Real-Time Cloud based Weather Monitoring System

Neha Kumari
School of Electrical Engineering,
MITAOE, Pune, INDIA.
nehakumari@mitaoe.ac.in

Sakshi
School of Electrical Engineering,
MITAOE, Pune, INDIA.
sakshi@mitaoe.ac.in

Shivani Gosavi
School of Electrical Engineering,
MITAOE, Pune, INDIA.
ssgosavi@mitaoe.ac.in

Sandeep S. Nagre
School of Electrical Engineering,
MITAOE, Pune, INDIA.
ssnagare@gmail.com

***Abstract*-IoT is an emerging technology in today s world. Things are widely used for collecting and storing the data from sensors to the cloud. Weather parameters can be easily accessed remotely using IoT applications. This is an IoT based system to collect the real-time weather parameters and store the data to the cloud platform. The collected data is displayed through the webpage. The stored data is of great advantage where weather forecasting is required. The weather parameter includes temperature, humidity, dew point, light intensity, air pressure, precipitation, and smoke percentage. The NodeMCU is used as an MQTT client to transfer the sensed data to the Thingspeak cloud platform.**

***Keywords*: - IoT, Sensors, NodeMCU**

I. INTRODUCTION

With the drastically changing climate, it becomes very important to collect weather parameters and monitor it continuously to predict future weather. Typical weather conditions-based database can be formed using weather monitoring. Weather events can be predicted or explained using this information. It thus helps people to plan their day-to-day activities. Weather forecasting plays a very crucial role in the Agriculture sector. Crop harvesting and planting require weather information. Accurate knowledge of real-time weather parameters such as temperature, humidity, precipitation helps protect crops and produces a good yield. Also, Life and property can be protected by weather forecasting [1].

IoT has made it possible to connect things and places in the world. It establishes a connection between not only humans but devices that can communicate among themselves [2]. The weather parameters can be easily measured with the help of sensors and can be communicated to humans through the internet. Therefore, IoT enables us to monitor real-time data remotely.

IoT operates on various protocols. To communicate between microcontrollers, low power sensors, and various computing devices, the lightweight attribute of MQTT makes it suitable for all the IoT based applications. It is designed for low bandwidth-constrained devices. It is based on the publish-subscribe model.

It has three essential components: Publisher, Broker, and Subscriber. The Publisher/client publishes the data. NodeMCU works as a client to publish the data sensed by the various sensors to the Thingspeak. The broker is responsible for sharing the published data to interested subscribers. The subscribers can access the data through a webpage. This paper describes an IoT based system consisting of various weather measuring sensors like Temperature and Humidity (DHT11), Air Pressure (BMP180), Dew Point, Light Intensity (LDR), Precipitation (FC37), Smoke percentage (MQ135). The sensed data is published to cloud platform Thingspeak through the MQTT protocol. The data is stored for analysis and visualized suitably to be displayed through a webpage.

II. SYSTEM ARCHITECTURE

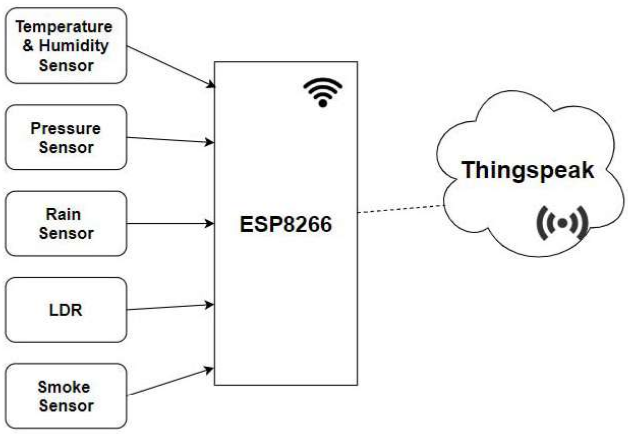

Fig.1: Architectural Diagram of System

The architectural model is shown in Fig.1. The system consists of various sensor nodes, Wi-Fi-based microcontroller (esp8266) and IoT cloud platform Thinkspeak. The weather parameters are measured by sensor nodes and data is sent to the Thingspeak via ESP8266 microcontroller.

A. Hardware Specifications

DHT11 is a temperature and humidity sensor. It uses an NTC thermistor to measure temperature and resistive components to measure the relative humidity. Its anti-interference ability, fast response, cost-effectiveness, small size, lower power, excellent quality and long transmission distance (up to 20m) makes it suitable for various applications.

BMP180 is a digital pressure sensor. It consists of a piezo-resistive sensor that measures the surrounding pressure and temperature, an analog to digital converter, a control unit with E2PROM to store 176 bit of individual calibration data and a serial I2C interface to be connected directly to a microcontroller.

Photoresistor, LDR (Light Dependent Resistor) is a photocell working on the principle of photoconductivity. It consists of a resistor whose value varies depending on the intensity of light. They are cheap and available in small sizes. It requires low power and small voltage for its operation.

