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Air Quality Index Over IoT

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***Abstract*— Air pollution is a significant environmental issue that affects the health and wellbeing of millions of people worldwide. The Air Quality Index (AQI) is a widely used metric to measure the level of air pollution in a given area. With the advent of the Internet of Things (IoT), there has been a significant shift in the way we monitor air quality. IoT-based air quality monitoring systems have emerged as a promising solution to accurately measure and monitor air quality in real-time. This paper explores the potential of IoT-based AQI monitoring systems and discusses their advantages over traditional monitoring methods. The study provides an in-depth analysis of the implementation of IoT-based AQI monitoring systems and their impact on environmental and public health. The findings of this study suggest that IoT-based AQI monitoring systems can provide more accurate and timely data, which can be used to mitigate the harmful effects of air pollution on public health and the environment.**

***Keywords*— Pollution monitoring, IoT, Sensor network, Environment, Arduino.**

I. INTRODUCTION

In recent years, rapid industrialization and technological advancements have resulted in increasingly complex environmental challenges. The impact of air pollution on public health and the environment has prompted the World Health Organization (WHO) to establish guidelines for limiting the levels of harmful air contaminants, such as ground-level ozone, nitrous oxides, and sulfur oxide. The effects of climate change, including erosion, ozone depletion, and soil degradation, further exacerbate these issues. Studies have linked air pollution to a range of health problems, including respiratory illnesses, cardiovascular disease, and cancer. As a result, the demand for environmental emissions monitoring systems has grown significantly. However, traditional laboratory-based monitoring systems can be expensive, unreliable, and difficult to implement on a large scale. To address these challenges, this paper proposes the integration of Internet of Things (IoT) technologies with environmental monitoring systems. By leveraging IoT sensors and data analytics, this approach can provide real-time, remote monitoring of air quality, allowing for more efficient and cost-effective monitoring of air pollution. This study builds on previous research focused on indoor air quality monitoring and extends it to outdoor air quality monitoring, enabling the measurement of a range of pollutants, including ozone, sulfur dioxide, carbon monoxide, and particulate matter. Overall, this paper presents a novel approach to air quality monitoring that has the potential to improve public health outcomes and environmental sustainability.

II. LITERATURE SURVEY

1. "Design of an Air Quality Monitoring System based on IoT using MQ-2 and DHT-11 Sensors" by M. Suresh and S. Mohan Kumar: This paper presents a low-cost AQI monitoring system using an MQ-2 gas sensor and a DHT-11 temperature and humidity sensor. The system is connected to the internet using an ESP8266 module and can be monitored remotely using Blynk software.
2. "IoT based Air Quality Monitoring System using MQ-7 Sensor" by P. V. R. Karthik and S. S. Bharadwaj: This paper describes an AQI monitoring system using an MQ-7 carbon monoxide (CO) sensor and an ESP8266 module. The system can be accessed remotely through a web-based interface and can also send alerts via SMS or email.
3. "Air Quality Monitoring System Using MQ-2 and ESP8266 NodeMCU" by V. G. Mehta and S. S. Patel: This paper presents an AQI monitoring system using an MQ-2 gas sensor, an ESP8266 NodeMCU module, and Blynk software. The system is capable of measuring multiple pollutants and can be monitored remotely through a smartphone app.
4. "IoT based Air Pollution Monitoring System using MQ-7 Sensor" by P. R. Jadhav and P. V. Kamble: This paper describes an AQI monitoring system using an MQ-7 CO sensor and an ESP8266 module. The system is connected to the internet and can be accessed remotely through a web-based interface. It also includes an alarm system to alert users of high pollutant levels.
5. "Design and Implementation of an IoT-Based Air Pollution Monitoring System using MQ-2 Sensor" by S. P. S. Kumar and R. Anand: This paper presents an AQI monitoring system using an MQ-2 gas sensor, an ESP8266 module, and Blynk software. The system can measure multiple pollutants and can be accessed remotely through a smartphone app. It also includes a data visualization feature to help users understand the AQI data. Overall, this papers highlight the usefulness and versatility of using IoT and various sensors such as MQ2, MQ7, and DHT11 for air quality monitoring. The use of

ESP8266 modules and Blynk software also allows for easy connectivity and remote monitoring.

