IoT-Based Real-Time Weather Monitoring System

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ABSTRACT:
A dedicated weather monitoring system designed to collect, analyze, and promulgate real-time atmospheric data for agriculture and other industrial use. Deployed various sensors, such as thermistors, barometers, anemometers, rain gauges, and hygrometers, at strategic locations to measure temperature, pressure, wind speed, rainfall, and humidity, respectively. These sensors continuously collect data and transmit it to the central processing unit for data processing, and analysis. The processed weather data, accessible through various channels, including, weather websites, mobile applications, and weather stations become useful for the end users. Users of this system get real-time access to sensor data, weather updates, forecasts, and alerts based on their geographical location. By providing accurate and timely weather updates, this system plays a crucial role in supporting various industries and improving overall public safety. The system is comprised of an Arduino UNO board with sensors and a Wi-Fi module (ESP8266) interfaced. The system ensures the uploading of sensor data on the Thingspeak cloud platform at programmable data frequency.

KEYWORDS: Weather monitoring, Internet of Things, Thingspeak, Cloud computing, Arduino UNO, Wi-Fi communication, Embedded System, Industrial Internet of Things, Wireless Sensor Network., ESP8266

INTRODUCTION:

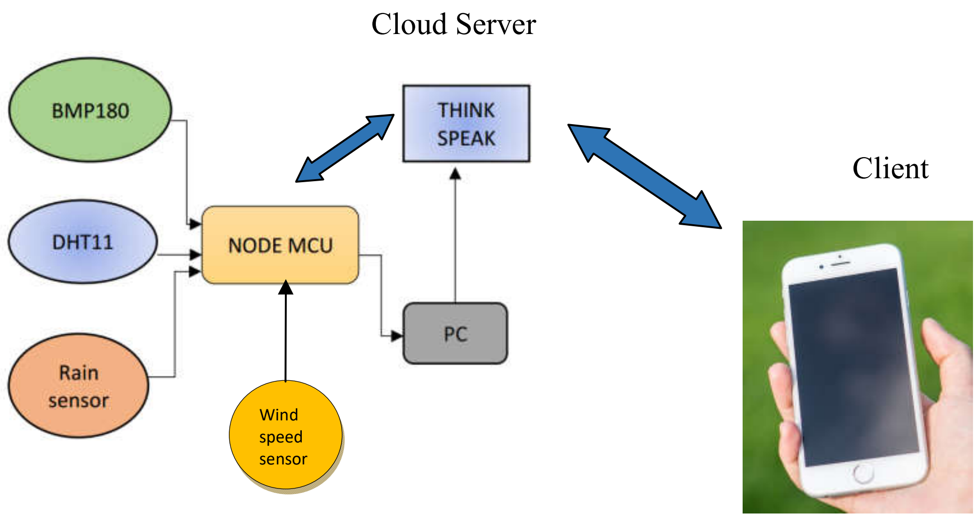
Global warming and climate change have a significant impact on local weather patterns and crop productivity [1]. Here are a few outcomes of impacts on local weather systems:

1. An increase in the frequency and severity of extreme weather events: Heatwaves, droughts, floods, hurricanes, and storms all occur more frequently and with greater severity because of global warming[2,3]. These severe weather conditions have the potential to destroy local infrastructure, upend ecosystems, and endanger life.
2. Modifications to Rainfall Patterns: Climate change may change rainfall patterns, resulting in longer dry spells in certain locations and more intense rainfall in others[4,5]. Because of this agriculture, water supplies, and ecosystems have a major impact on local water supply.
3. Increasing Sea Levels: Polar ice and glaciers melt because of global warming, which raises sea levels[6,7].
4. Climate Zone Changes: Due to some crops no longer flourishing in their traditional growing zones, this may result in changes to crop choices and agricultural practices[8,9].

PROBLEM STATEMENT:

Alterations to growing seasons, lower crop yields, changes in pests and diseases, water stress, and difficulties with crop adaptability are the main effects of climatic change on agriculture that have been reported[10].

With so many challenges in modern-day farming due to global climate change, the Internet of Things (IoT) has the potential to be instrumental in reducing the negative consequences of climate change on agriculture[11]. Sensors, drones, and satellite imagery are examples of Internet of Things (IoT) devices that can offer real-time data on environmental variables such as temperature, humidity, and soil moisture levels. This information aids farmers in making wise decisions about crop protection, fertilization, and irrigation, which minimizes the use of water and chemicals. With the help of real-time information from IoT devices, farmers can get local forecasts of climatic changes, extreme weather events, and weather patterns. Based on this



information farmers may plan their planting and harvesting timetables. Examples of IoT-based smart models for agricultural use were studied in detail, which demonstrated the integration of sensors and camera modules for collecting local data and sending it to a cloud-based server system[12,13].

