IoT Based Weather Monitoring System

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Abstract: The current weather forecast has become highly unpredictable due to frequent and drastic climate changes. Consequently, the Weather Reporting System is primarily employed to continuously monitor and report changing climatic and weather conditions in various controlled areas such as homes, industries, and agriculture in real-time. Utilizing an Internet of Things (IoT) platform offers several advantages, as it can seamlessly and ubiquitously display weather parameters through an OLED display. This information is transmitted with two-way communication via Wi-Fi hotspots and is particularly beneficial for accurate and up-to-date weather reporting. Satellite weather reports often fail to provide precise current weather conditions, highlighting the importance of real-time accuracy. Within the Internet of Things (IoT) weather reporting system, an ESP32 microcontroller takes the role of a server to manage all the weather parameter sensors. This microcontroller collects data from the sensors and transmits it to a database hosted on Thing Speak, enabling global access and display on an OLED screen. This OLED screen is operated by a Wemos D1 mini microcontroller, which serves as a client.The gathered data is then subjected to a comparative analysis with weather forecast information and statistics generated by forecast stations. Additionally, the system employs the IFTT tool to save all the collected data in a Google Sheets format, facilitating data analysis. This comprehensive system continuously monitors environmental

changes in weather conditions and provides users with real-time readings.

Keywords: Manuscript, preparation, typeset, format.

1. Introduction

The Weather Monitoring System is designed to detect and collect diverse weather parameters at various locations, making this data available for analysis and weather forecasting. This system leverages technologies like the IoT and Cloud computing to achieve its objectives. IoT connects devices to the internet and to other required linked devices. Through the internet, information from IoT devices is seamlessly transferred to the cloud and then distributed to end users. Weather Monitoring serves as a practical application of IoT, involving the sensing and recording of different weather parameters for purposes like alerts, notifications, adjusting appliances, and long-term analysis. Additionally, it strives to identify and visualize trends in these parameters through graphical representations.

The devices utilized for this task are responsible for gathering, organizing, and displaying information. The Internet of Things (IoT) is anticipated to bring a transformation to environmental monitoring, utilizing sensors and devices with the capacity to collect, process, and transmit weather data. Cloud computing offers access to computer resources like data storage and computational power without necessitating direct user supervision. The system transmits the collected data to the cloud for subsequent display and analysis.

The system also comprises components like the Arduino UNO board, which serves as a microcontroller board with 14 digital pins, a USB connection, and necessary support for the microcontroller. The DHT11 sensor is used to detect temperature and humidity parameters. A WIFI module is employed to collect data from sensors and send it to a web server. This enables the monitoring of weather conditions at any location worldwide. A dedicated web page is created to access the cloud, where the required results are displayed and organized.

2. Related Work

The initial phase of the survey focused on establishing a standard sensor network by first examining standard technologies. The study then proceeded to select appropriate standard sensors that needed to meet criteria such as economic and technological suitability. A crucial consideration during the selection process was the communication range.

The implemented system comprises a microcontroller, specifically the ESP8266, which plays a vital role in this device. This microcontroller operates the sensors to collect data, processes the data analysis, and updates it to the internet through a WIFI module, an ICSP header, and a reset button. It includes all the necessary components to support the microcontroller, requiring a simple connection to a computer using a USB cable or powering it with an AC-to-DC adapter to get started.

The system utilizes an Arduino Uno integrated with a Wi-Fi module known as Arduino Uno Wi-Fi. To establish communication with the ESP8266 Wi-Fi module, the microcontroller employs specific AT commands. Within the system, there are two primary environmental sensors: a temperature and humidity sensor (DHT11) and a Barometric Pressure Sensor (BMP180). These sensors measure essential environmental parameters, such as temperature and humidity, and provide analog voltage inputs to the microcontroller board. Each analog voltage corresponds to a specific weather factor, and the microcontroller converts this analog voltage into digital data.