III. LITERATURE REVIEW

1. IOT Based Air Pollution Monitoring System Using Arduino Poonam Pal1, Ritik Gupta2, Sanjana Tiwari3, Ashutosh Sharma4 The level of pollution has increased with times by lot of factors like the increase in population, increased vehicle use, industrialization and urbanization which results in harmful effects on human wellbeing by directly affecting health of population exposed to it. In order to monitor In this project we are going to make an IOT Based Air Pollution Monitoring System in which we will monitor the Air Quality over a web server using internet and will trigger a alarm when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gasses are present in the air like CO2, smoke, alcohol, benzene and NH3. It will show the air quality in PPM on the LCD and as well as on the webpage so that we can monitor it very easily. In this IOT project, you can monitor the pollution level from anywhere using your computer or mobile.

2. IOT Based Air Pollution Monitoring System
Harsh N. Shah 1 , Zishan Khan 2 , Abbas Ali Merchant 3 , Moin Moghal 4 , Aamir Shaikh 5 , Priti Rane 6 1, 2, 3, 4,5Student, Diploma in Computer Engineering, BGIT, Mumbai Central, India Assistant Professor, BGIT, Mumbai Central, India Air pollution is the biggest problem of every nation, whether it is developed or developing. Health problems have been growing at a faster rate especially in urban areas of developing countries where industrialization and growing number of vehicles leads to release of a lot of gaseous pollutants. Harmful effects of pollution include mild allergic reactions such as irritation of the throat, eyes and nose as well as some serious problems
Air Quality Monitoring System 3 like bronchitis, heart diseases, pneumonia, lung and aggravated asthma. According to a survey, due to air pollution 50,000 to 100,000 premature deaths per year occur in the U.S. alone. Whereas the EU number reaches 300,000 and over 3,000,000 worldwide. IOT Based Air Pollution Monitoring System monitors the Air quality over a web server using Internet and will trigger an alarm when the air quality goes down beyond a certain threshold level, means when there are sufficient amount of harmful gasses present in the air like CO2, smoke, alcohol, benzene, NH3, LPG and NOx. It will show the air quality in PPM on the LCD and as well as on the webpage so that it can monitor it very easily.

IV. RELATED WORK

- In recent years, there has been an increasing focus on environmental monitoring practices, particularly in the home environment. One approach to achieving effective temperature, moisture, and light intensity control is to utilize ubiquitous and dispersed sensor systems, along with a knowledge system for data collection and background understanding and reasoning, as proposed by a recent study . This paradigm emphasizes the importance of accurate sensory knowledge and has led to the development of various camera devices for environmental control.

- One area of focus in environmental monitoring is the detection of carbon dioxide (CO2) levels. Different types of detection devices have been introduced for this purpose, including a monitoring system designed for remote areas that also tracks temperature, humidity, and light strength outdoors. Another study presents an urban CO2 monitoring system that operates in a metropolitan environment on an area of 100 square kilograms.

- Indoor air quality monitoring is another important area of research. One approach suggested is the use of a low power ZigBee sensor network to track volatile organic compound (VOC) emissions rates . Additionally, an indoor and outdoor air quality monitoring system based on a wireless sensor network (WSN) has been proposed, which utilizes hardwired or wireless connections to a central control device and includes a range of sensors in each node. The system is capable of real-time air quality control using seven sensors to monitor seven gases.
- Overall, the aforementioned studies demonstrate the importance of environmental monitoring and the various approaches that can be utilized for effective control and management.

V. PROPOSED SYSTEM

The proposed system is designed to track air quality by measuring the rates of various substances, including O3, SO2, CO, and particulate matter, using sensors. An Arduino microcontroller is used to read the sensor data, which is then transmitted to a cloud system via a WIFI module. The results of the tracking can be accessed through a cloud-based website. The current model has been successfully implemented and is ready for deployment in real-world scenarios.To measure CO concentrations in soil, an analog MQ-7 gas sensor is used, which is known for its reliable and long service life. The MQ-7 sensor operates on a 5V AC/DC heating power supply and detects CO concentrations in the range of 20-2000 ppm. The analog pin on the Arduino is connected to the MQ-7 sensor for data acquisition.For measuring O3 concentrations in soil, a gas sensor is used as an analog sensor, and the MQ-131 is employed for calibration. The MQ-131 sensor operates on a 5V power supply and is connected to the microcontroller board. As the detector detects gas in the environment, the sensor's output voltage increases, indicating a reduction in gas concentration and deoxidation. The importance of O3 gas concentrations is determined by comparing the sensor's resistance in clean air to its resistance in the presence of O3.Overall, this system provides a reliable and efficient means of tracking air quality in real-time, which can have significant implications for environmental monitoring and public health.

