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Portable and User-friendly Air Watch System Based on IoT

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Abstract

The internet of things (IoT) based air monitoring system is a novel approach to monitoring air quality in real time. With the increasing concerns over pollution and its impact on human health, our IoT-based air monitoring system offers a solution to gather and analyze air quality data efficiently. The system utilizes IoT devices like Node MCU and sensors like MQ135 and DTH11 to collect data such as temperature, air quality, and humidity, respectively, providing valuable insights for individuals and authorities to make informed decisions for a cleaner and healthier environment. Sophisticated real-time air monitoring systems have been developed because of growing global awareness of air quality and its direct impact on human health. The IoT-based portable and user-friendly air watch system seeks to give people and communities useful information about air pollution levels. This analysis delves into the technical underpinnings of IoT-based air monitoring systems, emphasizing their portability, user friendliness, and capacity to integrate many sensors to gather data on a range of contaminants. It goes into additional detail about the practical applications of these systems, their importance in reducing health hazards, and the techniques used in their development and implementation. A discussion of upcoming trends and potential enhancements, for broader adoption and scalability rounds up the review.

Keywords: MQ135 gas sensor, DTH11 temperature sensor, Node MCU, internet of things, microcontroller, random access memory (RAM), Wi-Fi module

INTRODUCTION

An air monitoring station is a gadget that uses several sensors to gather information about the surroundings and weather. Given the recent changes in the climate, environmental monitoring is crucial to guaranteeing a prosperous and safe existence for both humans and artefacts. Weather monitoring is a methodical approach to provide us with comprehensive weather information about our immediate surroundings. Two categories of weather monitoring exist. One which has inbuilt sensors, and the second type of weather monitoring is where the data is extracted from the weather station servers. Because the weather varies daily based on external factors, it is imperative to monitor the surrounding conditions. To collect environmental data, this field is reliant on wireless sensor networks and remote sensing. As everyone knows, a weather system is made up of several tiny instruments working together to produce a bigger system. There are two different kinds of weather systems: the first uses its own sensors, while the second uses servers to gather data from the weather monitoring system [1]. In this, we will go for the first one, that is, we can design our own weather monitoring station. In order for a device to be part of the internet of things (IoT), it must be able to communicate with other devices. Therefore, it

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requires some sort of built-in wired or wireless communication. Most IoT devices are Wi-Fi enabled, but Bluetooth also can be used to transfer data to nearby devices. IoT devices are commonly called “smart devices”, since they are ready to communicate with other things. Along with the capacity to speak, many IoT devices also include an array of sensors that provide useful information. While the IoT is still in its infancy, it provides promising opportunities for the future. In time, the web of Things will subside of an abstract idea and more of how of life. IoT-based air quality monitoring systems comprise interconnected devices equipped with sensors capable of detecting various pollutants present in the atmosphere. The Node MCU gas and temperature sensor emerges as a pivotal component in this ecosystem. Node MCU, a low-cost open-source IoT platform based on the ESP8266 Wi-Fi module, provides a robust framework for sensor integration and data transmission. Coupled with gas and temperature sensors, it enables the real-time monitoring of air quality parameters in indoor and outdoor environments. The sensors used in a system for tracking the air might be a DHT11 sensor for temperature and humidity and MQ135 gas sensor for air quality detection. One of the most consistently difficult problems in meteorology worldwide is weather forecasting, which plays a crucial role in the field.

LITERATURE SURVEY

In the article by Solanki et al. [2] a weather monitoring gadget used various sensors to gather meteorological and environmental data.

Shetty et al. [1] presented the design and implementation of an air quality monitoring system utilizing Node MCU, a low-cost Wi-Fi enabled microcontroller, for real-time monitoring and analysis of air pollutants. The system aimed to address the increasing concerns regarding air pollution and its adverse effects on public health and the environment. Through the integration of Node MCU with various sensors capable of measuring different air quality parameters, such as particulate matter (PM), carbon monoxide (CO), nitrogen dioxide (NO_2), and ozone (O_3), the system provides continuous monitoring and data collection [1].

