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Design and Development of Black Carbon Prediction and Monitoring System Using Arduino Micro Controller

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ABSTRACT

An extensive research work Design and Development of a Black Carbon Prediction and Monitoring System Using Arduino Micro Controller aims to develop an effective and affordable method of forecasting and monitoring the amounts of black carbon in the environment. Black carbons are released from a variety of sources, including biomass burning, industrial processes, and automobile exhaust. Black carbon has negative impacts on both human health, environment and Attenuation of Signals in Wireless Communication. The main tool used in this project to forecast black carbon levels and collect real-time data is an Arduino micro controller. The three basic phases of the system are data gathering, data processing, and prediction. A network of sensors is established during the data collecting stage to monitor the amounts of black carbon at sites. The data acquisition stage, a network of sensors is deployed to measure black carbon concentrations at specific locations. These sensors continuously sample the air and provide raw data to the Arduino controller. The collected data is then processed by the Arduino controller in the data processing stage. The controller performs data filtering, calibration, and normalization to account for sensor variations and to ensure accurate and consistent results. The Black Carbon Prediction and Monitoring System (BCPMS)using an Arduino controller provides an innovative and cost-effective approach to address the challenges of black carbon pollution. The system's real-time predictions and monitoring capabilities hold great promise for improving air quality and informing policies aimed at reducing black carbon emissions. The development of such a system aligns with the global efforts to combat air pollution and enhance environmental sustainability.

KEYWORDS

Node MCU ESP8266, Gas Sensor, Noise Sensor, DHT11 Sensor, LCD, Black Carbon Detection Sensor, Blynk Application, Arduino IDE, Embedded C.

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1. INTRODUCTION

One component of fine particulate particles is black carbon, that are released into the atmosphere through incomplete combustion of carbon-based fuels. These fuels can include those used in transportation, industrial process, biomass burning, and residential heating. Black Carbon is typically in the form of tiny, solid particles or aerosols, which can be suspended in the air for extended periods. Black Carbon has significant environmental and human health impacts. It can penetrate deep into the respiratory system, can lead to a range of respiratory cardiovascular problems. It is a major component of air pollution and results in serious health risks, particularly in urban areas. Increased access to better data and quicker business insights are the main drives for utilizing Internet of Things (IOT) technologies to create low-carbon products. Urban planning and low-carbon management initiatives greatly benefit from this technology. Its use, however, might be restricted in tiny places with weak economies and inadequate data infrastructure [1,2,3]. This article describes how to modify the carbon monoxide measurement method and creates a carbon monoxide control system that is connected to long-term (real-time) data in response to the issues. A platform for smart carbon monitoring was created in this direction [4,5]. A comprehensive understanding of data collecting, processing, and analysis is still required, even if this work offers a basic structure and provides a platform for small communities to monitor their carbon emissions in smart cities.

2. LITERATURE REVIEW

Review of Cost-Effective Automatic Weather Stations, Ms. M. Raste, Vinayak Aappasaheb Pujari, Ms. AA. Pujari (2016) techniques for solar panel use. This device is used to track temperature, humidity, rainfall, wind direction, and speed. [17,18,19,20]. The GSM module receives the required data, which is then forwarded to the PC via the gateway. The database and server are connected.In 2016, Ms. Poonam

Khermalis, Ms. SanikaDoke, Ms. Varsha Dherange, and Professor SatyashilNagrale proposed employing real-time data transfer to monitor the weather. The suggested system transmits data to the control room using the VAISALA air emission sensor WXT520. [21,22,23]. In addition to other parameters, it measures temperature, relative humidity, wind pressure, wind speed, and wind direction. Currently, GSM is used to send data wirelessly over great distances. [24,25]. As demand fluctuates, the system adapts. Weather Prediction with an Arduino-Powered Cube-Sat System 2016; R. Bhattacharjee, M. Sau Giri, P. Bhattacharya M. Laskar, Rahaman, and others. A weather report created by Cube-Sat and Arduino is showcased: Three sensors are used by the device: an altimeter (ADXL-335), a pressure and altitude sensor (BMP180), and a temperature and humidity sensor (DHT11) Open the Arduino UNO project file.Cube Sat's are used to provide weather information from anywhere without using the internet [26,27,28]. Balloons are used to house and transport Cube Sat's. The system is portable, affordable, energy-efficient, simple to install, and dependable. There are several restrictions, though, such the fact that the device can't communicate for very long without a strong transceiver, it will be difficult to collect information with the help of balloons at high altitude, and the product may be damaged by rain or long-term use.