This research work presents a system, which is cost-effective, compact, and more energy efficient than previously studied by the author.

PROPOSED ARCHITECTURE

The proposed architecture is threefold, sensors placed at farm sites, cloud servers, and clients. The farm site sensors are:

1) Temperature and Humidity Sensor
2) Rain sensor
3) BMP 180
4) I2C module for sensor interfacing
5) Local display system
6) ESP8266 Wi-Fi module

An Internet of Things (IoT) "cloud server" to store, organize, and process data generated by nearby IoT devices at the farm. The information is delivered to clients by delivering different notifications from the cloud server via different channels like Twitter, WhatsApp, or SMS.

EXPERIMENTAL WORK AND METHODOLOGY:

ANALYSIS OF THE SYSTEM REQUIREMENTS:

Assessment and selection of sensors: To guarantee accurate and reliable detection of the pertinent meteorological parameters, the assessment and selection of sensors is a thorough procedure. The system's requirements, integration and compatibility, environmental factors, data transfer, power needs, availability, and cost analysis were studied before choosing the sensors.

IoT Platform selection: Choosing the appropriate Internet of Things (IoT) platform is essential to ensuring smooth data gathering, processing, and administration. The selected IoT platform for the system is ESP8266 Node MCU, which supports MQTT protocol for data collection and connectivity. The Node MCU is cost-effective and consumes less power as compared to other IoT platforms. It has rich support of library function and community to deal with any difficult computation or data transmission task.

Prototyping, data transmission, and connectivity: A prototype of a real-time weather monitoring system designed by connecting the Node MCU, sensors BMP180, DHT11, Wind Speed Sensor, and Rain sensor by taking reference from the datasheet manual. The program is loaded in the Node MCU using the programmer and the Arduino IDE.

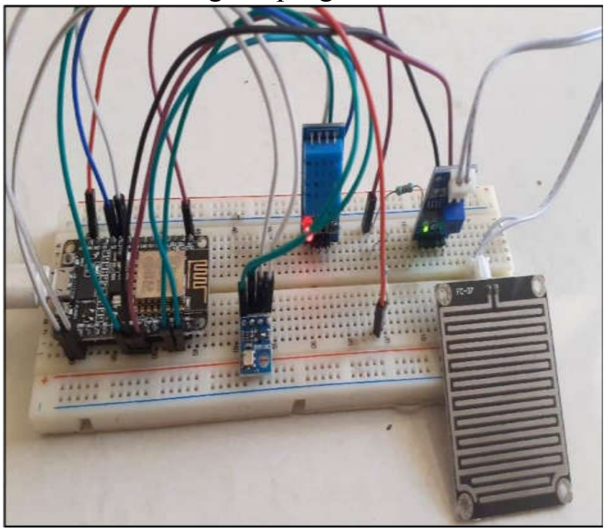


Figure 1 IoT-based sensor system using ESP 8266 NodeMCU

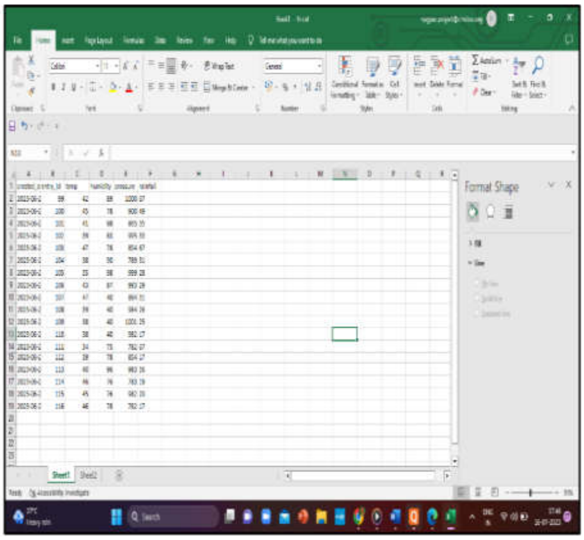
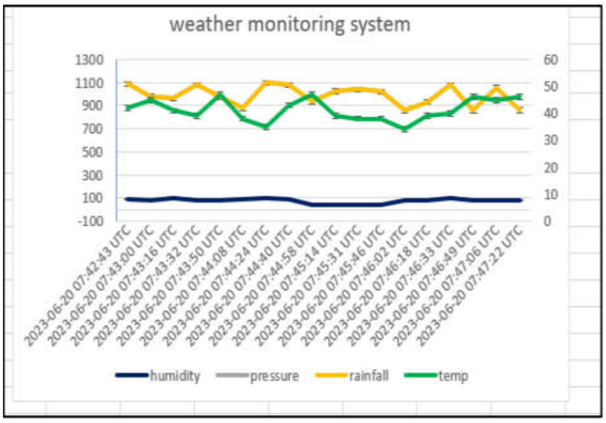
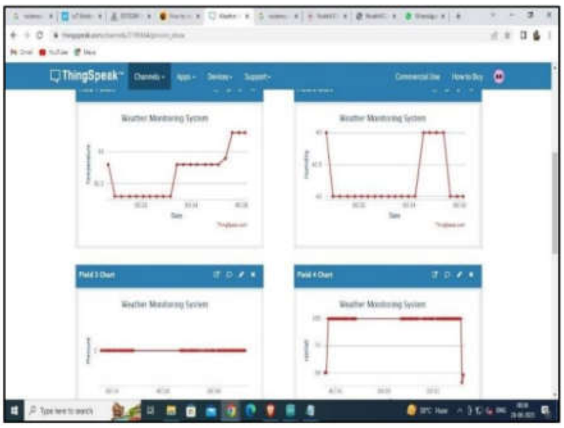