Lumbangaol et al. [3] used an Arduino microcontroller connected with MQ135 and MQ6 gas sensor which senses the different types of gases present in the environment. It was then connected to the Wi-Fi module which connects to the internet and a liquid crystal display (LCD) is used to display the output to the user and buzzer alerts when the ppm crosses certain limit. Jayakumar et al. [4] reported on IoT measuring the concentration of gas using various sensors which were observed through serial monitor of Arduino [4]. This data is collected in ThingSpeak channels by means of Ethernet shield which is available in live for further processing. These analyzed results were viewed through ThingSpeak in a graphical format. Then the average pollution level was calculated using MATLAB analysis and the time-controlled results were viewed through an Android app [4].

The paper by Kulkarni and Mukhopadhyay [5] describes how to build a weather display system utilizing inexpensive components that can be assembled by any enthusiast in electronics. Rather than relying on sensors to gather weather data, the development uses a worldwide weather data source to obtain information from weather stations located all over the world. Severe weather events present a challenge to the complex weather forecasting methodology with its incomplete explanation. There are too many parameters for weather occurrences to be detailed and calculated. As communication methods advance, weather prediction specialists can pool and exchange resources, leading to the emergence of hybrid systems. Even with these advancements in climate prediction, weather forecasting remains a major challenge, making these expert systems not totally dependable [5].

Parmar et al. [6] have created a prototype for an environmental air pollution monitoring system that tracks the amounts of main air pollutant gases. Low-cost semiconductor gas sensors with Wi-Fi modules make up the system's low-cost air-quality monitoring nodes. Using semiconductor sensors, their system monitored the amounts of gases like CO, CO_2, SO_2, and NO_2. To show data on a website, a MEAN stack was created. The basic feature of proposed work was to provide low-cost infrastructure to enable the data gathering and distribution to all stakeholders [6].

A technique for monitoring air pollution was proposed by Okokpujie et al. [7]. The Arduino microcontroller was used in the development of the system. The purpose of the air pollution monitoring system's design was to continuously monitor and assess the quality of the air while logging data to a distant server and updating it online. Microsoft Excel was used to analyze the air quality measurements, which were based on the parts per million (ppm) parameters. The system's measurements of the air quality were precise. The outcome was shown on the hardware's display interface and was accessible on any smart mobile device through the cloud [7].

In order to set an example for an effective IoT device, Rout et al. [8] covered the design and development of a device prototype that monitors air and noise pollution in real time and notifies the appropriate authorities whenever the pollution levels cross the threshold via push notification services on mobile phones using a cloud service provider.

A network for monitoring indoor and outdoor air quality was presented by Postolache et al. [9]. Each node has tin dioxide sensor arrays connected to an acquisition and control system, and each was set up in a separate room. A central monitoring unit was either hardwired or wirelessly connected to the nodes. Two gas sensor influencing quantities, namely temperature and humidity, were also measured in order to improve the accuracy of the gas concentration measurement and avoid false alarms. The network sensor nodes employ advanced processing based on multiple-input-single-output neural networks to obtain temperature and humidity corrected gas concentration measurements. Power consumption and abnormal network sensing node functioning were also covered [9].

COMPONENTS REQUIRED

Node MCU ESP8266

It is the device's central component. It offers the IoT platform. It is a Wi-Fi module with firmware for the ESP8266 inside of it. This microcontroller is connected to every other sensor. It receives the measured values from them and uploads them all to the cloud for analysis. This board is developed by ESP8266 Opensource Community. XTOS is the name of its operating system. Node MCU ESP8266 is shown in Figure 1. The ESP8266 (LX106) is the central processing unit (CPU). This microcontroller is connected to every other sensor. It receives the measured values from them and uploads them all to the cloud for analysis. This board is developed by ESP8266 Opensource Community. It features a 4 MB storage capacity and 128 Kbytes of built-in random access memory (RAM).