The DHT11 sensor is used to measure humidity and temperature, offering temperature and humidity as serial data output. It operates within a voltage range of 3.5 to 5.5V and has four pins.

It is factory calibrated, making it easy to set up and cost-effective. The sensor is suitable for humidity readings between 20-80% with 5% accuracy and can sense the temperature of the surrounding environment. It has both digital and analog outputs and operates at 5V, offering the advantages of ease of use and high accuracy. With an internet connection, data can be exchanged globally using its IP address. Further investigation focused on selecting the appropriate microcontroller with a hidden objective of achieving a low-power consumption solution.

3. Methodology

3.1. Brief Discussion

We present a smart internet-based weather reporting system in our proposal. Our system enables the reporting of weather parameters over the internet, allowing individuals to access real-time weather statistics without relying on a dedicated weather forecasting agency. The system utilizes temperature, humidity, and rain sensors to continuously monitor weather conditions and deliver live weather reports. It constantly tracks temperature and humidity via dedicated sensors.

This paper primarily focuses on developing an IoT platform known as ThingSpeak to showcase the sensor data. The paper have two main components: software and hardware development. In the realm of hardware development, it entails the construction of essential circuits and the generation of a prototype. On the other hand, software development encompasses aspects such as IoT programming, circuit schematic design, circuit simulation, and the acquisition of data. The system utilizes three distinct sensor types to monitor various weather parameters, encompassing temperature, humidity, rainfall, and air quality. Through the analysis of data collected by these sensors, the system offers real-time weather condition displays.

The ESP32 microcontroller is responsible for managing all the collected data, while the Wemos acts as the client, receiving sensor data from the ESP32 and presenting it on an OLED screen. Moreover, the system offers accessibility through a dedicated ThingSpeak channel designed for user convenience. Additionally, users can access the sensor data via an Android application called Blynk. The collected data is analyzed and compared with data from the Jabatan Meteorologi Malaysia to ensure accuracy in current weather conditions. The Internet of Things (IoT) technology wirelessly connects the system to users online, eliminating the need for manual weather checks.

3.2. Sensors, Gateway, and Data logging

Gateway or data collector: In our proposed system design, the Node MCU serves as the central gateway. It facilitates the connection within the system, transmitting data to the local network, which is then presented on our computer's web page.

Mode 1 Temperature and humidity Sensor: The DHT11 sensor enables us to gauge both temperature and humidity within our system. This sensor functions at a voltage of 5V and has a current consumption of 2.5 mA. It is capable of accurately measuring temperatures within the range of 0 to 50 degrees Celsius and humidity levels between 20% and 90%. The sensor provides a high level of precision, with a margin of error of approximately +/- 1 degree for temperature and about +/- 1% for humidity. It operates with a power supply voltage between 3 and 5V for both input and output.

1. Its maximum current consumption during conversion is 2.5 mA.
2. It is suitable for humidity levels ranging from 20% to 80% with a 5% accuracy.
3. It can effectively measure temperatures as low as -50 degrees Celsius.
4. It features four pins with a 0.1 unit spacing between them.

Mode 2 Barometric pressure sensor: The BMP 180 is a digital barometric pressure sensor designed to gauge the atmospheric pressure. It represents an improvement over its predecessor, the BMP 085, incorporating numerous enhancements.

1. It boasts incredibly low power consumption, reaching as low as 3 microamperes.
2. It functions within a DC voltage range of 3 to 5V.

3. The BMP180 is designed to sense pressures within the range of 300 to 1100 hPa, which corresponds to altitudes ranging from 9000 to 500 meters above sea level.

4. This chip employs an I2C communication protocol with a 7-bit address of 0X77.

Mode 3 Raindrop sensor:

1. The raindrop sensor is employed for detecting water presence beyond what a humidity sensor can identify.

2. 2. The rain sensor identifies water on its sensor board, causing a change in its resistance, which typically starts at 100K Ohms.

3.3. Circuit Diagram

Below, you will find the circuit diagram for our proposed system. This diagram illustrates the sensor connections and how these connections will be established.