The Rain sensor is used as a switching device to detect the rain. It has two components: an electronic board and a collector board. The collector board is nickel-coated and is responsible for detecting the raindrops. It works on the principle of varying resistance. When the collector is dry, it shows more resistance and less resistance to wet. This sensor is used to indicate the total precipitation percentage over a given period.

MQ135 is a gas detector to monitor the encircling air quality. The MQ-135 alcohol detector consists of tin oxide (SnO_2), a perspective layer within corundum small tubes (measuring electrodes) and a constituent within a cannular casing. The top face of the detector is penned by a stainless-steel web and therefore the back aspect holds the affiliation terminals. The MQ135 gas detector detects Ammonia, sulfide and benzine steam and sensitive to fumes and alternative harmful gases. It is with low value and appropriate for various applications like harmful gases/smoke detection. They are employed in air internal control instrumentality for buildings/offices, are appropriate for detective work of NH_3, NO_x, alcohol, Benzene, smoke, CO_2, etc.

Node MCU contains firmware which is compatible and runs on ESP8266 Wi-Fi System on Chip (SoC), and the hardware depends on ESP 12E Module. ESP8266 has an integrated Wi-Fi module, low cost and has ultra-low power technology. It is coordinated with 32-bit Ten Silica L 106 Microcontroller which is responsible for the extra-low power consumption feature.

B. Software Specifications

Various IoT based applications use Thinkspeak as their cloud platform. This updates real-time data that streams on the cloud. The streamed data is live and is aggregated and analyzed by application inputs and visualized by the user. It is the open-source application of IoT to update and retrieve data from different sources using the HTTP and MQTT protocol over local area network or via the internet.

Message queuing telemetry transport (MQTT) protocol nowadays is the most commonly used protocols in IoT based applications. It is a lightweight messaging protocol which generally exchanges data between the clients that is the subscriber of the data and server that are publishers of data. This protocol is designed for the devices with low bandwidth.

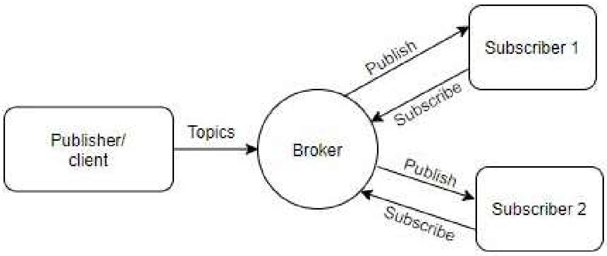

Fig.2: Architecture of MQTT Protocol

Hypertext Markup Language is the standard language for creating webpages. It ensures the proper formatting of text and images to be displayed by the Internet Explorer as they are supposed to look.

III. IMPLEMENTATION

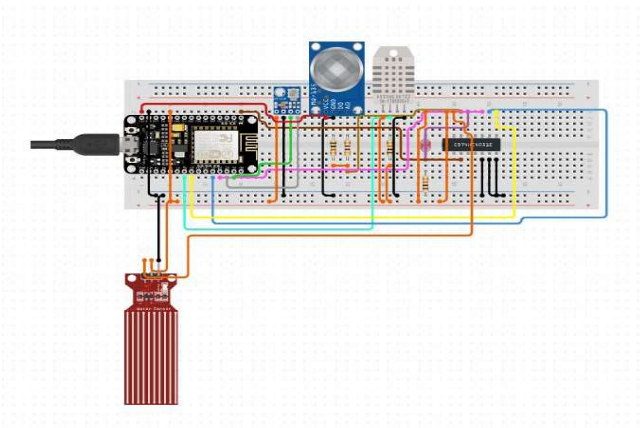

Fig.3 Circuit Connections

Weather parameters include Temperature, Precipitation, Wind speed, Wind direction, Dew Point, Atmospheric Pressure, Humidity, Light Intensity and Smoke Percentage in air. In this paper, out of 9 above parameters, 7 parameters are interfaced except for wind speed and direction. ESP8266 microcontroller is used to process and sense information. Thinkspeak is preferred as a cloud platform for this system because it is an open data platform for IoT based applications. In the actual circuit connection DHT11, BMP180, MQ135, LDR, FC37 these all sensors are used to get data of weather parameters like temperature & humidity, pressure, smoke percentage, the intensity of light and rain percentage respectively. Dew point percentage is also part of this system and is calculated using humidity's and temperature's data. All of the above sensors are interfaced with NodeMCU digitally except LDR, FC37 (Rain sensor) these two are interfaced using analog input. To program ESP8266, Arduino IDE is used. The output is being uploaded timely on Thinkspeak cloud platform that uses MQTT protocol and the result is displayed in the form of Graph to allowed users only on a webpage designed using HTML.

