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AIR QUALITY DETECTION AND MONITORING WITH VISUALISED ANANLYSIS OF PARTICULATE MATTER USING RASPBERRY PI

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Abstract: Every major city in the world is currently facing a worsening situation in terms of public health and environmental disruption. More than 85% of people in urbanized regions are exposed to high quantities of particulate matter, making poor air quality a big concern. Recent estimates show that the burden of disease brought on by air pollution is now on pace with other major global health issues, such as poor food and cigarette use. The global nature of the challenge necessitates a more comprehensive global response. Despite some noticeable air quality improvements, since the 1990s, the number of fatalities and years of healthy life lost around the world has not changed. Accordingly, we have suggested a compact, low-cost system to monitor and visualize air quality. This system is implemented using a Raspberry Pi and a SDS011 sensor module to calculate the amount of Particulate Matter which is majorly responsible for degrading the quality of air. This problem is solved using a simple Air filter used in vehicles which drastically reduces the PM levels thereby providing a low-cost way of measuring and improving the overall quality of Air.

Keywords: Air-Quality, air-quality analysis, particulate matter, green computing, IOT, raspberry pi

I. INTRODUCTION

For every living being, natural resources like air, and water is essential to sustain their existence. The Air that we breathe consists of around 78% nitrogen, 21% oxygen, and 1% argon, plus many other bits and pieces, many of which have been emitted by humans and the technologies required to support us. Individual well-being has decreased as a result of the rapid increase in population and pollution brought on by automation, which directly impacts the general population's health. Intensive urbanization and industrialization have led to a global problem, namely Air pollution. Any chemical, physical, or biological agent that tampers with the characteristics of the atmosphere and contaminates either the indoor or outdoor environment is referred to as "air pollution." Lead, Nitrogen Dioxide, Ozone, Sulfur Dioxide, and Carbon Monoxide are a few of the main pollutants of the air.

We should be worried about other pollutants for human health, such as particulate matter, in addition to carbon dioxide, which is undoubtedly a significant contributor to climate change. Particle pollution, commonly known as particulate matter (PM), is a type of air pollutant made up of microscopic fragments of solids or liquids. They are categorized according to their size, with PM2.5 particles, which are less than 2.5 microns wide, and PM10 particles, which are between 10 and 2.5 microns wide, being the most significant from a health standpoint. One way to monitor air quality is by using sensors and other technology, such as the Raspberry Pi.

The Raspberry Pi is a small, affordable computer that can be used for a wide range of projects, including air quality monitoring. By combining the Raspberry Pi with sensors and other equipment, it is possible to build a low-cost, effective air quality monitoring system that can provide real-time data on the levels of various pollutants in the air. In addition to providing data on air quality, the Raspberry Pi can also be used to visualize the data in a user-friendly way, allowing users to easily understand the levels of pollutants in their surroundings. This can help individuals take action to protect their health and the environment, such as by avoiding areas with high pollution levels or by using air purifiers.

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II. LITERATURE REVIEW

A. Analysis of Air Pollution by using Raspberry Pi-IoT:

This study suggests an Internet of Things (IoT)-based system for tracking air pollution levels and quality via a web server. Various sites can be equipped with sensors that can sense and gather data. Big data can be accessed with Google Cloud from any location in the world. An air quality control module, a resonant intensity module for exposing specific areas, a cloud-based tracking module, and an anomaly alert module make up the proposed system's four parts. The sensors monitor sound power, and the air quality index is computed based on five air pollutant factors. The cloud-based tracking module uses the Raspberry Pi WLAN module to ensure regular data analysis. Last but not least, the anomaly alert module notifies the user of any unexpected events.

B. Analysis and Monitoring Air Quality System using Raspberry PI:

The proposed system is a Raspberry Pi and IOT-based air and sound pollution monitoring machine project to reduce the difficulty of tracking air and sound pollutants. The monitoring gadget makes use of a CO2 sensor, a methane sensor, and a microphone to measure the levels of air and noise pollution. The measured sensor data is subsequently sent over a WI-FI link to a remote network server. By effective monitoring of pollutant levels, measures may be taken to bring those levels down. The output procedure may be abruptly stopped by the sensor module after it has assessed and determined the percentage of dangerous gases present in the environment. Fuel sensors are used to acquire records from the air and sent to Arduino IDE. The statistics are sent to the cloud through Arduino IDE with the help of a WI-FI module. The information gathered may then be sent from one cloud to the specific device recommended by the user, allowing users to obtain the pertinent air exceptional data.

