IoT- based Wireless Real time Temperature and Humidity Surveillance System for Hill Stations

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***Abstract*— Constructing a cloud-based surveillance system is very significant to minimize the cost of maintaining servers, to prevent data losses and to make the access easy with various devices connected with the Internet(for instance, computer, tablet, mobile phone) at the same time anywhere in the world. There are many hill station areas that require surveillance of temperature and humidity because they need to keep track of information about the climate there because they are major tourist spots for people and also the agricultural fields that yield crops grown mainly by contour farming. As hill stations are located far above the plains, hence temperature and humidity are an important factor in hill stations. The aim of this paper is to make use of the advantages of the evolving technology i.e. IoT and help the workers in hill stations keep a record of humidity and temperature of the climate and fields, and monitor them and thus reducing their work load of being present at the location. This paper features a simple design of a system which can monitor temperature and humidity through a sensor i.e. DHT11 sensor and a NodeMCU ESP8266 IoT module and uploading the information over the Wi-Fi network to the ThingSpeak server, and hence the respective authorities in the hill stations can take actions depending on the information.**

Keywords- Internet of Things, Hill Stations, DHT11, NodeMCU ESP8266, ThingSpeak.

I. INTRODUCTION

Hill stations constitute one of the important factors in India not only in terms of economy but also in terms of beauty. Hill stations in India produce a large number of agricultural crops that are used for domestic use as well as to export in other countries. Also hill stations are a major contributor to the Indian economy as a lot of tourists gather there all around the year. Studies show that foreign tourism in India has helped to grow the economy of the country. The hill stations in Tamil Nadu account for over 22.2% of the tourism in India. The state of Uttarakhand which has a lot of hill stations has seen a large number of tourists visiting them. According to statistics, the number of domestic tourists has increased sharply from 10 million tourists in 2001 to 21.9 million tourists in 2009 visiting Uttarakhand. While the number of foreign tourists is about one-tenth of domestic tourists, there was an increase in the number from 55,000 in 2001 to 1,06,000 in 2009[1]. Here surveillance of temperature and humidity is required because by doing so the officials present in the hill stations can determine when it is the perfect time to visit the hill stations as recently due to many climatic changes, challenging situations like landslides like occurring in hill stations which pose a dangerous threat to the tourists.

Many studies show that relative humidity and temperature plays a great role in the agriculture in hill stations that are very important because India is an agricultural country and most of its population depends on the crops yielded. For example, in case of tea cultivation, it needs a low temperature between 18 and 21 degree Celsius and a high humidity of 70% to 90%. If the humidity falls below 40% then the growth is inhibited. Studies show that the production of crops in hill stations is decreasing due to the climatic changes there. Hence humidity and temperature need to be maintained for the growth of these crops. Figure 1 depicts the average relative humidity in Shimla.

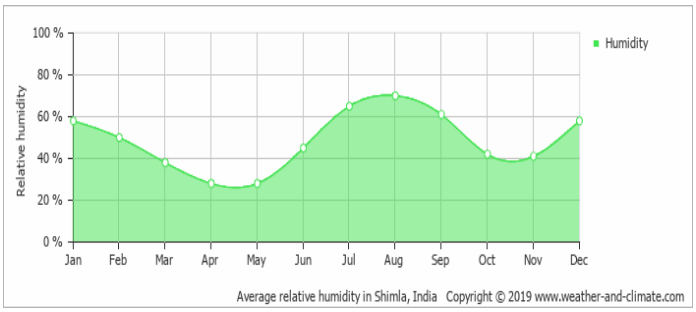

Figure 1. Average relative humidity in Shimla

Recently, the Internet of Things(IoT) has been enormously implemented in various practices, for instance calculating the temperature, humidity and the amount of sunlight needed for agriculture [2], switching home appliances on and off with the help of mobile application through the Internet or locally [3], surveilling not only biogas and the amount of water, but also, triggering fire alarms in animal farms [4], alarming warnings to floods [5], and heart beat recordings with the help of ECG [6]. Futhermore, IoT can be easily integrated with smart mobile phones, popularizing them. There are various applications in any smart phone that are compatible with Internet of Things for example, the Blynk app, Line Notify and NETPIE. Moreover, there are many applications that are compatible with IoT on

PCs, like ThingSpeak. According to statistics, there were 31.7 million smartphone users in around 2016 which accounted for 50.5 percent of the total population in the world [7]. Figure 2 depicts that the total number of devices connected to the Internet of Things used globally.

