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A Cloud-Based Real Time Weather Reporting System Using IoT

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Abstract. Predicting weather has become very difficult due to constant changing in weather patterns over the months. IoT based plays a critical role in measuring environmental factors. IoT extends internet connectivity beyond mobile phones and desktops. In this paper, an IoT and cloud-based weather reporting system has been developed. The proposed work detects, record, and display various weather characteristics like temperature, humidity, and precipitation. The system uses sensors to detect and monitor weather factors, and the data is transferred to a cloud that can be accessed via the Internet. The system uses a microcontroller, sensors, a WiFi connection that sends data to a cloud-based server. The data is presented to the user using the cloud application.

Keywords. Temperature sensor, Humidity sensor, Internet of Things, Cloud, ThingSpeak.

1. Introduction

Climate change has received a lot of attention recently. People desire to know about the current weather conditions in any location, such as our home or any around any place. As the world changes so rapidly industrial growth and traffic flow have had a profound effect on clean air and the environment. Weather monitoring helps to track a variety of climate characteristics including temperature, humidity, pressure and rainfall.

Institutions, massive IT businesses, and, of course, users are all interested in the Internet of Things. All application-based devices, such as transducers and sensors, are connected to a small wired or wireless data controller for distant cloud service or local data storage, which transforms raw data into useful information that can be used in many locations. Smart watches, smart homes, smart security alarm are all based on IOT which have gained attention recently. IoT is a very promising technology for enabling remote monitoring of nearly any item with a chip and radio interface over the internet. It facilitates access to various devices which can communicate with other via the internet.

In this paper we have designed a weather reporting system which is the main component here. It is interfaced with various weather sensors like humidity, temperature, and rainfall in the input level and the sensed data will be transmitted via the

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microcontroller to a cloud after processing and converting the analog data into digital one.

2. Literature survey

The concept of Wireless Sensor Networks (WSNs) where different sensors nodes are placed in a space which collects the data continuously. Then the data is sent to a base station [1]. The data is processed and computed in real time manner which is then send to a user through graphic API. It has been demonstrated an interactive weather forecasting system using numerical weather forecasting model system which is focused on Jordan [2]. It utilizes a data mining technique based on previous climate data to forecast rain. HIRLAM and ALADIN are the foundations of this model. The HIRLAM model is primarily a weather prediction model with parameters for at a short-term weather forecast only. The ALADIN model is built on the principle of global model compliance (ARPEGE), from which it derives. According to [3], the authors proposed a model to measure the environment activities such as temperature, humidity and pressure using sensors. Analog-to-digital converters convert analogue signals to digital signals. Data from various weather monitoring devices are collected and shows them in a user interface map. In [4] the proposed a model based on short-range X-band mini radars which has the possibility of measuring precipitation over a wide area. The author in [5] proposed a system in which the temperature or humidity can be monitor of a particular room or place by using Raspberry and Arduino module. The temperature or humidity can be sensed through DHT11 sensor which is connected to the Raspberry module. When the values exceeded the threshold value, the user get a notification In his/her mobile via telegram API.

3. Proposed System

Our proposed model will collect the weather conditions around any house and transfer the information over a cloud server for analyzing. This comprises of different environmental sensors for collecting weather parameters such as temperature, humidity, pressure and rain drop and forward to a low-cost microcontroller for processing and computing it. Then the processed data will be sent to a cloud server for user purpose.
Hardware Components: NodeMCU ESP8266 Microcontroller, Temperature and Humidity sensor (DHT11), Raindrop sensor, Breadboard, Jumper wires, Desktop for receiving information from cloud
Software requirements: Arduino IDE, ThingSpeak for cloud

4. System Architecture

4.1. Microcontroller (NodeMCU ESP8266)

The NodeMCU ESP8266 microcontroller is an IoT development board for designing IoT-based applications as shown in Figure 1. The Arduino IDE may be used to simply programme this for prototype IoT devices. The development board contains an ESP8266 chip 32-bit microprocessor. This microprocessor runs on 80MHz to 160MHz clock frequency. It also supports multiple programs being run on the same time. For storing data, the NodeMCU is provided with a 128 KB RAM and 4MB flash memory. Its excellent processing capabilities, built-in Wi-Fi make it ideal for IoT projects. It can be turned on by using a micro-USB jack or by connecting VIN to power supply.