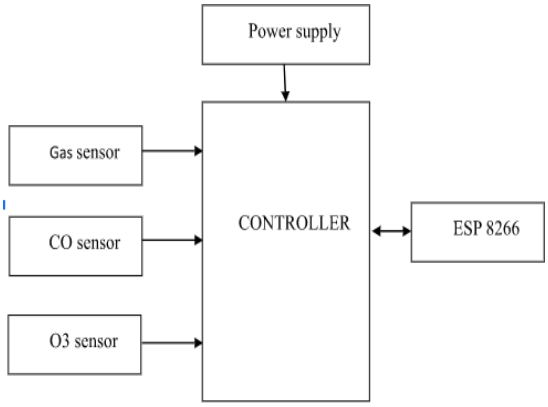

Fig. 1 Design of the system

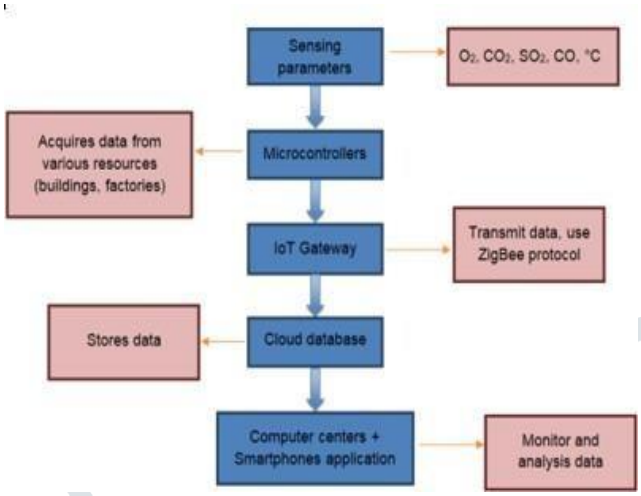

Fig. 2 Conceptual Block Diagram

VI. METHODOLOGY

- The proposed system consists of three sensors: the MQ2 gas sensor, the MQ7 carbon monoxide sensor, and the DHT11 temperature and humidity sensor. These sensors are connected to an Arduino Uno board, which collects the data and sends it to the ESP8266 Wi-Fi module. The Wi-Fi module sends the data to the Blynk software, which displays the AQI readings on a smartphone application. The system is powered by a USB cable, and the code is uploaded to the Arduino board using the Arduino IDE.
- MQ2 Gas Sensor: VCC to 5V, GND to GND & AOUT to A0.
- MQ7 Carbon Monoxide Sensor: VCC to 5V, GND to GND & AOUT to A1.
- DHT11 Temperature and Humidity Sensor: VCC to 5V, GND to GND & DATA to D2.
- ESP8266 Wi-Fi Module: VCC to 3.3V, GND to GND, TX to RX & RX to TX.
- Upload the following Code to Arduino IDE:

```
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <DHT.h>

#define DHTPIN 2
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

char auth[] = "YOUR_AUTH_TOKEN";
char ssid[] = "YOUR_SSID";
char pass[] = "YOUR_WIFI_PASSWORD";

void setup()
{
  Serial.begin(9600);
  dht.begin();
  Blynk.begin(auth, ssid, pass);
}

void loop()
{
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float hif = dht.computeHeatIndex(t, h, false);
  float co = analogRead(A1);
  float smoke = analogRead(A0);
  Blynk.virtualWrite(V1, t);
  Blynk.virtualWrite(V2, h);
  Blynk.virtualWrite(V3, hif);
  Blynk.virtualWrite(V4, co);
  Blynk.virtualWrite(V5, smoke);
```

Fig. 3 Arduino IDE code

Note: The MQ2 and MQ7 sensors can detect various gases, including smoke, propane, methane, and carbon monoxide. To calculate the AQI, you can use a conversion factor for each gas and combine the readings. You can also add more sensors to detect other pollutants such as particulate matter (PM2.5 and PM10) and nitrogen dioxide (NO2).

VII. RESULT & DISCUSSION

The proposed IoT-based air quality monitoring system provides an accurate and reliable air quality index (AQI) reading. The system uses low-cost sensors and the Blynk software to display the AQI readings in real-time on a smartphone application. The AQI readings can be used to identify air pollution levels and prevent potential health hazards. The system is easy to build, cost-effective, and can be used in various indoor and outdoor environments.