IV. RESULTS

A. *Thinkspeak Channel Status*

Fig.4: Temperature Analysis

Fig.5: Humidity Analysis

Fig.6: Dew Point measurements

Fig.7: Air Pressure Analysis

Fig.8: Smoke Percentage in air

Fig.9: Light Intensity

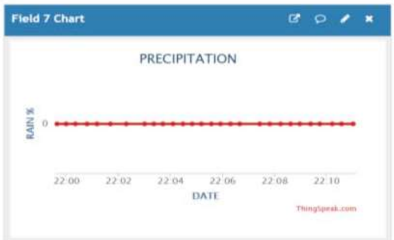

Fig.10: Rain Percentage

All the above figures show the connection and graph of various parameters in the Thinkspeak platform respectively. The system is implemented to a keep record on different environmental conditions and also the measurement of the required data and then represented effectively with the help of the charts. Sensed data updates with real-time features on Thinkspeak cloud and allowed user can analyze the parameters through the webpage.

B. *Display of google gauges on the website*

Fig.11: Google gauge of the current temperature

Fig.12: Google gauge of current Humidity

Fig.13: Google gauge of current Dew Point

Fig.14: Google gauge of current Air Pressure

Fig.15: Google gauge of current Smoke Percentage

Fig.16: Google gauge of current Light Intensity

Fig.17: Google gauge of current Rain Percentage

All the above figures show the different google gauge for various measured weather parameters. These gauges are displayed on the website by using HTML, CSS and JavaScript along with Thinkspeak plugin feature.

C. MATLAB Visualization of Collected Data

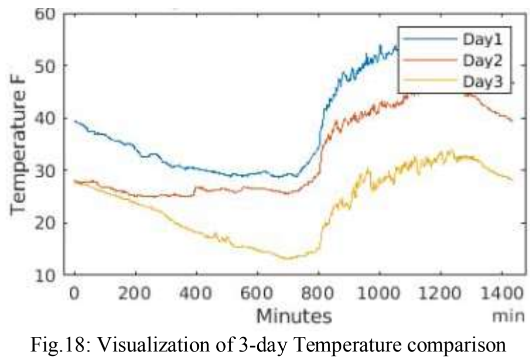

Fig.18: Visualization of 3-day Temperature comparison

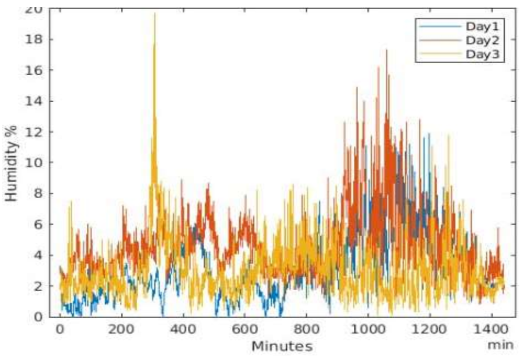

Fig.19: Visualization of 3-day Humidity comparison

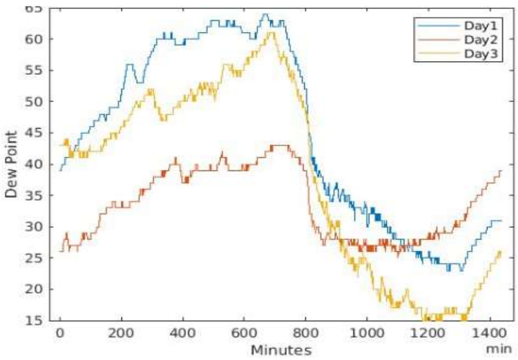

Fig.20: Visualization of 3-day Dew Point comparison

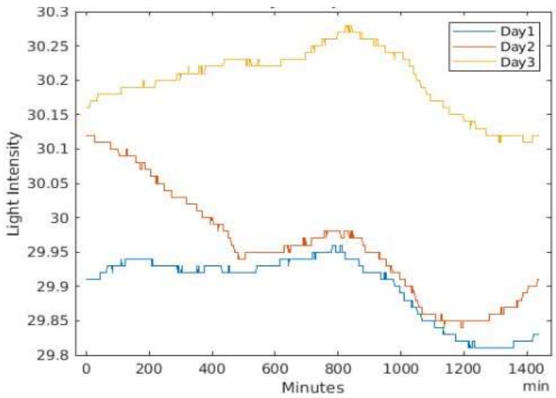

Fig.21: Visualization of 3-day Light Intensity comparison

All the above figures show the visualizations of three-day Temperature, Humidity, Light Intensity and Dew Point Percentage comparison. Different MATLAB plots can be used to visualize and analyze the collected data on Thingspeak

V. CONCLUSION

Weather monitoring system is designed by using NodeMCU, DHT11 sensor, BMP180 pressure sensor, Light Dependent Resistor, rain sensor and a gas sensor which can measure the physical parameters like temperature & humidity, pressure, smoke percentage, intensity of light and train percentage respectively. This system uses MQTT protocol which can publish /subscribe for controlling and graphically monitoring environmental parameters. The measured data is sent to the cloud through the internet, here Thinkspeak platform analyses real-time data. Data can be accessed and controlled remotely from internet-connected devices like mobile computers and laptop.

VI. FUTURE SCOPE

In the future, this system can be interfaced with LoRa in place of Esp8266 to provide long-range connectivity. Development can be done in a mobile application to monitor the data and alert feature can be added to get the notification in case of emergencies. Also, more sensors could measure for more weather conditions.

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