

## Real Time Weather Analysis Using ThingSpeak

<sup>1</sup>Dr.Parashuram Baraki, Professor & Head, Dept of CSE, HIT, Nidasoshi.
<sup>2</sup>Shankarayya Shastri, Asst Professor, Dept of CSE, SJEC Mangalore.
<sup>3</sup>Asif Mohemmed, Dept Of CSE.
<sup>4</sup>Anusha Hegde, Asst Professor, Dept of ICT,MIT Manipal.

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### Abstract

Real time Weather analysis and forecasting is very important in recent years of science and technology to predict the state of the atmosphere for a future time and a given location. In this paper we are trying to analyse weather streaming data like temperature, humidity using ThingSpeak tool ,mean while data is collected through IOT sensors.

*Key Words*:Streaming data, ThingSpeak, MATLAB. IOT sensors, cloud computing,

## 1 Introduction

we are presenting how to analyze real time weather streaming data collected from IoT (Internet of Things) sensors, using ThingSpeak tool. Various locations(For example: Bangalore, Belgaum, Dharwad and Gulbarga) are considered for several kinds of weather data analysis. Temperature sensors are the platforms providing continuous information about the current location with exact data . The

future state of the atmosphere could be predicted with the help of current weather analysis. Surface weather observations are the fundamental data used for safety as well as climatologically reasons to forecast weather and issue warnings worldwide.

If we want to understand what weather analysis takes to collect, track and analyze reams of data, just check the weather. There are constant fluctuations, scores of data points and intense interest from different locations. Analyze the data correctly and someone in the place of Bangalore knows whether or not to wear a raincoat. This paper in particular uses a accurate IOT sensors to collect data and to increase accuracy.

This problem statement goes as follows

"Accurate analysis of various weather parameters like temperature, humidity, pressure, etc on real time streaming data using advanced technologies like Internet of Things(for collecting data),cloud computing(for storage),Big data(for analysis) and web design platforms(for displaying results)."

The main objective of this work is to analyze Weather data for maximum temperature, minimum temperature, humidity levels, CO2 level, wind speed, environment pressure level, etc. The weather observation data is used to archive for basic research in fundamental areas of atmospheric sciences. As a usual practice emergency drills are conducted periodically at particular locations to keep the management familiar and comfortable to handle such events at any point of time.

## 2 Literature Survey

Basically some weather analysis tools are as follows

#### **Doppler Radar**

Doppler radars are used predict the rain chances and wind speed of a specified locations or geographical regions. These radars are also able to calculate the wind speed, relation between warm air fronts and cold air fronts. Dopplers are treated as most important tools for weather forecasting.

### Digital Computers

Solving complex mathematical weather equations through calculators is very difficult, even evaluating these numerical forecasting equations is not a job of normal computers or desktop computers. Supercomputers are used to analyze weather data from satellites, weather stations or some other sources. for producing accurate weather prediction results, they perform many calculations that take into wast and complex-scale factors such as differences between air pressure, the Earths revolving time and measures and the water flow etc.

### Other Weather Analysis Tools

Another type of weather analysis device called Dropsondes are used to collect weather data as they drop from the jet aircrafts or parachutes , later collected data is send to central nodes. Weather buoys are also used to observe and store weather parameters like temperature, humidity and pressure levels of a fixed locations.

Ships and Aeroplanes are dynamic or movable weather stations used to observe, collect data at their existing places. The data from all of these sources are streaming into a supercomputer at a central location to make weather predictions.

The people who contributed and worked on Weather analysis are as follows:

1. Mr Ashwin Andale, Mrs. Jadhawa B.K et al[1] developed an efficient Data mining techniques. The algorithms used are Artificial Neural Networks and Decision tree Algorithms for meteorological forecasting weather. The performance of this algorithm would be compared with the standard performance metrics. It used two approaches that are empirical approach and dynamic approach. The comparison of results were carried out by using CART to predict future values of parameters given the month and year.

2. T V Krishna kumar, R.B Sinha Balaram et al[2] implemented the k-Nearest neighbor clustering technique to grouping the similar data sets to predict the humidity,temperature, rainfall amount so it required higher scientific techniques like Decision learning algorithms for effective study and predictions of weather conditions using linear regression. It is found through k means cluster analysis.

3. M.Viswambari and Dr.R.Anbu Selvi [3] implemented the data mining techniques to forecast rainfall, wind pressure, and humidity about past historical and future value. Classification became the problem to identify the group of classifications. A new observation on the basis of a training data containing the observations whose group membership is known. The goal of any supervised

learning algorithm is to find a correct output to minimize errors.