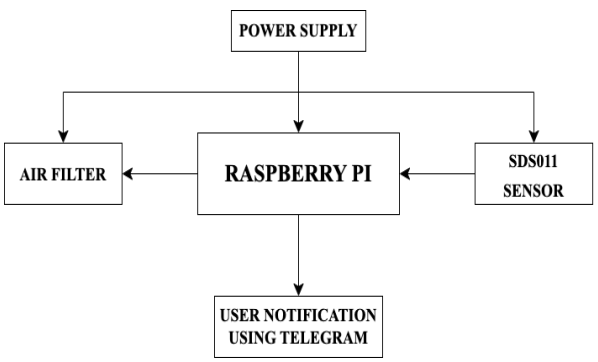
C. Design and Development of Low-cost Wireless Sensor Device for Air Quality Networks:

The development and analysis of a low-cost wireless sensor device for air quality networks with real-time monitoring is proposed. Low power electrochemical gas sensors (NO2 and Oz) and a Particulate Matter (PM2.5) sensor are interfaced to a low power sub-1GHz RF transceiver for the accumulation and transmission of measured data of ambient air pollutants. At the host node, Raspberry Pi is used to collect, store, and upload data from sensor devices to a web server for analytics and visualization. For calibration and data validation, the high-quality reference-grade analyzers are used with the gas sensor devices. The processing of raw sensor data yields the coefficient of determination (R2) values > 0.80. With power consumption less than 0.5W and priced at less than $500, the device is suitable for deployments of dense wireless sensor networks for air quality monitoring.

D. IoT based Indoor Air Quality Monitoring system using Raspberry Pi4:

The system introduced in the article is designed to be energy-efficient and data-efficient, which makes it ideal for long-term monitoring of air quality. The sensors used in the system are the Grove-Air Quality Sensor v1.3, CCS811 CO2 Air Quality Sensor, and DHT11 Temperature and Humidity Sensor. These sensors provide accurate and reliable measurements of air quality parameters, such as CO2 levels, temperature, and humidity. The implementation code for the system is written in Python, which is a popular and versatile programming language. The code is used to control the sensors and process the data they generate. Communication between the sensors and Raspberry Pi4 is achieved through a serial port communication protocol, which is a reliable and efficient way of transferring data between devices. To enable remote monitoring of indoor air quality, the system is integrated with Connectionless Sensor Networks and the Internet of Things (IoT) using the Thing Speak cloud platform. ThingSpeak is a platform that enables users to collect, analyze, and act on data from IoT devices. The MQTT protocol is used to connect the system to the IoT-based platform, which allows for secure and reliable communication between devices.

III. METHODOLOGY



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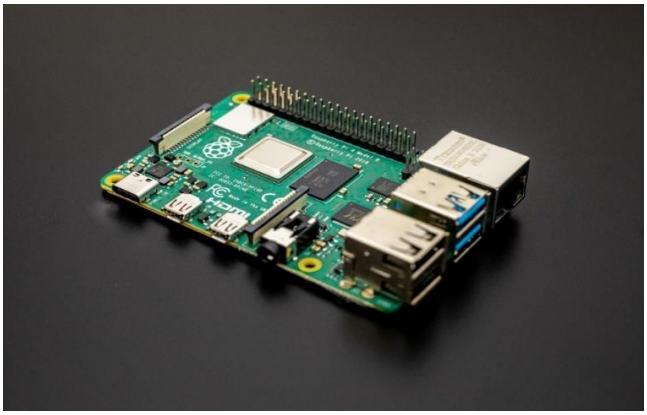
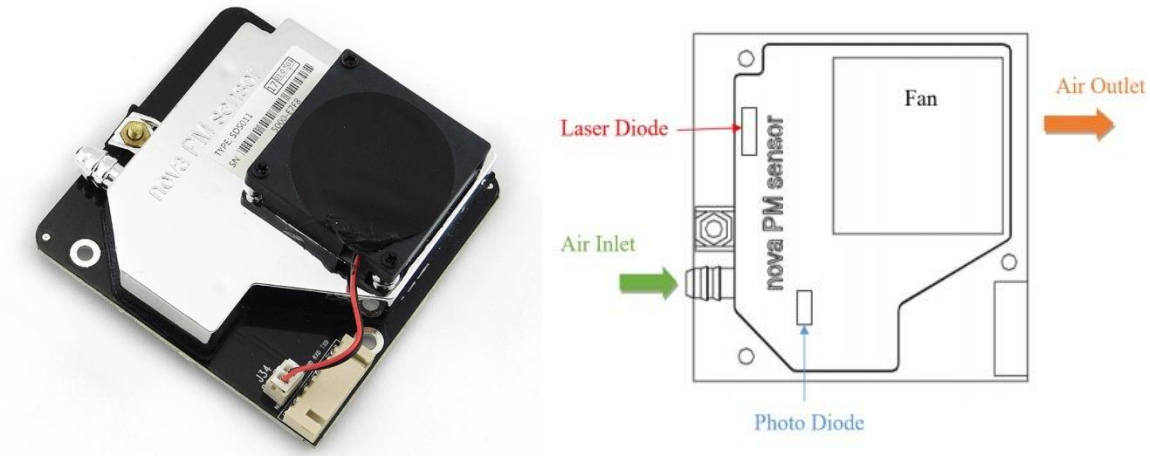
The above figure illustrates the architecture of the proposed system. Our system uses a Raspberry Pi computer, an SDS011 Particulate Matter Sensor, and an air filter paired with a suction fan to automate the process of improving the air quality around us. The Raspberry Pi processes the data from the sensor and sends it to the user via a Telegram bot, allowing for real-time monitoring and visualization of the air quality. By automating the process of cleaning the air, our system can help users maintain healthy and breathable environments in their homes or offices. The use of a Telegram bot allows for easy and convenient access to the air-quality data from any device with an internet connection.