Figure 1. NodeMCU ESP8266 **Figure 2.** DHT11 Temperature and humidity sensor

4.2. . Temperature and Humidity sensor (DHT11)

The DHT11 is a low-cost digital humidity and temperature sensor as shown in Figure 2. To detect moisture and temperature fast, this sensor can be readily linked to any small controller like Arduino Uno, NodeMCU ESP8266 Raspberry Pi, etc. It can measure temperatures from 0 to 50 degrees Celsius, with a 2-degree precision. Also its relative humidity comes with 20-80 percent, with a 5% accuracy. It can take one reading per second and works on 3 to 5 volt. It has maximum current consumption while measuring is 2.5mA. DHT11 sensor is a four pin device. Pin1 is connected to VCC, Pin2 is the output DATA Pin, Pin4 is connected to GND and Pin3 is not in use. For communication between the sensor and the tiny controller, a 5k to 10k ohms pull-up resistor is provided.

4.3. Raindrop sensor

The Raindrop module is essentially a board with nickel coating in a line that detects rain as shown in Figure 3. It utilizes the resistance principle. The control module measures moisture via analogue output pins and converts it into digital data. It contains a LM393 op amp. The sensor is an opposing dipole with lower wet resistance and higher dry resistance. This module requires a 5V power supply to operate. VCC, GND, D0, and A0 are the four pins. It is simple to use and has a high level of accuracy.

Figure 3. Raindrop module **Figure 4.** ThingSpeak login page

4.4. ThingSpeak

ThingSpeak is an cloud-based IoT platform for transfering data to the cloud. ThingSpeak service is managed by MathWorks as shown in Figure 4. User must either establish a new account or sign in to your existing one before using it. For non-commercial projects, ThingSpeak is free. ThingSpeak provides a web service that allows you to collect, store, and create IoT objects in the cloud. Arduino, Raspberry Pi, and MATLAB are all supported (pre-existing libraries and existing APIs). However, because it uses REST API and HTTP, it should function with any programming language.

5. Architecture Design and Methodology

The architecture of the weather reporting system can be illustrated in figure. 5. Moreover, the connections have been shown in Figure 6.

Figure 5. Architecture Design

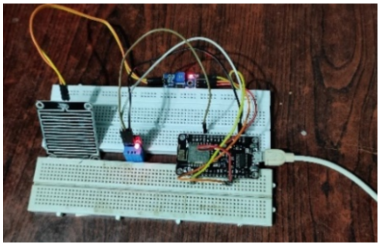

Figure 6. Hardware connections

The first phase is to work on programming in microcontroller to interface all the sensors. After the sensors have been interfaced, the microcontroller's WiFi module will be linked up with the cloud server so that it may access the network and send data to it. The next step is to setup ThingSpeak channel using MATLAB account for monitoring weather data. After creating channel, we have to create new fields to store data. Before compiling the code, we have to select the proper board and COM port in the Arduino IDE. After successfully updating the sensed data in the ThingSpeak channel, we have to create an HTML page with the help of Field chart IFrame. After creating an HTML page, we can keep the channel view sharing public, private or to a specific person for accessing the weather status.

6. Results

All the sensors have been successfully connected and the testing of each sensor is carried out successfully. The values are analysed and graphs are plotted when the sensor data is uploaded to the cloud. On the basis of inputs from various sensors, the outcome of various environmental variables such as temperature, humidity, and precipitation may be measured. We've chosen three fields in ThingSpeak on this page. The temperature is displayed in the first field. The graph in Figure 7 depicts range of temperature versus time. Here temperature reading is updated after every 16 seconds. Similarly, humidity has been shown in the second field. The graph in Figure 8 depicts range of humidity vs. time, with humidity data refreshed after every 16 seconds. The third field displays the range of rainfall values over a period of time. Figure 9 depicts rainfall vs. time graph with the rainfall values revised after every 16 seconds. Table 1 and 2 shows the experimental results and comparison with existing models, respectively.