3. EXISTING SYSTEM

Current technology for monitoring air pollution requires constant manual typing and experience and requires team members to regularly monitor and collect information. A model was developed that filters differences in areas such as air, sound, humidity, lightness, and temperature. The pollution monitoring equipment that is now in use needs to be continuously inspected from time to time, which calls for a team of workers to keep an eye on documents and data. Management always forces people to complete tasks correctly, the problem is that people are not perfect. With the use of machines, services become based on individuals; This requires ongoing management to motivate employees and ensure they follow correct procedures. It is often easy to change details and see inconsistencies in data entry or written orders. Additionally, those who work to collect information will change the leaders' information, making it unreliable.

4. PROPOSED SYSTEM

Plan of operation, CO and CO2 levels, as well as humidity, temperature, and other factors. It will examine contaminants like these using local gas. Uploading sensor data to the cloud is possible, and an email is forwarded to the pollution group if any of the data exceeds the threshold. If needed, the pollution authority can remotely shut down the entire firm and view data from a distance using the Android app. Information access is made secure with the aid of encryption technologies. The original purpose of the mobile application was to guarantee anytime, anywhere, access to in-demand IOT procedures. The platform was utilized in buildings to verify its viability, and the device's data dependability was examined.

5. METHODOLOGY

A. Working Process

Carbon emissions and measurement techniques are constantly evolving, and this forms the foundation for small city administration and surveillance. [6,7].The research is typically broken down into three stages: big data-based carbon emission coefficient estimation is the second stage; electricity use is the first stage,Carbon emissions are determined by the use of the Intergovernmental Panel on Climate Change (IPCC) methodology.Measurement of carbon emissions using the Internet of Things is crucial in the third stage[8].Human life, manufacturing, and transportation are the three primary divisions that make up small cities' carbon emission departments, according to the IPCC carbon inventory approach. fossils from China. Correcting crucial information from the past is the primary link of the SCMP system and involves evaluating carbon emission impact factors at the block and road scale [9,10,11]. Due to their lack of ability to contribute for a large-scale IOT devices, choosing a good value for analysis, monitoring small samples, and reducing the quality of analysis can Reduce the expense of constructing SCMP systems in small towns and make them feasible. Carbon emissions in transportation can increase due to faulty equipment, engine damage or poor planning.

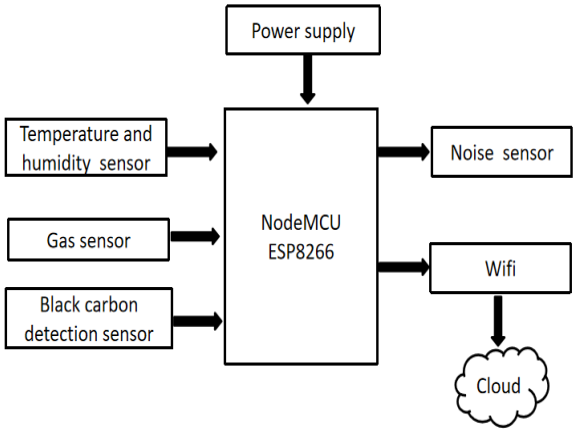

Fig. 1 Block Diagram

B. Explanation of Block Diagram

The project's main control device is an Arduino Board. Its code is built to read sensor data, control the WiFi module, turn on the display, and connect to the Blynk app. This type of sensor, which measures both temperature and humidity, is called a DHT sensor. A gas sensor called aMQ-2 Gas

sensor is utilized to gauge the air quality, particularly when dangerous chemicals like carbon monoxide and carbon dioxide are present. The Arduino board then processes the code and sends it to a 16*2 LCD display. The Arduino is connected to Wi-Fi via the ESP8266 module. By serving as a bridge between Arduino and the internet, it enables Wi-Fi communication between Arduino and the Blynk software and cloud server