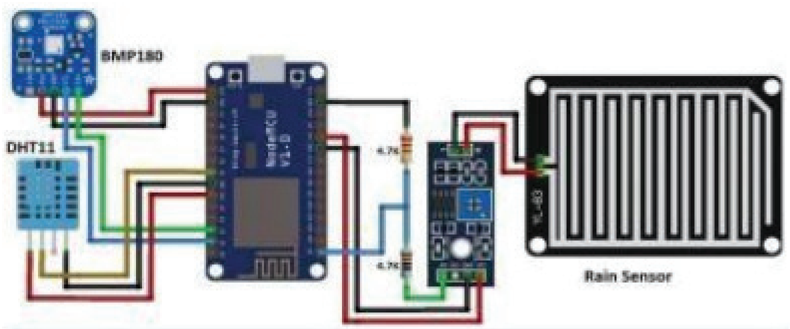

Fig.1. weather monitoring system diagram

The DHT11 sensor, BMP180 sensor, and rain sensor are all linked to the Node MCU pins, and power is supplied via a USB cable connecting the hardware to the system. The prototype model is depicted in the images above. Consistency in the connections is essential for obtaining accurate results. The subsequent tables outline the pin connections for each sensor.

DHT11/DHT22	ESP8266 NodeMCU
VCC=3.3V	VCC
GND	GND
DATA	GPIO12/D6

3.4. Flowchart of the proposed model

The flowchart depicts how our proposed system functions. It serves as a weather monitoring system designed for the Gorakhpur region and relies on just three sensors. The system delivers its findings on a webpage through HTTP.

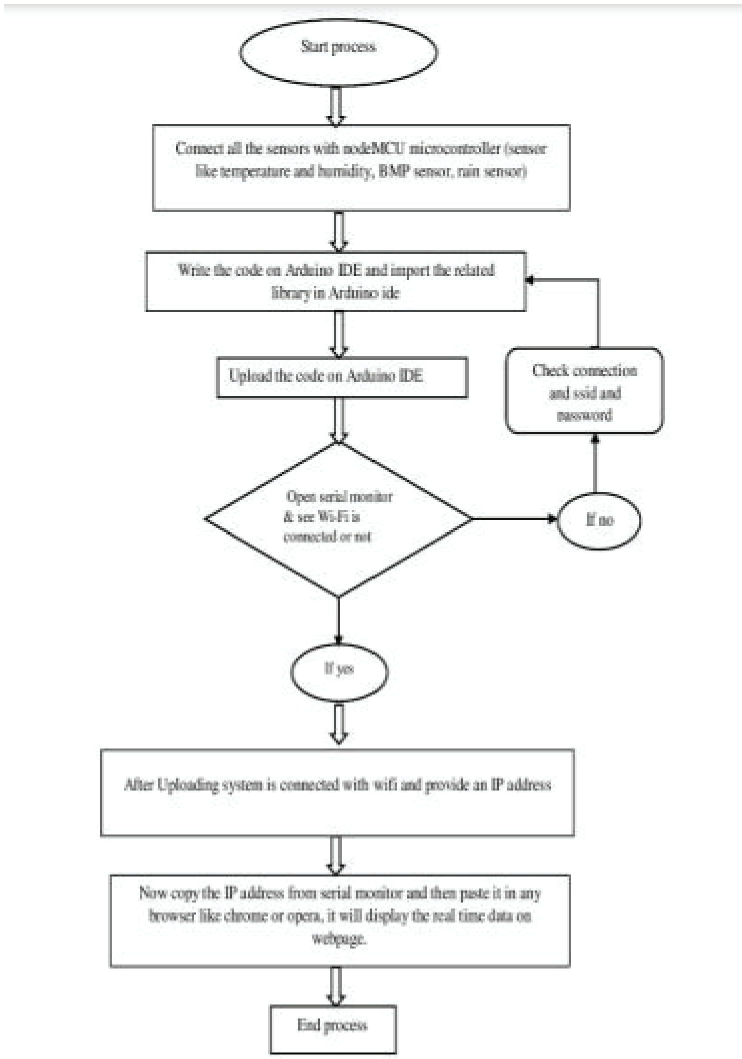

Figure 4.2 *Flowchart of the Proposed Design*

3.5. Concepts and Problem Analysis

The measurement and monitoring of weather carry significant significance and find applications in various domains.