The Raspberry Pi 3B+ is the main component of our project, selected for its compact size and high performance. This device serves as the central hub for controlling the SDS011 sensor and processing the incoming data. The Raspberry Pi runs on the Raspberrian operating system, which is optimized for its hardware and provides a reliable foundation for our python 3.8 scripts. Together, these elements provide a powerful and flexible platform for our project.



The SDS011 Sensor is a crucial component of our project. Developed by Nova Fitness, this air quality sensor uses laser scattering to accurately measure the concentration of particles in the air with diameters between 0.3 and 10µm. The sensor consists of a fan, air inlet valve, laser diode, and photodiode. As air is drawn in through the inlet, the laser illuminates the particles, and the scattered light is detected by the photodiode. The resulting signals are amplified and processed to determine the concentration of PM2.5 and PM10 particles. This highly sensitive and precise technology allows us to provide reliable and accurate air quality readings.

SDS011 Sensor Specifications:

- Output: PM2.5, PM10
- Measuring Range: 0.0-999.9µg/m3
- Input Voltage: 4.7V to 5.3V
- Particle Diameter Resolution: ≤ 0.3µm
- Relative Error:10%
- Temperature Range: -20~50°C

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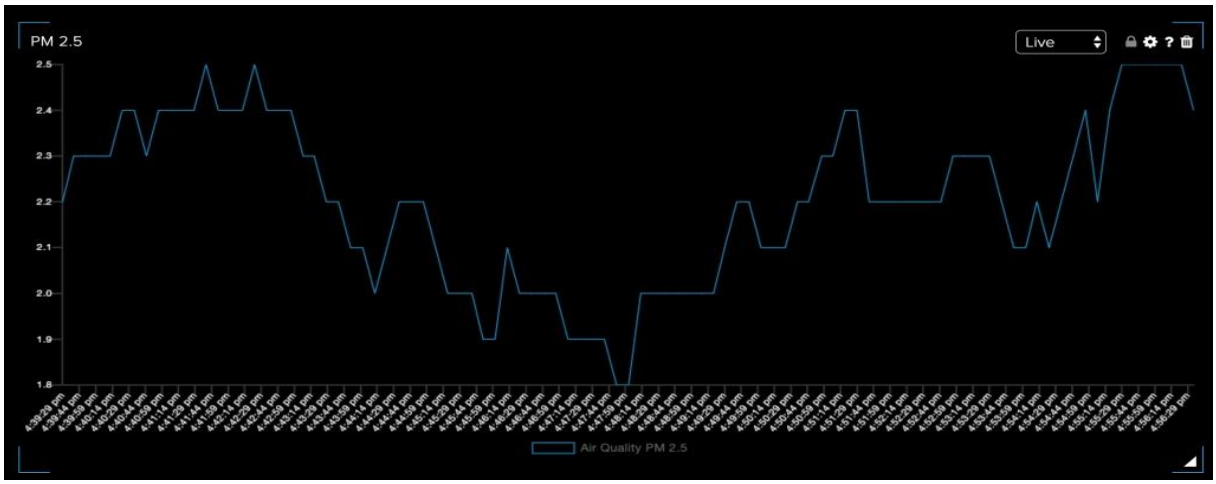
To ensure that the air quality in our surroundings is always at a healthy level, we are using a common automobile air filter. This provides an effective and affordable way to remove PM10 particles from the air, ensuring that users can breathe clean and healthy air. The air filter is paired with a CPU suction fan, which creates an air inlet that draws in particulate matter and passes it through the filter. The purified air is then released back into the environment. This module is connected to the Raspberry Pi, which monitors the air quality and automatically activates the air filter when necessary to maintain healthy levels of PM particles. This allows for automatic and continuous air purification, ensuring that users always have access to clean and breathable air.

Integrating the system using Python



To provide users with real-time data and insights on the air quality in their surroundings, we are using python 3 and the Seaborn and Matplotlib modules to visualize the incoming data from the sensor. This allows users to easily understand and interpret the data, providing a clear picture of the air quality in their environment. The visualized data is then sent to the user through a custom telegram bot, implemented using the telegram module for python. This allows users to access the data from any device with an internet connection, providing convenient and easy access to air-quality information. By combining advanced data visualization techniques with easy-to-use messaging technology, we can provide users with a comprehensive and user-friendly system for monitoring and improving the air quality in their surroundings.

IV. CONCLUSION

The suggested system is affordable, computationally powerful, compact, and power-efficient. It is highly accurate when using sensors to monitor the environment from anywhere in the world. Air quality tracking device can be made more useful if it measures and monitors pollutants such as nitrogen dioxide, ground level ozone, Sulphur dioxide etc. Also, long-term pollutants behaviour can be discovered and tremendous relationships of various air pollutants can be observed by upgrading the air quality monitoring systems. Overall, this project demonstrates how a Raspberry Pi, an SDS011 sensor, and Python can be used together to create a system for monitoring air quality and alerting the user when necessary. This can help in improving the quality of air and protect the health of the user.

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