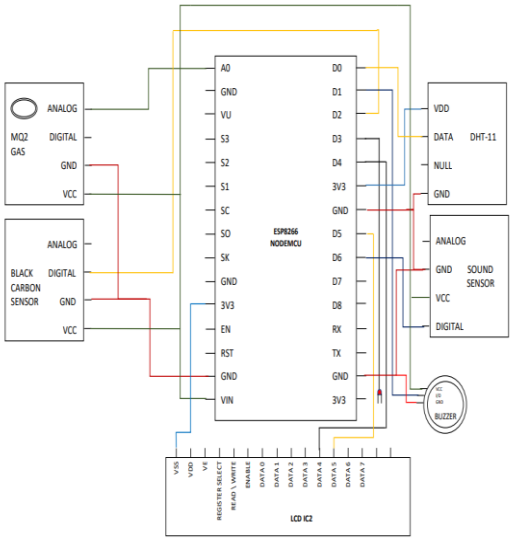

Fig. 2 Circuit Diagram

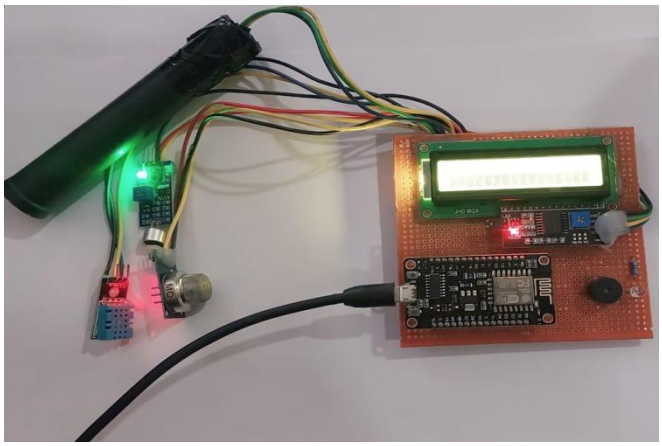

Fig. 3 Experimental Kit

C. Hardware Description

- NODE MCU ESP8266

ESP8266 WiFi chip is compatible with Node MCU, an open-source firmware based on LUA. Through investigating the possibilities of the ESP8266 chip, Both the ESP8266 development board/kit and the Node MCU development board come with the Node MCU firmware. Its hardware is also open to development, modification, and alteration because Node MCU is an open platform.

- **MQ-2 Gas Sensor**

The MQ-2 Gas Sensor is an electrical device that communicates with the outside world. Light, noise, smoke, proximity, etc. With the use of technology, a wide variety of sensors can detect, sensors come in both analog and digital. Sensors are an important part of security as well as communicating with the external environment. To measure fire and offer timely, suitable protection, fire extinguishers are utilized. Humidity sensors are used to regulate the humidity in equipment, which is necessary for sensitive electronic equipment and control systems to function properly. One type of sensor used in security systems to identify pollutants is the MQ-2 Gas Sensor Measuring the concentration of gases in the air, such as carbon monoxide, alcohol, hydrogen, propane, methane, and liquefied petroleum gas, is done with an electrical instrument called the MQ-2 Gas Sensor. Chemical resistance is another name for MQ-2 Gas Sensor. It has a sensory property that refuses to change when in contact with oil. The change in resistance is used to measure gas.

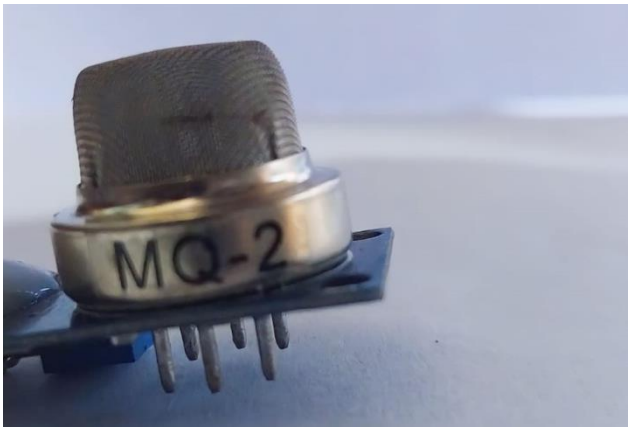

Fig. 4 MQ-2 Gas Sensor

- Temprature and Humidity sensor[DHT11]

The DHT11 temperature and humidity sensor produces a digital output that is calibrated. Typically, DHT11 is compatible with Arduino, Raspberry Pi, and other devices.It is associated with any micro controller like and is very useful. DHT11 is a low-cost, highly dependable, and long-lasting temperature and humidity sensor. The sensor contains four pins, as shown in Fig 5: VCC, data pin, NC, and GND. The DHT11 temperature and humidity sensor contains a temperature and humidity sensor complex with a calibrated digital signal output. It uses digital signal reception technology in conjunction with temperature and humidity measurement technology to guarantee long-term dependability and superior quality. The sensor is coupled to an 8-bit ARM high-performance processor and has an anti-humidity sensor and an NTC temperature sensor.