Figure 2 Data transmitted from the various sensor using the ESP 8266 Wi-Fi module of NodeMCU

DATA PROCESSING AND ANALYZING:





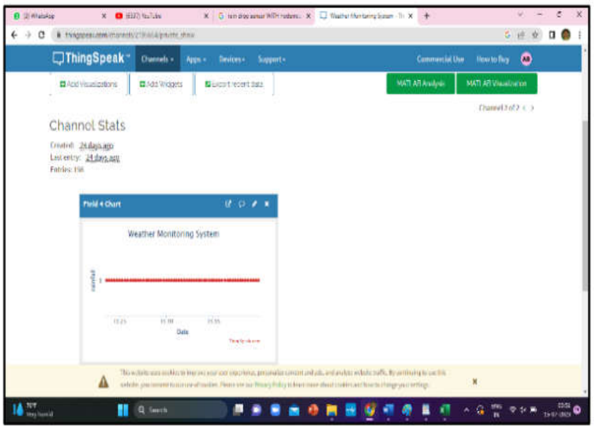


Figure 3 Rain sensor data

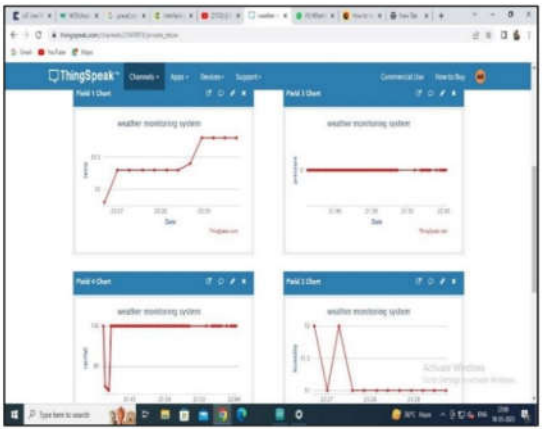


Figure 4 DHT 11 Sensor data

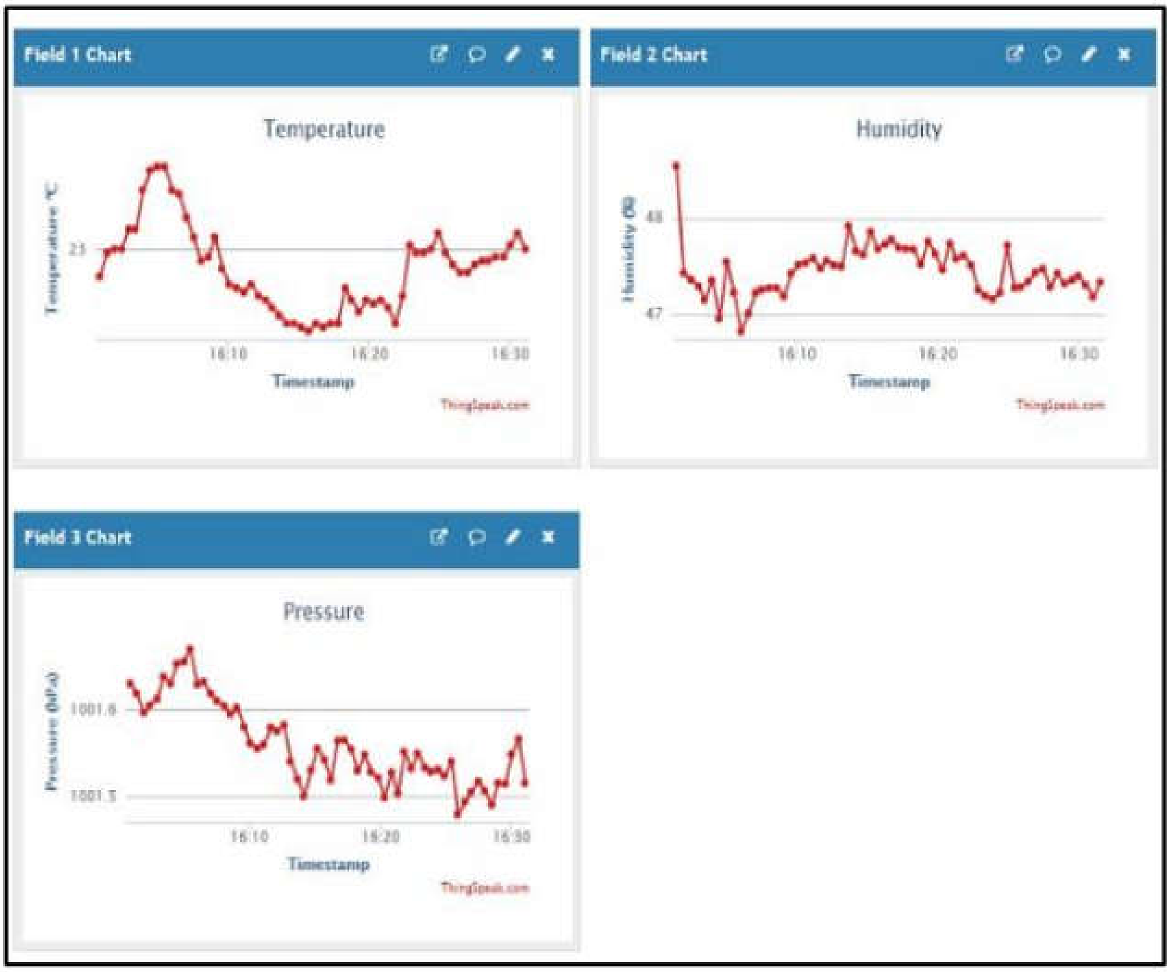


Figure 5 Temperature, humidity, and pressure sensor data

Field Testing and Calibration: The IoT-based weather-monitoring system was analyzed at the Department of Electronics, Kamla Nehru College at Nagpur at extreme and normal weather conditions. In Nagpur, (MS), the temperature reaches up to 46%. Thus, the system tested in variable weather conditions worked properly.

Validation of the data: The sensor data measured by the system when compared with the standard data received on the Mobile phone from weather notifications and trusted sources of the meteorological department via the internet for Nagpur, the location was similar and relevant.

Calibration and data frequency adjustment: The system does not have a program to calibrate automatically but the calibration is possible by comparing the data from standard sources. The data frequency is programmable. According to the need of the user, the system scans the ports, collect data from various sensor, and convert the data into a readable form.

RESULTS AND DISCUSSION:

RESULTS:

The Internet of Things-based weather monitoring system that was installed for the local area worked effectively and collected accurate data. The system was composed of many sensors that were strategically positioned around the region to collect information on different weather parameters. The solution demonstrated effective data collection and cloud storage for quick processing, analysis, and alert generation.