DHT-11 (Temperature Sensor)

It can detect the ambient temperature. A 10-k resistor needs to be connected between Pins 1 and 2. It is a 4-pin device as shown in Figure 2. Pin 1 is connected to the 3.3 V. GND is linked to Pin 4. Pin D4 of the Node MCU receives input from Pin 2, which is the output pin. Pin 3 remains unoccupied. DHT-11 (temperature sensor) is shown in Figure 2.

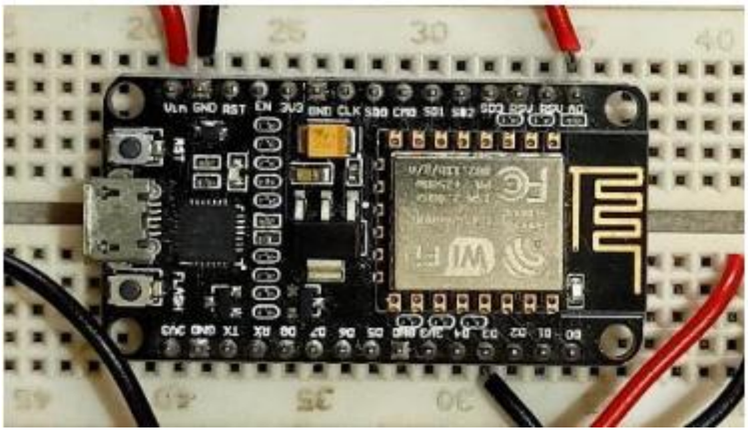


Figure 1. Node MCU ESP8266.

Figure 2. DHT-11 (temperature sensor).

Figure 3. Gas sensor.

MQ 135 Gas Sensor

Gas sensors detect the presence and concentration of different air pollutants, including carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and volatile organic compounds (VOCs). MQ 135 gas sensor is shown in Figure 3.

ThingSpeak

ThingSpeak is a cloud based IoT analytics platform service that lets you collect, view, and examine real-time data streams. Gillis [10] explained in his writing what role IoT played and how it is important Data uploaded to ThingSpeak by your devices is instantly visualized by ThingSpeak. ThingSpeak allows you to run MATLAB code [11], which allows you to process and analyze data as it comes online. ThingSpeak is frequently used for IoT devices that need analytics for prototyping and proof of concept. ThingSpeak is shown in Figure 4.

PROPOSED SYSTEM

The complete algorithm involves the following mentioned steps and the stepwise process is presented in Figure 5. The block diagram of the air watch system based on IoT is presented in Figure 6(a), while the complete components are arranged in the closed circuit as shown in Figure 6(b).

1. Start
2. Collected Data from the sensor is sent to Node MCU.
3. Node MCU process data.
4. Processed data is sent to the website through ThingSpeak and Blynk server.
5. Processed data is also sent to LCD display as
   - Temperature (in Celsius)
   - Humidity (in percentage)
   - Air quality (in PPM)
     - If gas value < 120 do
       Print “FRESH AIR”
     - else If gas value > 120 do
       Print “Bad AIR”
6. End