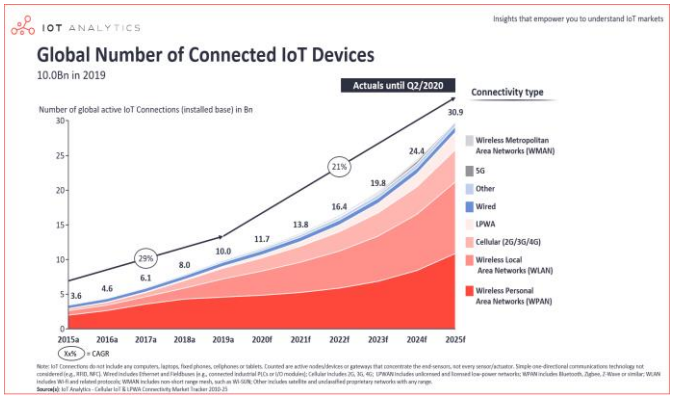

Figure 2. Total number of IoT devices used globally[10]

The proposed system is very cost effective and can be employed in hill stations. The proposed system is a sensor based hardware module which keeps track of the relative temperature and humidity of the area and directly communicates the information to the IoT server via the Internet that depicts the real time values of the parameters to the user. The aggregated data can be used to analyze and infer what steps should be taken to counter the effect of the climatic changes after monitoring the temperature and humidity.

II. LITERATURE REVIEW

A. *Internet of Things(IoT)*

The Internet of Things(IoT) is a interconnection of billions of physical devices around the globe that are connected with the help of Internet for the purpose of collecting and sharing data among themselves and with other systems through Internet. The term “Internet of Things” was invented by Kevin Ashton in 1999. The aim of IoT is to integrate everything around the globe with the help of a common infrastructure, the Internet, which will give us control of things around us as well as keep us informed of their states too. There are various technologies that are related to Internet of Things for example, Machine-to-Machine(M2M) and the Internet of Everything(IoE). Physical objects have to have sensors and MCUs to connect with each other ‘smartly’. These MCUs and sensors will then communicate data to an IoT server that will be the center for data interchange. In farms, IoT is implemented to surveil the surroundings and environment in mushroom cultivation [8]. IoT has been enormously utilized in various practices and fields, as depicted in Figure 3. It is estimated that the number of IoT connected devices worldwide will be almost 38.6 billion in 2025 and 50 billion in 2030. The wireless IoT communication technologies that are vastly implemented include Wireless Local Area Network(WLAN), Low-Power Wide Area Network(LPWAN), Narrow Band Internet of Things(NB-IoT) and Sigfox. The IoT network protocols popularly known are MQTT, CoAP and AMQP.

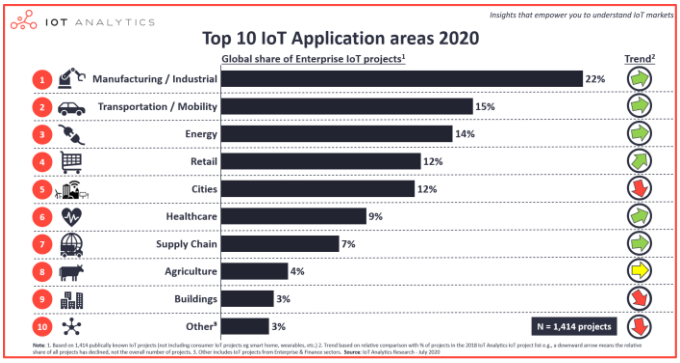

Figure 3. Implementations of IoT[11]

B. *ThingSpeak*

ThingSpeak is an IoT analytics service that allows us to collect, visualize and observe live data streams in the cloud. It is compatible with various types of MCUs, such as NodeMCU ESP8266, Arduino, Raspberry Pi and ESP32 with the help of Internet. With the ease to also execute MATLAB code in ThingSpeak, we can carry out online observation and processing of the data. ThingSpeak also provides instantaneous visualization of data communicated by the devices to ThingSpeak. ThingSpeak is used to prototype and to prove the concept IoT systems that require analytics. The details are depicted in Figure 4.