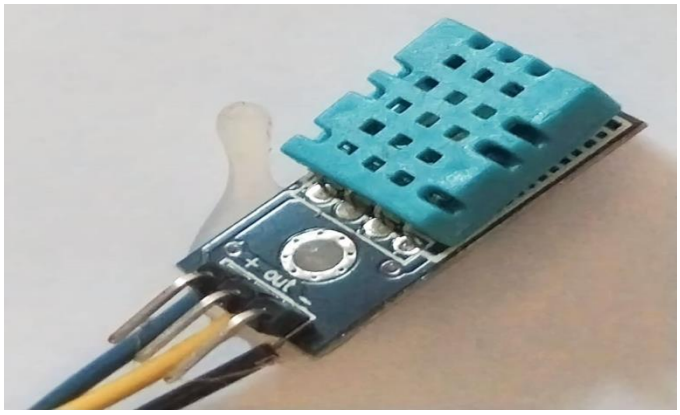

Fig. 5 DHT11 Sensor

- **Sound Sensor**

The sound sensor module has basic sound detection capabilities and is mostly used to measure sound strength. A microphone, buffer, amplifier, and peak detector make up the sound sensor module. An electrical output is produced by the sound sensor module shown in Fig 6, which then transfers the detected sound to the micro controller, which will then perform the required action.

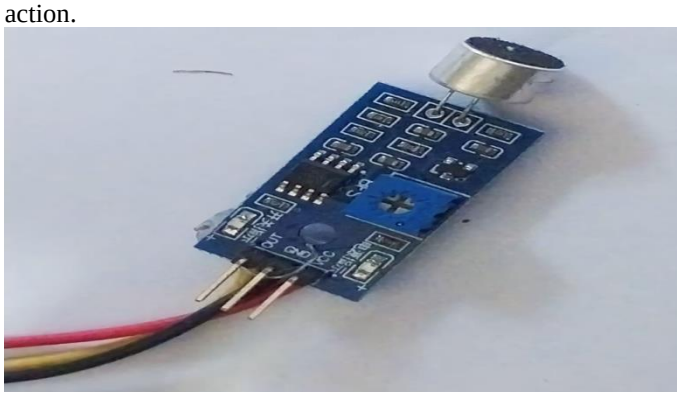

Fig. 6 Sound Sensor

- UIR Sensor

There are two infrared tubes: one for sending and one for receiving. The reflected infrared wave will reach the receiver when the outgoing light wave returns. The green LED illuminates when the inbuilt comparator circuit is finished. With VCC, GND, and an output pin at the end, the module features a 3-wire interface. Between 3.3 and 5V, it functions properly. The output pin generates a low signal, or digital signal, when it is blocked or disconnected. Presets that are built in aid to adjust performance.

Software Description

ARDUINO IDE

The open-source Arduino Integrated Development Environment allows developers to write code and deliver it to any Arduino board. The Arduino Integrated Development Environment, generally known as the Arduino Software (IDE), includes text boxes for coding text.

BLYNK APPLICATION

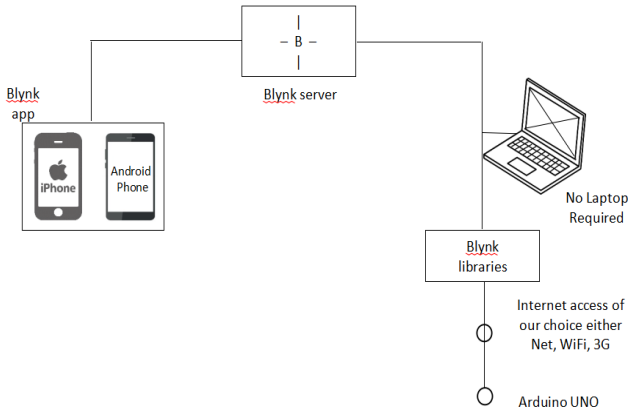

Fig. 7 Blynk Platform

The Blynk platform has three main components:
Blynk App -Using the many widgets we provide, the Blynk App lets you design stunning interactions for your projects.
Blynk Server - All communication between the smartphone and the hardware is managed by the Blynk Server. You can host your own Blynk server locally or utilize our Blynk Cloud. It can be constructed using Raspberry Pi, is open source, and can manage thousands of devices with ease.
Blynk library-The Blynk library, which manages all incoming and outgoing commands and facilitates communication with the server, is accessible on all widely used hardware platforms.