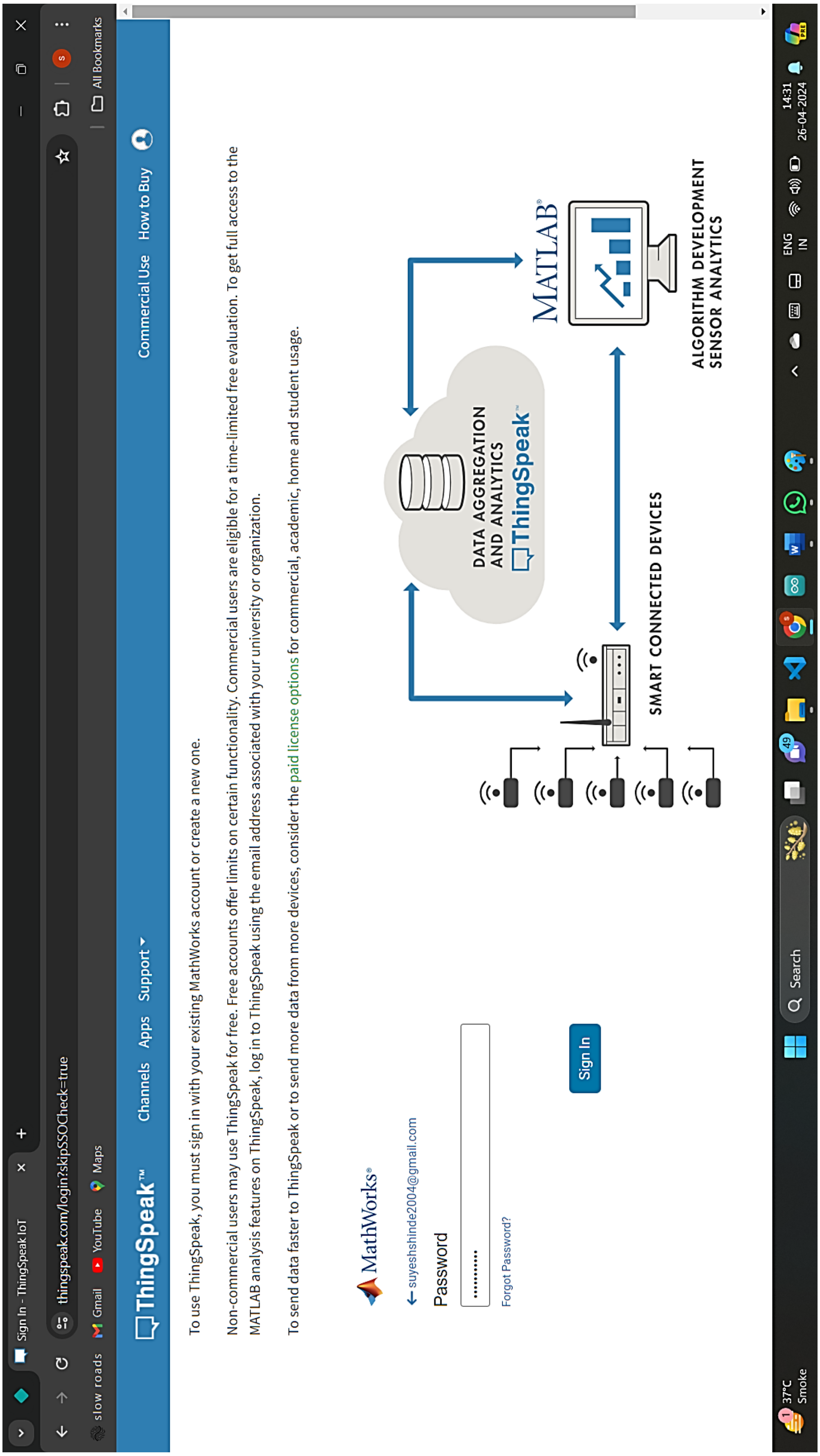


Figure 4. ThingsSpeak

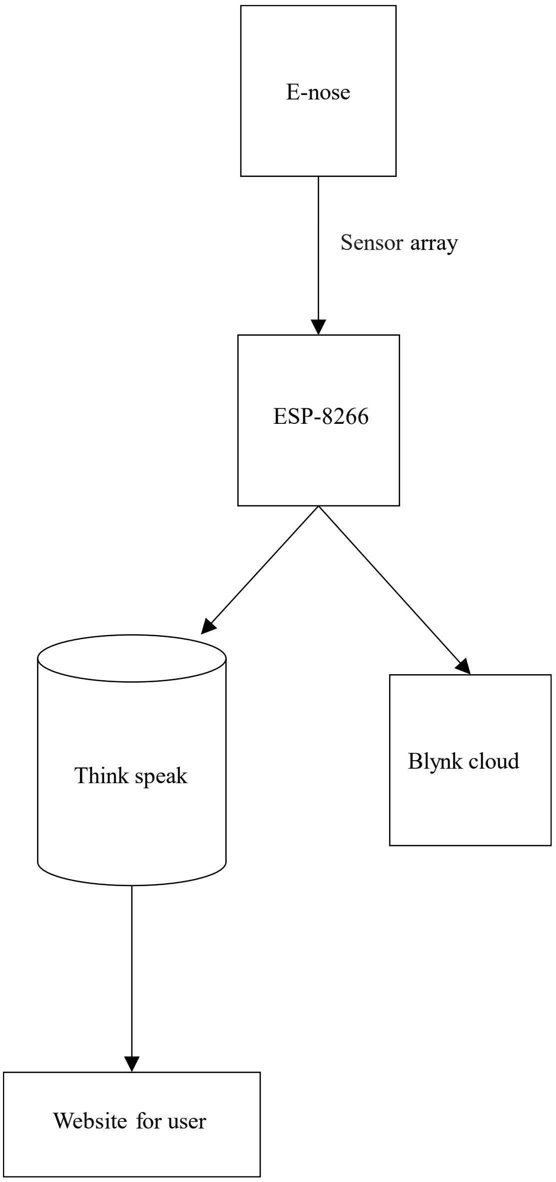