- TEMPERATURE: Temperature is a physical property that characterises the degree of hotness or coldness. It results from the presence of thermal energy within all substances, which leads to the transfer of heat, the movement of energy, when an object comes into contact with another object that is either warmer or cooler. Thermometers are the instruments used to quantify temperature.

- HUMIDITY: Humidity signifies the amount of water vapour in the atmosphere. Water vapour, the gaseous form of water, is typically imperceptible to the human eye. Humidity provides insights into the potential presence of precipitation, dew, or fog. It is contingent on the temperature and
- Indranil Banerjee et. al//NSHM International Journal of Technology & Management @2023, I (1): 128-138
- pressure within the system under consideration. The identical quantity of water vapour yields greater relative humidity in cooler air compared to warmer air. A hygrometer, a tool utilized in meteorology, is employed to gauge humidity levels.
- Rain: Rain refers to liquid water droplets that form through the condensation of atmospheric water vapour and subsequently gather enough mass to descend due to gravity. The conventional device employed to gauge rainfall is the 203mm (8-inch) rain gauge.
- Pressure: The surrounding air possesses weight, and it exerts pressure on everything it comes into contact with. This force is known as atmospheric pressure or air pressure. It represents the gravitational force exerted on a surface by the air above it, pulling it toward the Earth. Barometers are frequently used to measure atmospheric pressure.
- Wind: In meteorology, wind speed, also known as wind flow speed, is a crucial atmospheric parameter resulting from the movement of air from regions of high pressure to low pressure, often driven by temperature variations. Nowadays, anemometers are commonly used to measure wind speed.

3.6. Problem solution

The measurement and observation of weather conditions are of significant importance and find applications in various fields.

Temperature is a physical property that characterises the sensations of warmth and coldness. It emanates from thermal energy, which is inherent in all matter and serves as the source of heat, a transfer of energy that occurs when an object comes into contact with another object that is either colder or hotter. To measure temperature, a thermometer is utilised, with the DHT11 sensor being an example for temperature measurement.

Humidity, on the other hand, denotes the concentration of water vapour present in the atmosphere. Water vapour, which represents the gaseous form of water, is typically imperceptible to the human eye. Humidity provides insights into the likelihood of precipitation, dew, or fog. It is contingent upon the temperature and pressure within the system under consideration. Notably, the same quantity of water vapour results in higher relative humidity in cooler air compared to warmer air.

A hygrometer, an instrument used in meteorological science, is employed to measure humidity, and the DHT11 sensor is one such example for humidity measurement.

4 Conclusion and Future Scope

In our proposed system, we aim to use cost-effective devices for monitoring various weather parameters. The system operates on a client-side architecture model and adopts an approach that observes multiple environmental factors through several sensors. Compared to existing models, our system employs fewer sensors, emphasising cost-effectiveness to ensure widespread accessibility. Our primary goal is to create an affordable system that can be utilised by anyone free of charge.

In the system we have suggested, we capture data from sensors and transmit this data to a webpage through HTTP protocol on a web server. This system is implemented within the Gorakhpur region and covers three specific locations: Kolkata, STCET College. We compile and organise all the collected data into tables, recording the time and data for subsequent evaluation.

Our proposed system not only gathers data but also derives insights and makes decisions based on the observed data. This functionality is highly valuable for farmers as it interprets environmental data that can aid in agricultural decision-making. Furthermore, it has significant applications in various sectors such as industry and transportation. The accuracy of our proposed model closely aligns with real data, enhancing its reliability.

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