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Proceeding Paper

Climate Monitoring and Black Carbon Detection Using Raspberry Pi with Machine Learning †

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Abstract: The proposed climate monitoring system aims to address the substantial risks to human health, climate stability, and ecological balance posed by air pollution, utilizing Raspberry Pi as a central procession unit and integrating various sensors which also incorporate sensors to measure the concentrations of PM1, PM2.5, PM10, and black carbon. This method meets the need for effective and immediate air quality monitoring and offers useful information to communities, academics, and policy makers. Through IoT connectivity, the gathered data are sent to a cloud-based platform for analysis and visualization. The system offers a user-friendly interface that presents actionable insights for informed decision making. Its warning capabilities alert users when pollution levels exceed thresholds, and this system also contributes to a comprehensive understanding of air pollution. By measuring particulate matter and black carbon levels, it supports the development of effective air quality management strategies. The system helps to take proactive measures and create cleaner and healthier environments. In conclusion, the proposed climate monitoring system utilizing Raspberry Pi, sensors, IoT connectivity, and machine learning techniques offers an effective and real-time solution for monitoring air quality. The integration of IoT connectivity allows for remote access to air quality data, while machine learning algorithms analyze the data and initiate alerts.

Keywords: climate; Raspberry pi; sensors; IOT

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1. Introduction

In this paper, we explore machine learning algorithms in the context of air pollution (AP) prediction and monitoring utilizing data from Internet of Things (IoT) sensors. While machine learning algorithms have rapidly advanced and found applications across various fields and domains, the realm of AP prediction remains open for exploration. One particularly crucial parameter, particulate matter, serves as a pivotal indicator of pollution levels in specific areas at precise times. These essential pollutant data are gathered through sensor networks. Particulate matter, as a vital parameter, offers a distinct and unequivocal signal of pollution levels in an area at a specific time. These pollutant data are obtained through sensor-based extraction.

To process data from these sensors, an analog-to-digital converter is necessary since most produce analog output. The Raspberry Pi 3B+ microcontroller is employed to handle this task, using specialized software and coding. The data are then analyzed, and a graphical representation illustrating changes in the local environment over time is generated. The validity of the results was confirmed through verification and the experiment control authority. This system has the potential to facilitate real-time decision making and is particularly effective at addressing the ongoing issue of elevated air pollution levels in many Indian cities [1,2]

2. Data and Methodology

In this project, we suggest a technique to address this problem using a Raspberry Pi board and a few sensors. MQ2, MQ135, and DHT11 sensors can measure air temperature, humidity, and gas concentration. The BMP180 sensor will measure air pressure. These sensor measurements are continuously transferred to a cloud platform (shown in Figure 1). Consequently, using this technology makes it feasible to continuously monitor meteorological conditions. Data will be shown on an LCD. We require an ADC to send data from the gas sensors to the Raspberry Pi because the sensors generate analog values.

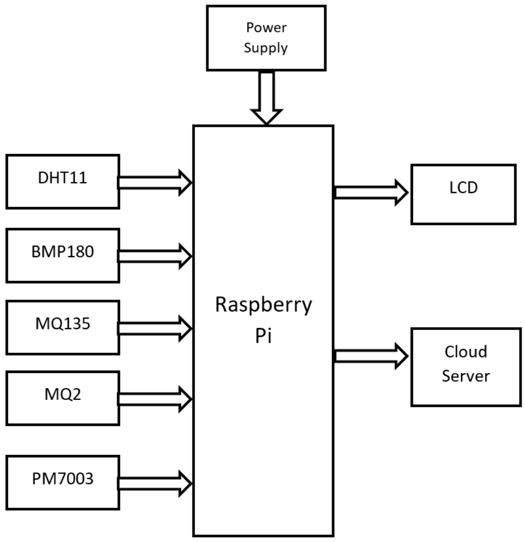

Figure 1. A block diagram of our climate monitoring system using machine learning and Raspberry Pi.

Web applications in embedded systems offer remote device and system monitoring and control using a web-based interface The integration of machine learning algorithms empowers the system to analyze the collected data [3,4], detect patterns, and identify potential air pollution sources or trends. With its user-friendly interface and actionable insights, this advanced air quality monitoring system using Raspberry Pi serves as a valuable tool for individuals, communities, and organizations in safeguarding and improving air quality for a healthier and more sustainable future [5,6].