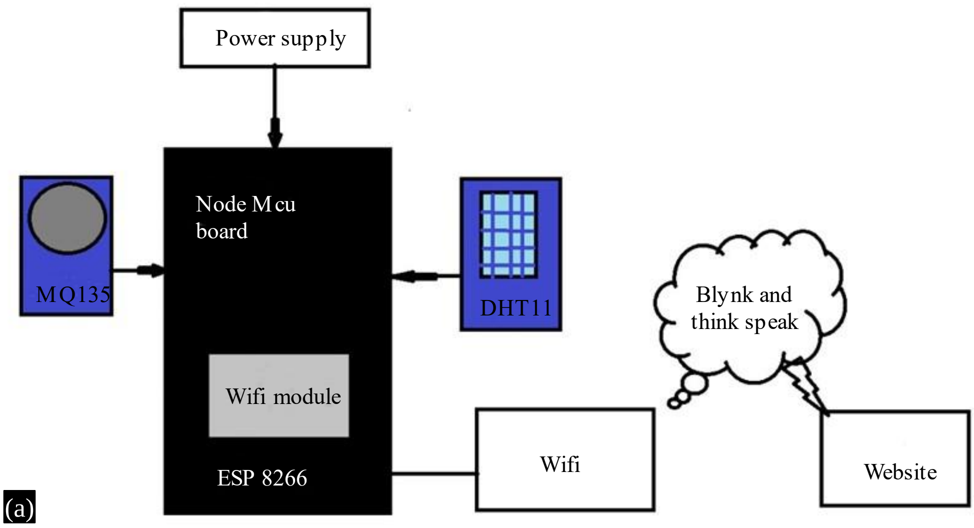


Figure 5. Flowchart of the algorithm.