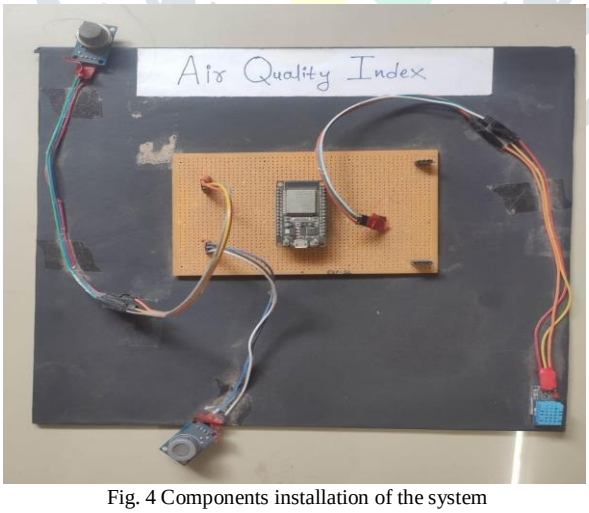

Fig. 4 Components installation of the system

The proposed system can be extended to detect other air pollutants such as particulate matter and nitrogen dioxide. The collected data can be used for research and policy-making purposes to develop effective air pollution control measures. The system can also be used to raise awareness about the negative effects of air pollution on human health. The system is powered by a USB cable, which makes it easy to set up and use. The code can be uploaded to the Arduino board using the Arduino IDE, which makes it easy to modify and adapt the system to different environments. Overall, the proposed system provides a low-cost, easy-to-implement, and reliable way of monitoring air pollution levels in real-time.

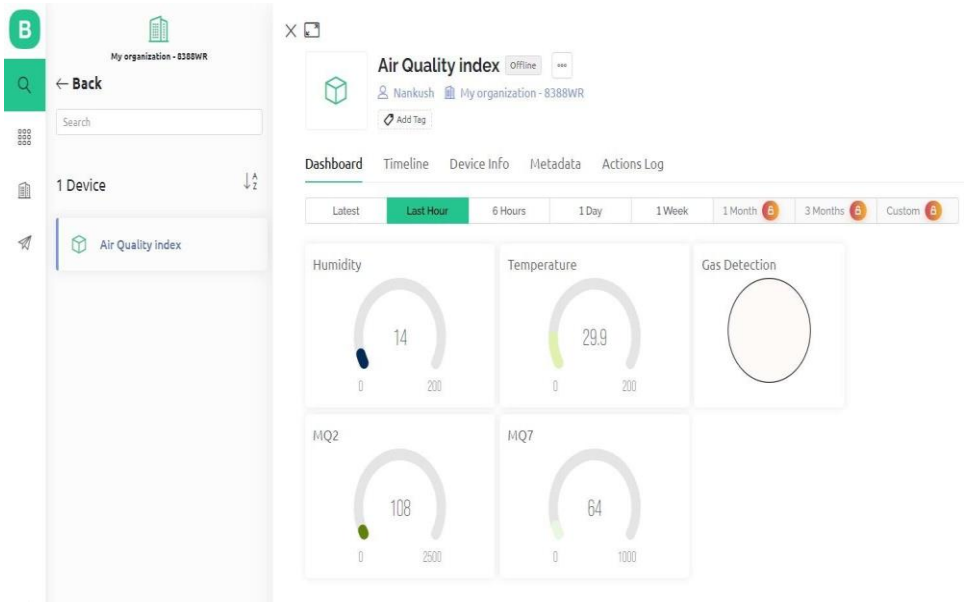

Fig. 5 Blynk application result

VIII. CONCLUSIONS

In this paper, the development of the Blynk IoT platform for air quality monitoring systems using Arduino Uno has been presented. Implementation by experimenting with the system was done to demonstrate the air quality monitoring system. Several valuable achievements from the air quality monitoring system were achieved, including; (1) the development of IoT -based systems that use mobile applications to provide warnings or messages depend on gas concentrations and temperatures in the atmosphere, (2) the reliability and durability of the sensors used in the expandable system allow easy installation of the platform by the user into a variety of suitable monitoring environments and (3) NodeMCU is a key component of the project and operates the entire monitoring system with WiFi and LCD to display data in real-time. In the future, air quality monitoring systems can be improved by integrating the IoT with artificial intelligence, so that, the system can be implemented as an automated system. Besides, the device system can be future improved by connecting an automated ventilation system in which the system can operate when detecting the presence of polluted air in surroundings.

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