4. Niraj Kumar Singh, Dr.Kanwal Garg [4] implemented Rainfall prediction model with empirical statistical technique. It used the multiple linear regression (MLR)technique for the early prediction of rainfall. There are two approaches used for predicting rainfall. One is Empirical and another one is Dynamical approach. The results proved that there is a close relations between the predicted and actual rainfall amount.

5. Ricky and Dr. Philip Luisi [5] shown the data analysis techniques to forecast rainfall, sunny and humidity about past historical and future value. A new observation on the basis of a training data containing the observation values whose group membership is known.

## **3** Objective of the project

The main objective of this work is to analyze Real Streaming Weather data collected from IoT sensors using ThingSpeak data analysis tool for finding

- 1. Maximum and Minimum temperature, Maximum and minimun humidity levels of a given city.
- 2. Comparison of two or more cities temperature at a time.
- 3. Comparison of two or more cities humidity levels at a time.
- 4. Carbon dioxide(CO2)level of a particular location.
- 5. To find wind speed in given location.
- 6. To find environment pressure rate at given location.

The weather observation data is used to archive for basic research in fundamental areas of atmospheric sciences. As a regular practice emergency calls are conducted periodically at particular locations to keep the government or managing bodies familiar and comfortable to handle such events at any point of time.

## 4 Methodology

"Real Time Weather Analytics" problem can be solved mainly using data analysis tool such as ThingSpeak. For analyzing various weather parameters we are continuously collecting data using Wi-Fi enabled IOT sensors then it is loaded into Google drive spread sheet(cloud storage). The stored streaming data is then fed into ThingSpeak for analysis purpose, ThingSpeak reads data continuously and calculates maximum temperature, minimum temperature, humidity levels ,CO2 level, wind speed, environment pressure level etc. After calculating we can view analysis results using MAT-LAB in different angles such as Line chart form,Pie chart form, Bar chart form, histogram form, table form, etc.

In summary the steps are as follows.

- 1. Collect the real time streaming weather data using Wi-Fi enabled IOT sensors.
- 2. Store the collected streaming data continuously on google spread sheet.
- 3. Analyse or calculate the collected streaming data using ThingSpeak.
- 4. Finally view analysis results in ThingSpeak MATLAB like Line charts, bar charts, through comparison tables or some user convenient manner.



Figure 1:Architecture of IOT connectivity with ThingSpeak

## 5 Technical Details

This project in implemented with IOT sensors, Arduino IDE and ThingSpeak, so let us introduce some basics of all above mentioned technologies.

### 5.1 Internet Of Things

Internet of Things(IoT) systems are very recent technology systems are used sense the realistic values and send them to trigger specific actions. IoT systems are used for variety of purposes such as networking, robotics, agriculture products, etc.

For making any projects that are integrated and automated with sensor data IoT systems are very helpful. IoT systems are very accurate, efficient and robust for emerging technology projects.

IoT systems make full use of recent advances in software, less cost hardware devices, and goal towards achieving target functions. Its recent and future oriented features bring major reforms in design of products, operations, services and moreover IoT changes life style of public, students, employees ,farmers, etc.

#### Features of IoT

The most significant features of Internet of Things covers artificial intelligence, sensors, active engagement, connectivity and small fabricated circuits in operations.

A brief summary of IoT features are as follows.

• Artificial Intelligence IoT enhances humans life very easy with its smart products, these IoT's are essentially makes all daily life things virtually anything smart, with the power of sensor data, artificial intelligence algorithms, and communications.

• Simplicity –IoT uses very easy and simple programming constructs for designing and implementing any type of IoT projects.

•Connectivity Through IoT devices we can establish network of devices in less smaller and less costlier scale and they are exactly practical in real time. IoT networking is very easy, and they are not bounded by any network designers. We can establish IoT networks with small system devices with new technologies.

• Sensors Without sensors IoT systems are useless and they lose their identity. Sensors are the major instruments which send and receive sensor data in a standard passive network devices to an active system with real world integration.

• Active Engagement Today's human life is much integrated with network technologies, it is called as passive engagement. Using this passive engagement method IoT launches a new method for active content, product, or service engagement.

• Small Devices IoT Devices as i earlier told are very small in

size, very less in cost and more accurate and powerful in nature. IoT defines specific built in and smaller devices to give scalability, exact precision and versatile operations.