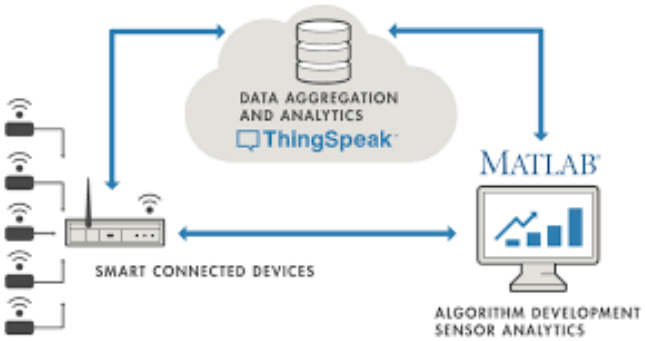

Figure 4. ThingSpeak Application protoype

C. *NodeMCU ESP8266*

The NodeMCU is an open-source IoT platform, invented in 2014. ESP8266 is an MCU [9] with a 160 MHz single-core CPU, a 32-bit Reduced Instruction Set Computer(RISC), an IEEE802.11b/g/n 2.4 GHz Wi-Fi, and 19.5 dBm output at the antenna. NodeMCU was made after ESP8266. The ESP8266 is a Wi-Fi System on Chip(SoC) which has a Tensilica Xtensa LX106 core integrated with it and is widely used in IoT. It can function in a wide range of temperature: -40 degree Celsius to 125 degree Celsius. The measurement of the chip is 18:23:3 mm. Figure 5 depicts the pin diagram of NodeMCU ESP8266.

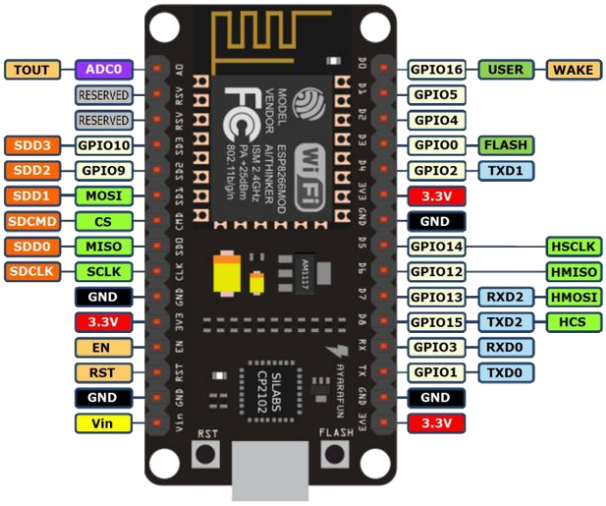

Figure 5. NodeMCU ESP8266 pin diagram[12]

D. *Sensor*

The DHT11 sensor is a very commonly used Temperature and Humidity sensor. The sensor comes with a allocated Negative Temperature Coefficient (NTC) to calculate temperature and an 8-bit MCU to pass the values of temperature and humidity as serial data output. It is a very high precision sensor that is also cheap and easy to use. The sensor can calculate temperature from 0 degree Celsius to 50 degree Celsius and humidity from 20% to 80%, having a 5% accuracy. The supply voltage ranges from 3.5V to 5.5V. Figure 6 depicts the DHT11 sensor.

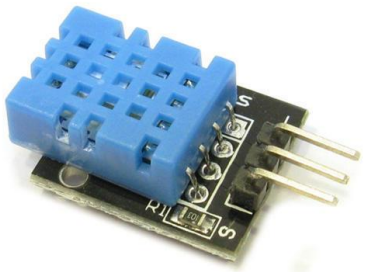

Figure 6. DHT11 temperature and humidity sensor

E. *Programming*

The Arduino Integrated Development Environment(IDE) or Arduino Software is basically an editor for writing codes, a text console, a message area and a toolbar having command functions and menus. The application of Arduino IDE is to connect to the Arduino Hardware to upload programs.

III. SYSTEM IMPLEMENTATION

A. *Block Diagram*

The block diagram of the proposed system in depicted in Figure 7. Temperature and humidity values are conveyed from the DHT11 sensor to the NodeMCU ESP8266 microcontroller, then it is being collected and kept in the ThingSpeak server wirelessly. When users want to analyze the values, they just need to open the ThingSpeak application on their computers.

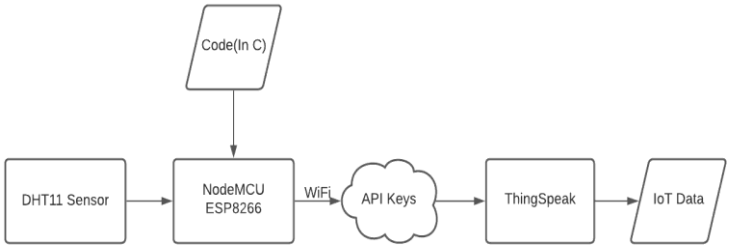

Figure 7. Block diagram of the monitoring system

B. *Circuit Diagram*

A circuit diagram design is essential, comprising a microcontroller, sensor and power supply as depicted in Figure 8, because malfunctioning and broken circuits could harm the sensitive devices.