6. EXPERIMENTAL RESULTS

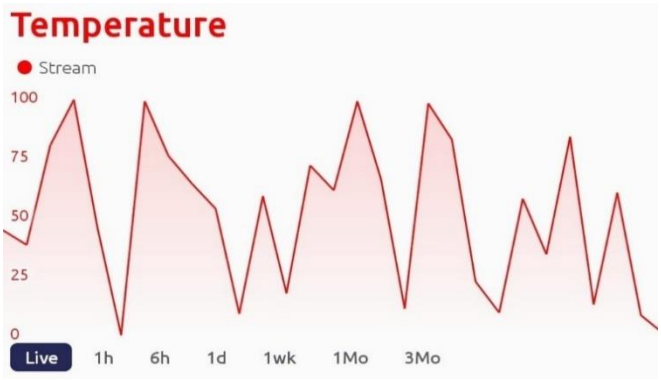

Fig. 8 : Temperature

As shown in the above Fig 8, the graph shows the real time monitoring data of temperature in hours,days,weaks and months expressed in ℃.

Fig. 9 Humidity

The graph provides humidity monitoring data in real time, represented in g.m^-3, for hours, days, weaks, and months, as shown in Fig 9.

Fig.10 Carbon

As seen in Fig 10 above, the graph displays the carbon mono oxide real-time monitoring data reported in parts per million (ppm) for carbon in hours, days, weeks, and months.

Fig.11: CO_2

As shown in the above Fig 11, the graph shows the real time monitoring data of CO_2 in hours, days, weeks and moths expressed in parts per million(ppm).

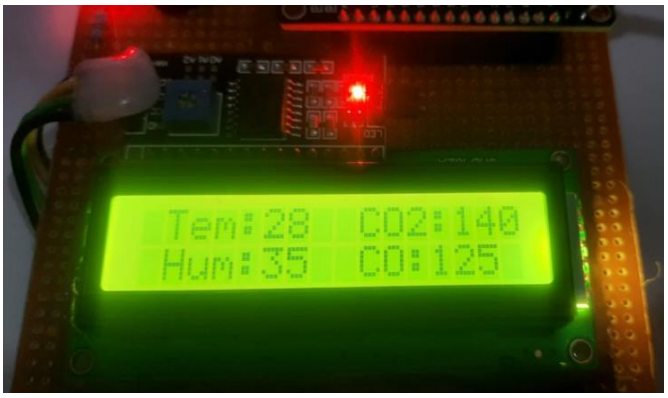

Fig.12: LCD Display

As shown in the above Fig,the graph shows the real time monitoring data of temperature ,humidity,C0 and $C0_2$ displayed on the 16*2 LCD Display.

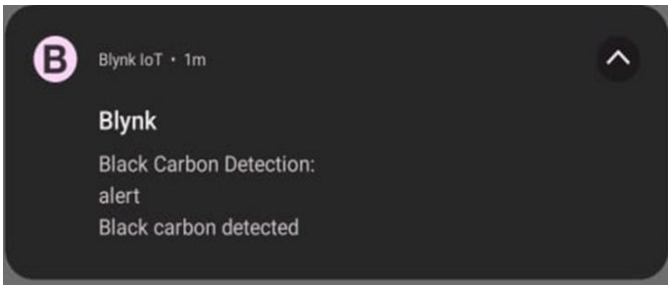

Fig.13: Alert

4. CONCLUSION

A The collection and release values of various parameters (gas, humidity, temperature and noise). IOT technology makes it possible to monitor and recover various environmental elements at any time and from any location, including problems with air quality monitoring. The NODE MCU ESP8266 serves as the process's foundation and oversees everything. The Wi-Fi module utilizes the LCD for visualization while connecting the entire system to the internet. Air and noise control may be an intervention that can help solve the most pressing problem. Air and sound monitoring overcomes significant problems that can occur in areas with high pollution. It is also automatic maintenance. Reducing human intervention in the dangerous environment and increasing safety are the key benefits of this. It advances both the idea of health and new technologies. The system has features that allow people to view pollution on their phones using the device.

Application

The Application of Carbon black is used as a pigment and additive in tires and other rubber products; It produces color and abrasion protective additives in plastic, paint and ink

pigments.

Advantage

Carbon black is a black powder produced by the thermal decomposition of coal. Carbon black is used as a pigment in paints and plastics. It is also an important component in the production of other carbon products such as graphite and activated carbon. Carbon black is a black powder or granule used as a pigment and additive to color many products. They are used only in the production of paper, paints, rubber products, printing inks and other synthetic products, cosmetics, sealants, creams, fillers. It is an easy to use, safe and environmentally friendly product.

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