Figure 2: Sensors used in the Project

### 5.2 Arduino

Arduino is very simple and understandable hardware and software system for IoT projects. It is a freely available electronics platform .Through Arduino boards programmers are read data from different sources - switch on lights, read biometric values from button sensors, trigger appropriate actions on social media events, switch on electromechanical motors, turn on LED bulbs, etc. User can tell Arduino board what to do by sending a set of instructions to the micro controller on the board. For achieving this programmers can make use of Arduino Software (IDE), based on Processing and the Arduino programming language (based on Wiring).



Figure 3 :Arduino IDE

Since from few years Arduino become the heart and intelligent part of millions of operational projects from small sensor projects to large complex instrument projects. Throughout the world community of makers - academic trainers, teachers, hobbyists, artists,

programmers, and professionals are successfully using this opensource platform, and contributing incrementally to an unbelievable quantity of accessible knowledge that can be of great help to beginners and professional experts alike.

Arduino basically invented for students who are not having any electronic and programming knowledge. Its aim is to design simple projects for novice hardware programmers and it was invented in Ivrea interaction design laboratories. within very small time gap it became very popular in electronic community of users and with their contributions Arduino board start updating for new technologies, services and applications. Now Arduino boards are available from small 8-bit boards to multi dimensional printers, complex embedded hardware systems, wearable applications, etc. All Arduino boards are completely open-source, making users to design and deploy independently and at the end use those applications to their personal or official needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

Arduino software IDE version 1.0 and prior to this versions uses the file extension as .pde after this version file extension becomes .ino. In IDE version 1.0 and above old sketches or .pde files can be open easily.

The commands available in Arduino IDE are

*Verify* - This command is used for checking syntax errors in the code.

*Upload*- This is used for compilation of source code and uploads it to the configured board.

*New* - This command is used to Creates a new program or sketch *Open* - This command is used to open existing Arduino sketches available in your directory.

Save -This is used save Saves your program or sketch Serial Monitor Opens the serial monitor for command inputs .

### 5.3 ThingSpeak

ThingSpeak is an Internet of Things (IoT) platform that helps you collect and store sensor data in the cloud and develop IoT applications. The ThingSpeak IoT platform provides apps that let you analyze and visualize your data in MATLAB, and then act on the data. Sensor data can be sent to ThingSpeak from Arduino, Raspberry Pi, BeagleBone Black, and other hardware platforms. ThingSpeak data analysis tool is an application oriented and mainly used for IoT devices. Users can build any type of projects designed for manipulating data collected from IoT sensors. ThingSpeak provides many key attributes including real stream data handling, static and dynamic data processing, MATLAB visualizations, finally applications and plugins. The core part of ThingSpeak is its Communicating ThingSpeak channel. It allows users to send and receive data from the stored place. Each channel supports maximum 8 fields of different data types, 3 location fields and 1 channel field for status value. After creating your own channel in the tool you can issue data into the channel, let the ThingSpeak evaluates and analyze the data, later you can view results according to your comfortable way.

### 5.3.1 Initial Setup with ThingSpeak with Arduino

Before start sending data to ThingSpeak from the Arduino board sensors, users are needed Arduino board with network connection either built-in Wi-Fi module or manual Wi-Fi connection set-up. For achieving this ThingSpeak provides library files for Arduino versions 1.6.x or above running on any versions Linux or Windows or Mac series. These library files are needs to be installed in Arduino devices before start communication between ThingSpeak and Arduino board.

#### 5.3.2 Setup ThingSpeak

In order to perform operations in ThingSpeak tool, every user must have an user account and a channel. In ThingSpeak, channel is treated most important because through this only sensor data is sending and storing. Through each channel user can utilize maximum 8 fields,3 location fields and 1 status field. For every 15 seconds user can send data to ThingSpeak and this delay time is customizable.

- For first time users open https://thingspeak.com website for registration and signup.
- After successful registration create your own channel by selecting Channels, next click My Channels, and then New

Channel

• Write down separately Write API Key and Channel ID for coding purposes.

### 5.3.3 Install ThingSpeak Communication Library for Arduino

Open the Arduino IDE from the menu choose Sketch option then select Include Library from the list select Manage Libraries. It opens library manager window in that select ThingSpeak Library from the list and press Install button.