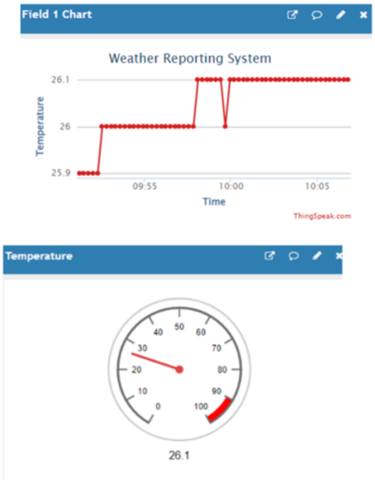

Figure 7. Temperature Vs Time graph(left) Temperature value(right)

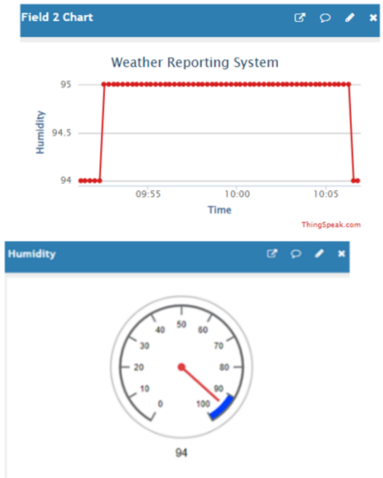

Figure 8. Humidity Vs Time graph(left) Humidity value(right)

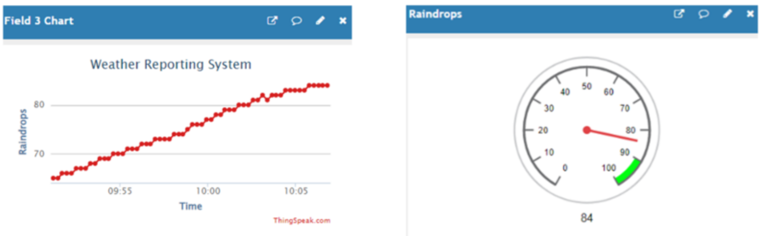

Figure 9. Raindrop Vs Time graph(left) Raindrop value(right)

Table 1. Experimental Results

Time	Temperature value	Humidity value	Raindrop value
09:51:13 am	25.9	94	65
09:51:44 am	25.9	94	65
09:51:44 am	25.9	94	66
09:52:00 am	25.9	94	66
09:52:16 am	25.9	94	66
09:52:32 am	26	95	67
09:52:47 am	26	95	67
09:53:03 am	26	95	67
09:53:19 am	26	95	68
09:53:35 am	26	95	68
09:53:51 am	26	95	69
09:54:07 am	26	95	69
09:54:23 am	26	95	69
09:54:38 am	26	95	70
09:54:54 am	26	95	70
09:55:10 am	26	95	70

Table 2. Comparison with existing models

Reference	Technique	Drawback
[7]	Zigbee based system	It has short range and cost of setup is high
[8]	Wireless sensor with MEMS	It is very time-consuming process and the cost of fabrication is high
[9]	IoT based	Data is updated after every 1 minute

The proposed work has numerous advantages such as it is a low cost and easy setup. The data updated to the server is relatively faster (every 16 seconds). The propose dmodel can be assemble relatively fast with a very low usage of wires.

7. Conclusion and Future Scope

The model can easily be implemented and has numerous characteristics such as temperature, humidity, and rainfall using IoT. Additional features can be added to the proposed IoT and cloud-based weather monitoring system. We may also integrate a GPS device into this system to provide the user with information about the current position of the environment. With the help of AI and ML, we can also prepare and train a model so that it can fetch data from the cloud and predict the future weather conditions based on the current data received from the cloud.

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