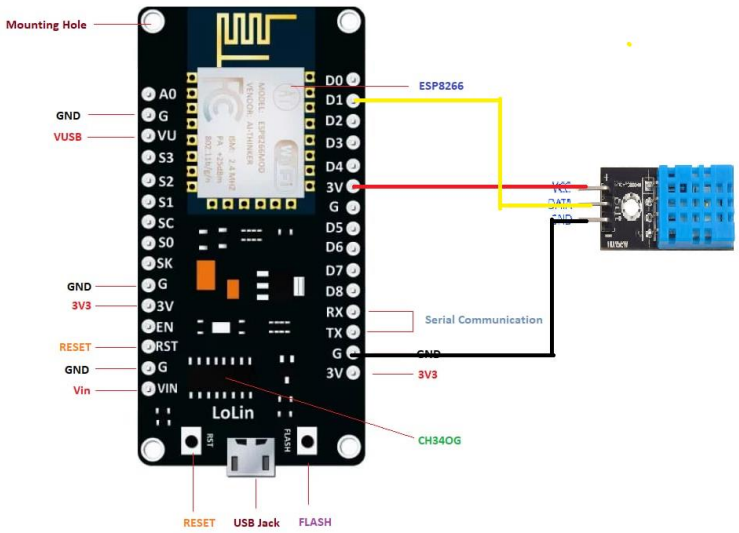

Figure 8. Circuit design

C. *Experiment*

The circuit was designed and implemented so that the system can precisely compute the temperature and humidity of a place. The data obtained were displayed in the ThingSpeak on an instantaneous basis. Figure 9 depicts the experimental setup of the system.

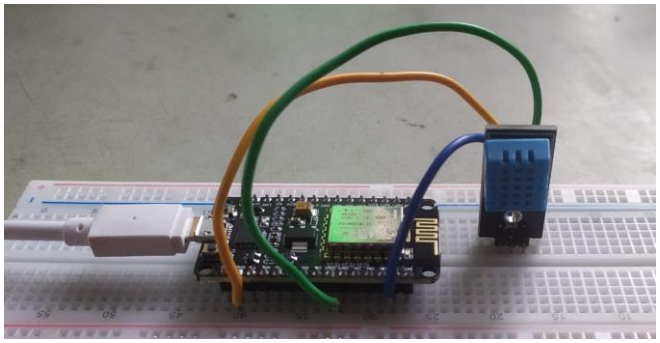

Figure 9. Experimental setup

IV. RESULTS

The results of this experimental setup are obtained as follows.

- The temperature and humidity data are displayed on the monitor through the use of the ThingSpeak application. Figure 10 and Figure 11 show the value of temperature and humidity at that particular instant of time.

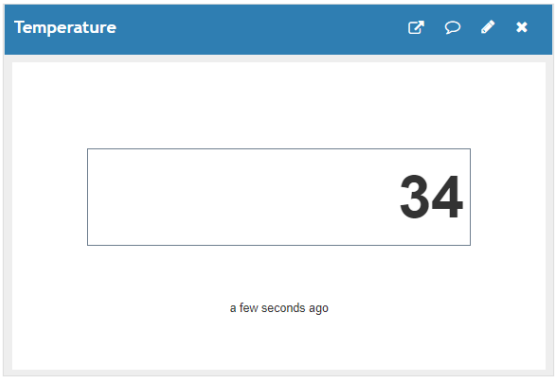

Figure 10. Real-time temperature value

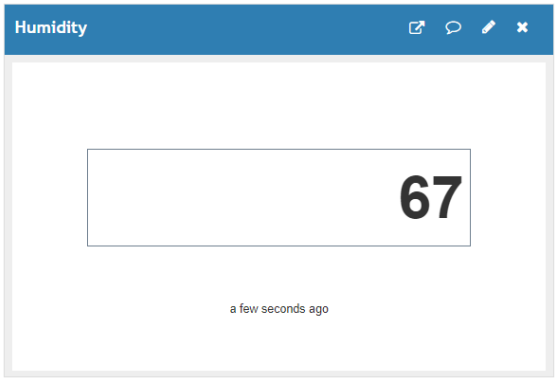

Figure 11. Real-time Humidity value

- The real-time graphs of temperature and humidity are also obtained on the screen through the use of ThingSpeak application. With the help of these graphs, the workers can easily juxtapose and observe the changes in the temperature and humidity on a real-time basis. Figure 12 and Figure 13 depict the trends of the graphs obtained.