### 5.3.4 Setup Arduino Sketch

Open the Arduino IDE software basically it is having few Arduino sketch examples with the ThingSpeak library. They are primarily help to work right away with no changes. If you want to work with built-in examples of ThingSpeak channel, you will need to configure the myChannelNumber and myWriteAPIKey variables. For example

unsigned long myChannelNumber = 31461; const char \* myWriteAPIKey ="LD79EOAAWRVY04Y";

## 6 Implementation Details

Here we are presenting hardware and software requirements and necessary connections to connect devices.

# 6.1 Hardware & Software Requirements Software

- 1. Arduino software version 1.6.12 and above
- 2. ThingSpeak data analysis tool
- 3. Wi-Fi connection
- 4. Windows OS 7 and above
- $\star$  Hardware

- 1. 2 set Arduino Uno boards
- 2. 2 set DHT-11 Sensors
- 3. 2 set Wi-Fi module ESP 8266
- 4. 2 set Bread boards
- 5. 15 Connector cables
- $\star$  Software side setup:
- 1. Create a account in ThingSpeak https://thingspeak.com/users/login
- 2. Create your own channel for reading real stream weather data
- 3. Inject data directly to MATLAB charts.
- 4. Start collecting data from Wi-Fi enabled IOT sensors.
- 5. Analyse the weather streaming data using ThingSpeak MAT-LAB(Line chart,Bar chart,Pie chart..etc)
- $\star$  Hardware side setup:
- 1. Set up Arduino board(Figure 8)
- 2. Set up Connections as per given in 6.2 and 6.3
- 3. Make sure that Aurdino is connected successfully with ThingSpeak tool.
- 4. Save and run the code in Aurdino IDE.



Figure 4: Arduino board



Figure 5: Connection of DHT-11 and Arduino with bread board



Figure 6: Detailed PIN Diagram of Arduino Uno



Figure 7:Detailed PIN Diagram of Wi-Fi Module ESP 8266



Figure 8: Connection of Wi-Fi module ESP 8266 with Arduino  $$\rm UNO$$ 

### 6.2 Connecting the ESP8266 to an Arduino

For connecting Wi-Fi module ESP8266 with an Arduino board follow the below steps  $% \mathcal{A}^{(1)}$ 

Refer figure 8 and do follow instructions carefully

- 1. Using red color connector wire connect the Arduinos 3.3V output pin to breadboard as shown in figure 3.5
- 2. Using Blue color connector wire connect GND (ground) pin to breadboard.
- 3. Using another set of blue connectors connect the RESET pins to breadboard the blue line. When you ground the reset pin, the Arduino works as a dumb USB to serial connector, which is what we want to talk to the ESP8266.
- 4. Connect the RX pin of the ESP8266 (yellow) to RXD pin of the Arduino.

- 5. Connect the TXD pin of the Arduino to the TX pin of the ESP (green color in the picture). In serial communications one channel is used for sending data and another channel is used for receiving data. For that purpose we need to connect TX (Serial out) pin of the Wi-Fi (ESP8266) module is connected to RX(Serial in) pin of the DHT-11 sensor and TX (Serial out)pin of the DHT-11 module is connected to RX(Serial in) pin of the DHT-11 module is connected to RX(Serial in) pin of the Wi-Fi module sensor. Arduino board automatically sets all communications channels to ThingSpeak tool.
- 6. Ground pin of the ESP 8266 is connect to breadboard.
- 7. Vcc pin of the ESP 8266 is connect to red color connector to power.
- 8. ESP 8266 CH\_PD pin is connect to bread board (Connections as per in the figure 3.5)

### 6.3 Connecting the DHT-11 to an Arduino

DHT\_11 sensor device consist of 3 pins namely Signal pin, Vcc and Ground pins as shown in Figure 3.7

- 1. Connect DHT-11 ground pin to bread board
- 2. Signal pin to power pin of Arduino board

values

3. Power or Vcc(+) pin to Digital output pin of Arduino board.

The algorithm for Arduino Software is as follows

Initialize the sensor variables Intialize the API key Declare and initialize power supply pins and ground pins Declare all variables related to arduino hardware void setup() { Set serial transmission rate Declare and initialize output pins Declare and initialize high and low pins for power and ground

Set the type of host node and station node with integer value(here 3)

Set the delay time Set connection type (single connection or multiple connection) } //for reading data continuously void loop() { if TCP connection success do { Set analogRead function with pin number Check temperature is reading or not Check humidity is reading or not Convert temperature to string type Convert humidity to string type print the temperature values continuously print the humidity values continuously } else TCP not connected Display connection error ł } do { Connect to ThingSpeak tool Communicate with ThingSpeak via port 80 Check port 80 for connection Update temperature and humidity values } close(Port 80 Connection)