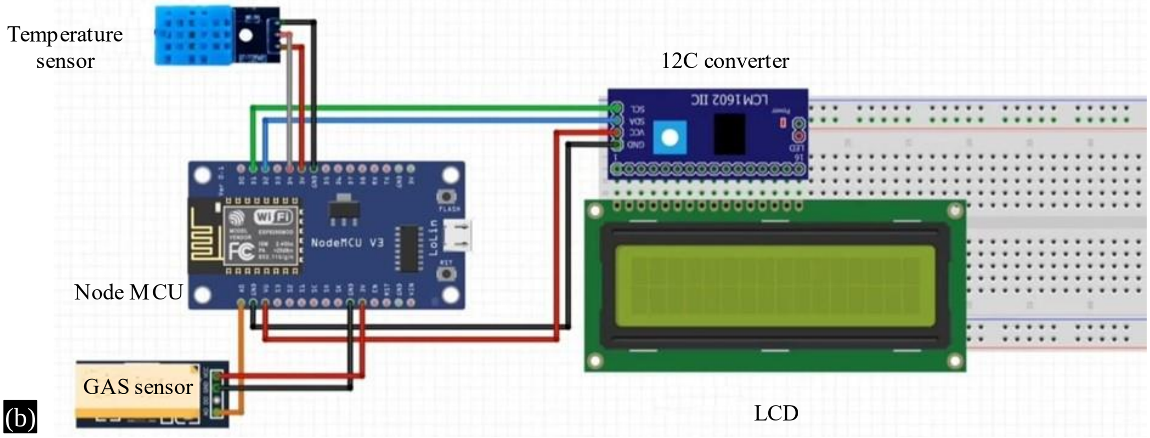


Figure 6. (a) Block diagram of air monitoring station; (b) Circuit diagram of air monitoring station.

PROBLEM STATEMENT

To make easy availability of atmospheric data and enhance healthy lifestyle we bought air monitoring system based on IoT and latest microcontroller (Node MCU), which gives information about present temperature, humidity, and air quality. Current air quality monitoring systems often provide delayed information, making it difficult for individuals and authorities to take immediate action in response to poor air quality. Existing air quality monitoring solutions may not be easily accessible to the general public, limiting awareness and understanding of local air pollution levels. Traditional air monitoring setups are often complex and expensive to install, hindering widespread implementation and adoption.

RESULTS

The IoT-based air monitoring system presented demonstrates an effective integration of various sensors and communication protocols to monitor air quality in real-time. By employing devices like the ESP8266, DHT11 sensor for temperature and humidity, and MQ135 for detecting gas levels, the system provides comprehensive insights into environmental conditions. Leveraging platforms like Blynk and ThingSpeak allows for seamless data visualization, analysis, and alerting. With such a system in place, users can remotely monitor air quality metrics, enabling proactive measures to mitigate pollution levels and ensure healthier living environments. Moreover, the modular design and flexibility of the system offer scalability and adaptability to cater to diverse monitoring needs, making it a valuable tool in the pursuit of sustainable and healthier living spaces. Website displaying results obtained from hardware is presented in Figure 7a–c.

DISCUSSION

An IoT-based air monitoring system utilizing Node MCU can revolutionize the way we track air quality. Node MCU, with its Wi-Fi capabilities and compatibility with various sensors, serves as a robust platform for building such systems. Firstly, let us highlight the significance of such a system. Air quality is a critical environmental factor affecting human health and well-being. By leveraging IoT technology, we can create a network of air quality monitoring devices distributed across various locations, providing real-time data on pollutant levels.

Node MCU can be equipped with sensors like particulate matter (PM), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3) sensors to measure different pollutants. These sensors can detect both indoor and outdoor air quality, allowing for a comprehensive monitoring solution. One of the key advantages of using Node MCU is its connectivity. It can transmit the collected data to a central server or cloud platform using Wi-Fi, enabling remote monitoring and data analysis. This data can then be visualized through a web or mobile application, providing users with insights into air quality trends and potential health risks.

