerized pin goes high. The onboard potentiometer can be used to set this threshold value. An analog voltage is sent out by the analog output pin, and this voltage can be used to estimate how much of these gasses are in the atmosphereThe MQ135 air quality sensor module works at 5V and consumes around 150mA. It requires some pre-warming before it can give exact outcomes. One of the most widely used gas sensors in air quality control equipment is the MQ135 from the MQ series. It is capable of providing both digital and analog output and

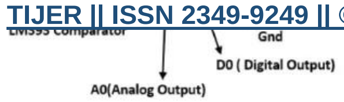
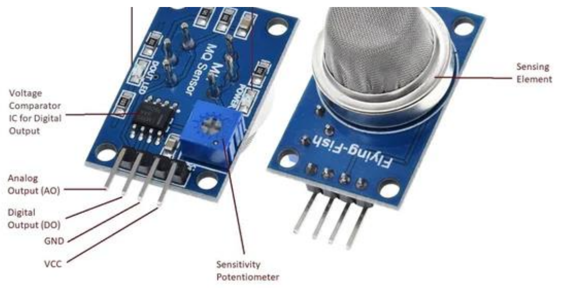


Fig. 2. MQ135 Sensor



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4) Fig. 3. MQ2 Sensor

5) *MQ7 Sensor:* The MQ7 gas sensor is one more member of the MQ Gas Sensors family, which also includes the MQ 2, MQ 4, MQ 3, MQ 8, and MQ 135. Mostly, it is used to find carbon monoxide. The sensing element of this sensor is mostly ceramic coated with Tin dioxide (SnO_2) and enclosed in a stainless steel mesh. The resistivity of the sensing element changes whenever CO gas comes into contact with it. The change is then measured to determine the gas concentration. It is necessary to preheat the MQ7 Sensor to get it into the working window because the sensor has a small heating element present. It can detect carbon monoxide gas in the air at concentrations ranging from 20 PPM to 2000 PPM. It is used in alarm applications in the event of a buildup of CO gas in the home or vehicle because CO is a very dangerous gas that can kill a person if it is present at a concentration greater than 300 parts per million.

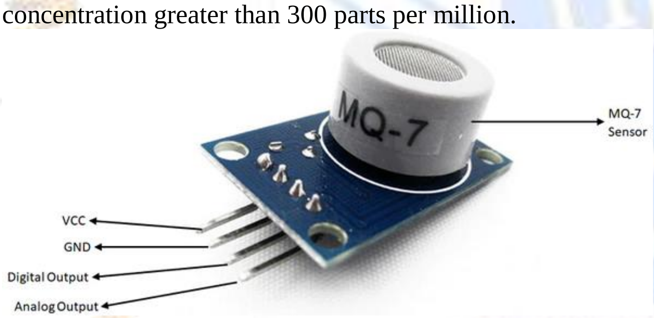

Fig. 4. MQ7 Sensor

6) *16x2 LCD:* In embedded system applications, LCDs (Liquid Crystal Displays) are used to display various system parameters and statuses. The LCD 16x2 device has 16 pins and two rows that can each hold 16 characters. The LCD 16x2 can operate in either 4-bit or 8-bit mode. Individual characters can also be made. It has three control lines and eight data lines that can be used for control.