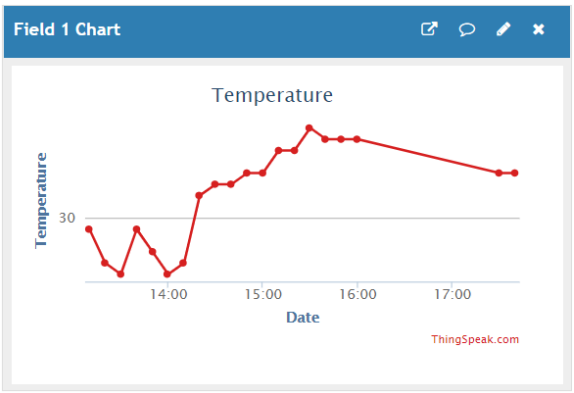

Figure 12. Temperature graph obtained on ThingSpeak

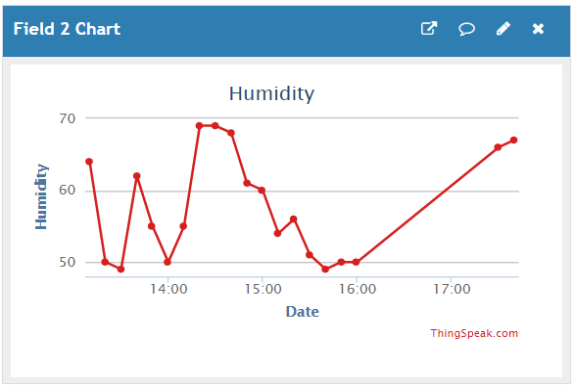

Figure 13. Humidity graph obtained on ThingSpeak

- There is also an alert system consisting of two lamp indicators, one for temperature and the other for humidity, on the ThingSpeak application which glows in red color whenever the temperature and humidity crosses a given threshold value. The threshold values can be set accordingly to the requirement of the workers varying from one hill station to another from the widgets option on the ThingSpeak application. Figure 14 depicts the lamp indicators.

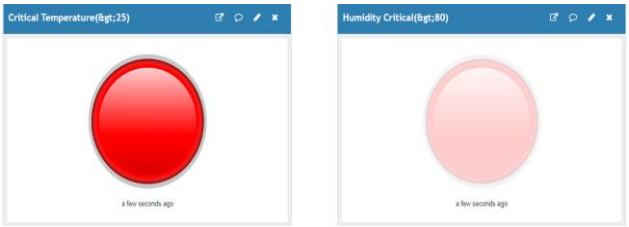

Figure 14. Lamp indicators for temperature and humidity

- Also, the temperature and humidity displayed are accumulated in the database to communicate a final result. The result will be sent to the specified contact in the form of a comma-separated values (CSV) file, as depicted in Figure 15. The date and time when the data is recorded are clearly depicted, making it easier to identify the changes in the parameter levels. The

obtained data can be further examined for future reference.

	created_a	entry_id	temperat	humidity
2	2021-04-1	1	26	61.00
3	2021-04-1	2	26	61.00
4	2021-04-1	3	26	62.00
5	2021-04-1	4	27	62.00
6	2021-04-1	5	27	64.00
7	2021-04-1	6	27	64.00
8	2021-04-1	7	28	66.00
9	2021-04-1	8	28	66.00
10	2021-04-1	9	28	64.00
11	2021-04-1	10	28	62.00
12	2021-04-1	11	28	60.00
13	2021-04-1	12	28	59.00
14	2021-04-1	13	28	62.00
15	2021-04-1	14	27	59.00
16	2021-04-1	15	26	47.00
17	2021-04-1	16	23	53.00
18	2021-04-1	17	22	68.00
19	2021-04-1	18	22	71.00
20	2021-04-1	19	22	68.00
21	2021-04-1	20	23	65.00

Figure 15. CSV file from ThingSpeak server

V. CONCLUSION

As temperature and humidity are an important factor in hill stations, this setup used IoT to calculate and observe the parameters. The proposed system can calculate the temperature and humidity of any place. Once the temperature and humidity of the required locations in hill stations are obtained, the officials and workers could determine what steps they need to take to counter the effects of the climatic changes. From the results, we can conclude that the Thingspeak application works well and the users can use basic widgets for free. The proposed system can effectively measure the temperature and humidity. Also, the ThingSpeak application is able to successfully exhibit all of the data and observe the parameter changes on a real-time basis. This indicates that the proposed system can be used for monitoring real-time temperature and humidity for hill stations.

VI. FUTURE WORK

We should conduct more research study on this topic to overcome the drawbacks of our proposed system. Like for instance, a prototype can be made for installing a meter which will automatically monitor the climatic parameters and show their changes and will be easier to install and remove in the required locations. Also, there can be an automated control mechanism to regulate the temperature and humidity as per the requirements for better results.

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