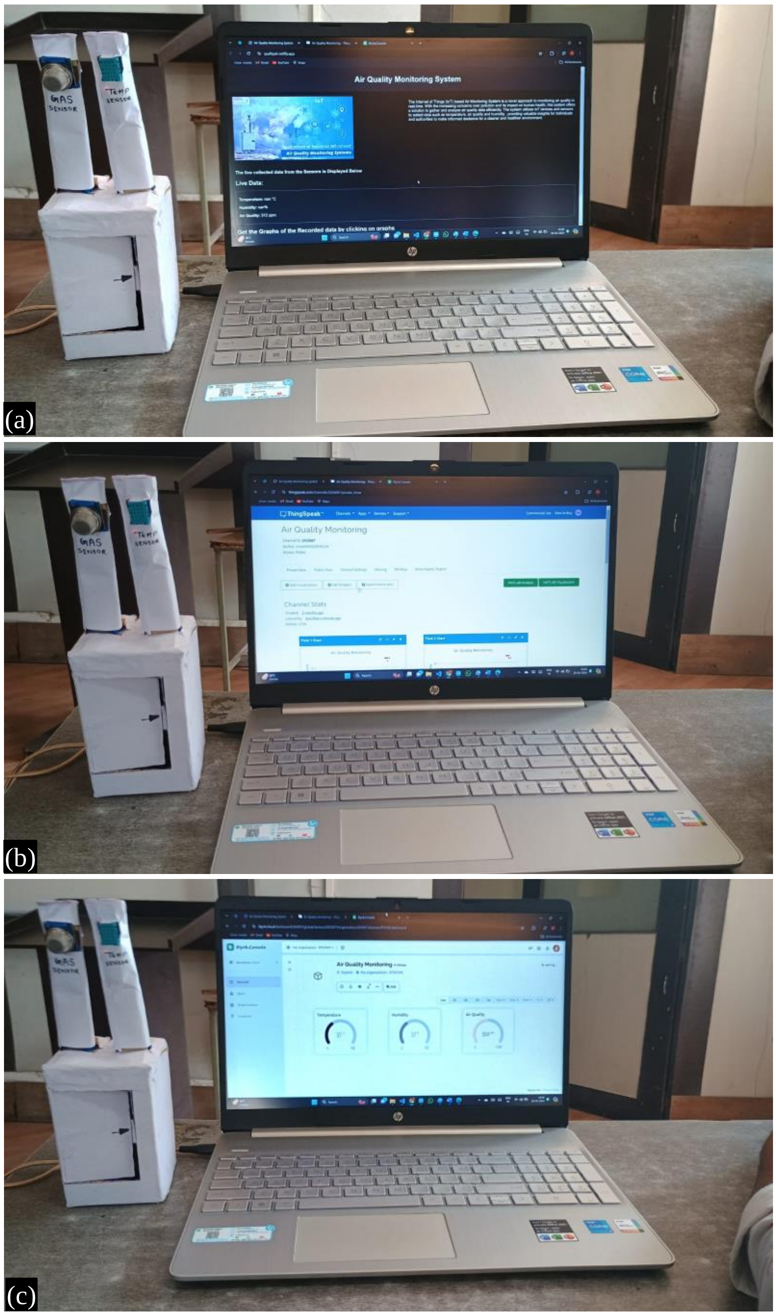


Figure 7. (a) Website displaying result obtained from hardware; (b) Result on ThingSpeak; (c) Result on Blynk.

However, it is essential to address challenges such as sensor calibration, data accuracy, and power consumption to ensure the reliability and effectiveness of the system. Additionally, data privacy and security measures must be implemented to protect sensitive information collected by these devices.

CONCLUSION

The IoT-based air monitoring system presented demonstrates an effective integration of various sensors and communication protocols to monitor air quality in real-time. By employing devices like the ESP8266, DHT11 sensor for temperature and humidity, and MQ135 for detecting gas levels, the system provides comprehensive insights into environmental conditions. Leveraging platforms like Blynk and ThingSpeak allows for seamless data visualization, analysis, and alerting. With such a system in place, users can remotely monitor air quality metrics, enabling proactive measures to mitigate pollution levels and ensure healthier living environments. Moreover, the modular design and flexibility of the system offer scalability and adaptability to cater to diverse monitoring needs, making it a valuable tool in the pursuit of sustainable and healthier living spaces.

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