3. Principle of Operation

Machine learning in embedded systems is the integration of machine learning algorithms and techniques into small, resource-constrained devices like microcontrollers, IoT devices, or embedded systems. This makes it possible for these devices to carry out intelligent functions, make predictions, and modify their behavior in response to inputs without needing constant online access. These devices can handle and analyze data in real time by integrating machine learning capabilities locally, making them more responsive and effective. Robotics, autonomous vehicles, smart home gadgets, industrial automation, and healthcare are just a few examples of the many fields in which machine learning in embedded systems finds applications [7,8]. To achieve effective and precise performance within the confines of the device, machine learning models must be deployed on embedded systems, which necessitates careful consideration of CPU resources, power consumption, memory constraints, and model optimization strategies [9]. Web applications in embedded systems offer remote device and system monitoring and control using a web-based interface The integration of machine learning algorithms empowers the system to analyze the collected data, detect patterns, and identify potential air pollution sources or trends [10,11]. With its user-friendly interface and actionable insights, this advanced climate monitoring system using Raspberry Pi serves as a valuable tool for individuals, communities, and organizations in safeguarding and improving the weather around us for a healthier and more sustainable future [12,13].

Components Used

- Raspberry Pi;
- MQ2 sensor;
- DHT11 sensor;
- LCD;
- BMP135 gas sensor module;
- PM7003 sensor.

4. Results

The results of the climate monitoring of block carbon detection using Raspberry Pi with machine learning are shown in Figures 2–4.

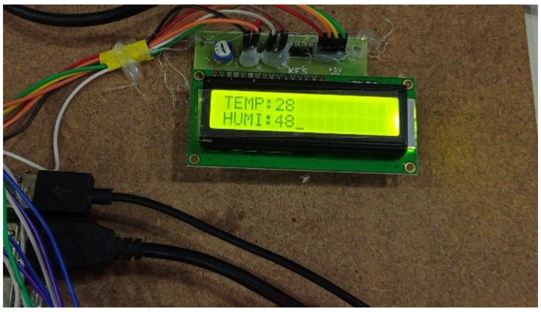

Figure 2. Photograph of the LCD screen showing real-time temperature and humidity readings.

Figure 3. Photograph of the LCD screen showing CO and CO_2 values.

Figure 4. *Cont.*

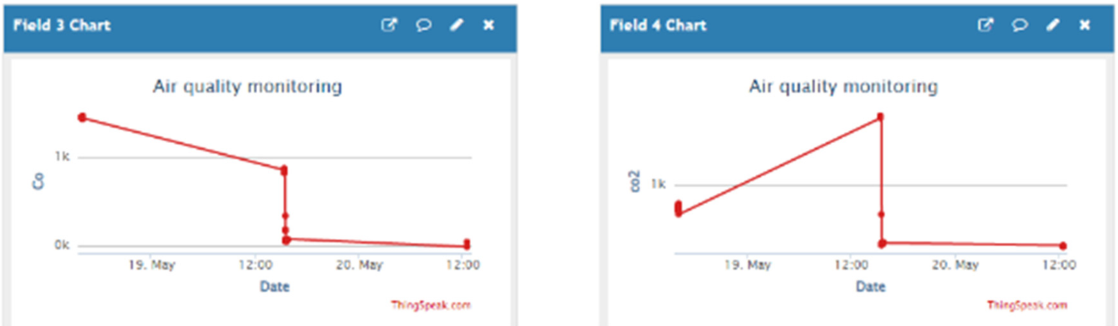

Figure 4. The sensor values are uploaded to a Thing speak server (IOT).

5. Conclusions

This project proposes the implementation of an IOT system utilizing a Raspberry Pi microcontroller for monitoring and improving the air quality of the environment. The utilization of IOT technology enhances the monitoring of various environmental factors, including the air quality issue addressed in this project. Here, the use of temperature and gas sensors and black carbon particles provides sensitivity to various harmful gases that regulate the entire operation. In order to solve the problems with air quality, the integrated IoT air pollution system was created. Various hazardous gases that are present in the environment are mostly detected by sensors. Additionally, these sensors can be implemented in mobile automatons that can detect the Earth's polluting gases. By introducing new conventions, security measures can be improved to secure the data delivered across the segments.

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