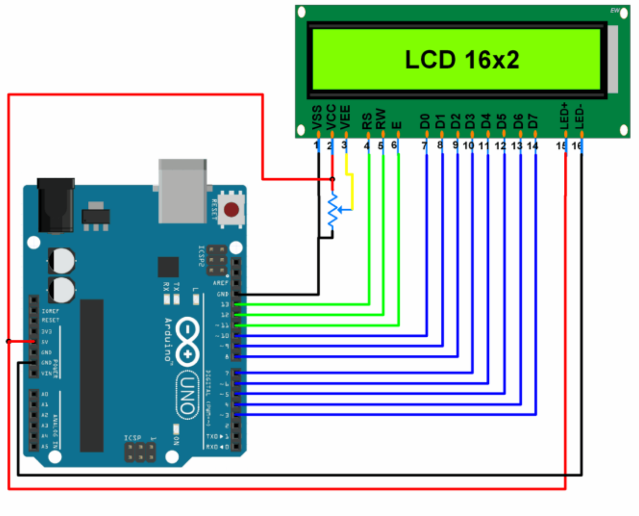

Fig. 5. 16x2 LCD

7) *Potentiometer:* A potentiometer is an electrical component that is used to vary the resistance in a circuit. It is made up of a resistive element and a sliding contact that can be moved along the resistive element to vary the resistance. When used as a sensor, a potentiometer can be used to measure changes in air quality by detecting changes in resistance. For example, a potentiometer could be used to measure the concentration of a particular gas in the air. The gas could be made to react with a sensing material, causing a change in resistance in the potentiometer. This change in resistance could be measured and used to calculate the concentration of the gas in the air.

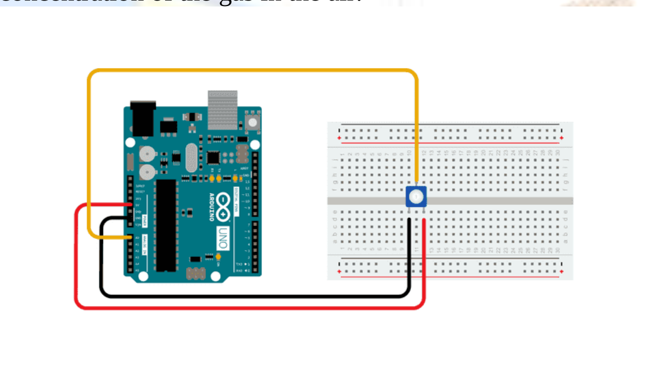

Fig. 6. Potentiometer

8) *Breadboard:* A breadboard is a prototyping tool that is commonly used in electronics projects to make temporary connections between components that are connected by metal strips, allowing components to be inserted and connected together without the need for soldering. Breadboards are useful in electronics projects because they allow you to quickly and easily prototype circuits without the need for specialized tools or skills. You can insert components into the breadboard and connect them together using jumper wires or other types of connectors.

Fig. 7. Breadboard.

Ref	Literature Survey		
	Devices Used for Detection	*Drawbacks*	*Efficiency*
[1]	This paper presented an indoor air quality detector (IAQD)system made up of a Zigbee wireless network, which enables monitoring of PM2.5, CO2, temperature, and humidity.	The alert message is not displayed and no alarm detector is attached even if the pollution level goes beyond a certain point.	73.3%
[2]	Raspberry pi4 is used which is a device that enables people of all ages to explore computing.	It only monitors CO, CO2, temperature, and humidity. It won't detect harmful gasses like NO2, and SO2	68%
[5]	This model comprises ML-based calculations to construct the estimating modules by training from the gathered information.	In this model XGBOOST algorithm is used which does not perform so well on sparse and unstructured data.	53%
[6]	This paper describes the design and development of the prototype for an IOT-enabled IAQ monitoring system, with a custom app for data logging and user recommendations.	It only contains 30 hours of battery life	55%
[9]	Experimental results showed notable improvement in the prediction accuracy for NO2.	This system uses a GP model algorithm where its runtime scales poorly with the number of samples.	59%

TABLE I. LITERATURE. SURVEY

9) *Blynk App:* Blynk is a platform for building mobile applications that can control hardware devices such as Arduino, Raspberry Pi, and ESP8266. It consists of a mobile app and a cloud-based server that allows users to create custom user interfaces, and communicate with their hardware projects over the Internet.The Blynk app is available for both iOS and Android and can be downloaded from their respective app stores. Once installed, users can create an account and start building their custom interfaces with a drag-and-drop interface builder. The app supports a wide range of widgets including buttons, sliders, gauges, and graphs, which can be used to control and monitor various aspects of a hardware project.

10)

Fig. 8. Blynk App.