The primary weather parameters monitored by the system included temperature, humidity, atmospheric pressure, wind speed, and rainfall. The manual calibration of the sensor limits the purpose of automation, but the programmable data frequency option makes the system more convenient and energy-efficient for remote use.
The collected data showed that the system is capable of providing real-time impressions of the surrounding weather conditions. The system's accurate recording of temperature, relative humidity, and atmospheric pressure fluctuations revealed the local climate's dynamic nature.

DISCUSSION:

The IoT-based weather monitoring system has several benefits over conventional weather monitoring methods. Because of its capacity to deliver real-time data, it enables quicker responses to changing weather conditions, enabling improved decision-making for a variety of applications, including agriculture, disaster management, and urban planning. The link between temperature and humidity changes was an important finding. The information demonstrated how variations in relative humidity and temperature influenced one another. Understanding the link between local environmental conditions and their possible impacts on ecosystems, agricultural development, and disease transmission is crucial. The system's rainfall data can be quite helpful for identifying trends in local rainfall. The system's capacity to deliver instantaneous notifications regarding rainfall events can assist in reducing the danger of water damage, minimize property damage, and improve water resource management tactics.
In conclusion, the IoT-based weather monitoring system that was installed successfully showed how well it could record and send precise real-time weather data for the local area. The gathered data offers insightful information for many industries and acts as a basis for wise decision-making in the face of changing climate conditions.

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