B. System Design

Arduino plays the main role in this project. It has been programmed in a manner, such that it senses the sensory signals from the sensors(MQ135, MQ2, and MQ7 sensor) and shows the quality level. The MQ135, MQ2, and MQ7 sensor module is used to measure the temperature and the humidity of the surroundings, Ammonia (NH3), Sulphur (S), Benzene (C6H6), CO2, and other harmful gasses such as LPG, smoke, alcohol, propane, hydrogen, methane, carbon monoxide, and 5V DC at concentrations ranging from 200 to 10000 PPM. These data are fed to the ThinkSpeak cloud over the internet. We have also provided LED and buzzer indicators to indicate the safety levels.

- Firstly, the calibration of the MQ-135,MQ2 gas sensor module is done. The sensor is set to preheat for 24 minutes. Then the software code is uploaded to the Arduino followed by the hardware circuit to calibrate the sensor has been performed.
- Then, the MQ7 sensor is set to preheat for 10 minutes.
- The result of calibration found in STEP 1 is used to configure the final working code.
- The final working code is then uploaded to the NodeMCU.
- Finally, the complete hardware circuit is implemented.

1)

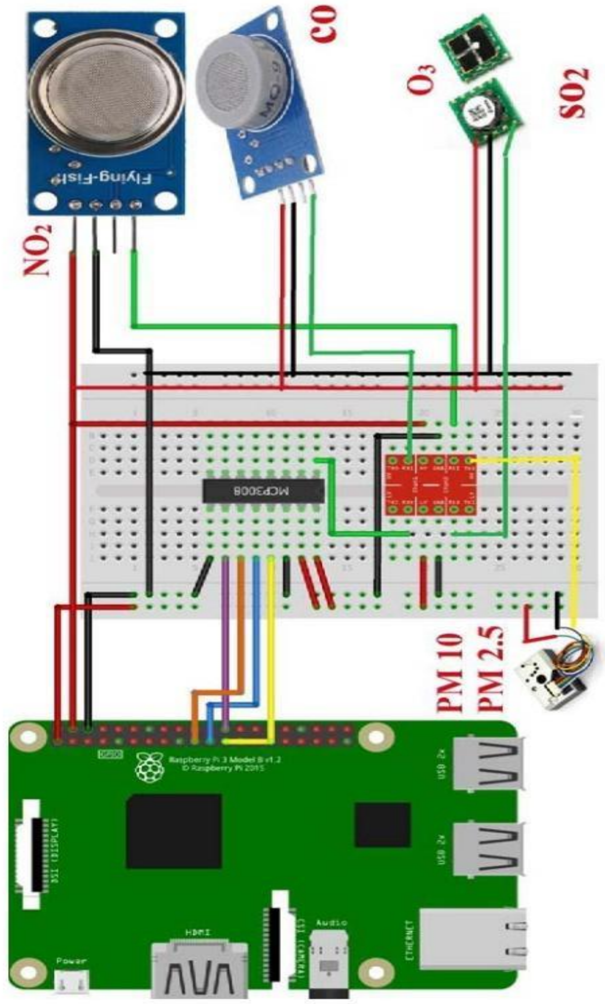

Fig. 9. Architecture of an outdoor air quality monitoring system using IoT

III. III. CONCLUSION

Implementing an outdoor IoT-based air quality monitoring system is a promising solution to address the growing concern over air pollution. The system utilizes sensors that are capable of measuring various air pollutants in real time, and the collected data can be used to generate accurate and up-to-date air quality information.The system allows for real-time monitoring of air quality parameters such as PM2.5, PM10, CO, SO2, and NO2, which are known to significantly impact human health and the environment. Through the use of sensors, data is collected and transmitted to a central location where it can be analyzed and used to inform decision-making regarding pollution mitigation efforts. The system can also provide early warning alerts to the public in case of hazardous air quality conditions.

The system utilizes cloud-based platforms for data storage, analysis, and visualization, making it easy for stakeholders to access the information they need to make informed decisions. Moreover, the system is designed to be scalable, allowing for the integration of sensors and the expansion of the monitoring network. Overall, the outdoor air quality monitoring system using IoT has the potential to improve air quality monitoring and management, and it could help in creating a cleaner and healthier environment for people. Therefore, it is essential to continue exploring and improving this technology to better address the challenges of air pollution.

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