## 7 How to run the project

- A . Ensure all connections are connected properly in Hardware side
- B . Check DHT-11 connections with Arduino board (As in Figure 3.3)
- C . Check Wi-Fi Module ESP 8266 is connected with Arduino board (As in Figure 3.6)
- D . Check power pins and ground pins are connected properly.
- **E** . Ensure Arduino program is edited without any errors (Software side)

- F . Very the program in IDE
- G . Upload the program
- H . Check Serial Monitor for Wi-Fi connections by executing following commands
- 1. AT ok
- 2. AT+CIFSR IP and MAC (AT+RST reset)
- 3. AT+CWMODE=3
- 4. AT+CIPMUX=0 (one way only sending values)
- 5. AT+CWLAP list access points
- 6. AT+CWJAP="uasername","password"
- 7. AT+CIFSR

IP address

If all above 7 steps are executed properly, then it means that Wi-Fi module is connected successfully. In ThingSpeak side

- 1. Login to https://thingspeak.com/users/login
- 2. Click the Channels option from the Menu bar
- 3. Mark down Write() function Key and Channel ID in separate sheet.
- 4. Start viewing the outputs in MATLAB line charts
- 5. Start viewing the outputs in MATLAB line charts( or According to your needs)

## 8 Results and Analysis

In this chapter the result of the project are depicted with the help of snapshots. The main data analysis tool ThingSpeak consists of various type of charts ,we can easily find out different types analysis values like maximum or minimum temperature location, ,high or low humidity location, high or low pressure locations.

### 8.1 Snapshots of experimental results



Figure 9: Temperature analysis of Dharwad Location using Builtin ThingSpeak MATLAB.



Figure 10: Temperature analysis of Bangalore Location using Builtin ThingSpeak MATLAB.



Figure 11: Humidity analysis of Dharwad Location using Builtin ThingSpeak MATLAB Figure



Figure 12: Humidity analysis of Bangalore Location using Builtin ThingSpeak MATLAB Figure



Figure 13 : Comparison of Bangalore and Dharwad Humidity



Figure 14 : Comparison of Bangalore and Dharwad Temperatures.

## 8.2 Analysis of experimental results

Here we are showing some temperature and humidity real time data in table form collected on May 4th 2017 from Bangalore and Dharwad cities.

Sl no	Temp in 'C	Time	
1	23	9am	
2	26	11am	
3	28	1pm	
4	29	3pm	
5	30	5pm	

### Table 1: Temperature in Bangalore

Sl no	Temp in 'C	Time	
1	28	9am	
2	30	11am	
3	31	1pm	
4	32	3pm	
5	31	5pm	

Table 2: Temperature in Dharwad

SI no	Humidity in %	Time	
1	29	9am	
2	24	11am	
3	22	1pm	
4	18	3pm	
5	18	5pm	

### Table 3: Humidity in Dharwad

Sl no	Humidity in %	Time	
1	40	9am	
2	35	11am	
3	33	1pm	
4	30	3pm	
5	31	5pm	

### Table 4: Humidity in Bangalore

Sl no	Temp in 'C	Temp in 'C	T ime
	Dharwad	Bangalore	
1	28	23	9am
2	30	26	11am
3	31	28	1 pm
4	32	29	3 pm
5	31	30	5pm

## Table 5: Comparison of Temperature , Bangalore Vs Dharwad

Sl no	Humidity %	Humidity %	T ime
	in Dharwad	in Bangalore	
1	29	40	9am
2	24	35	11am
3	22	33	1 pm
4	18	30	3pm
5	18	31	5pm

## Table 6: Comparison of Humidity , Bangalore Vs Dharwad

## 9 Conclusion and Future Scope

The project Real time weather analysis is implemented using IoT sensors and data analysis tool ThingSpeak and finally conclusion remarks are as follows.

### 9.1 Conclusion

The experimental results using ThingSpeak Matlab shows that the analysis of weather data is very easier and understandable. We have analyzed following real stream weather data for

- I. Maximum and Minimum temperature of given city.
- II. Maximum and Minimum humidity level of a given city.
- III. Comparison of two or more cities temperature at a time.
- IV. Comparison of two or more cities humidity levels at a time.

We can easily handle and analyze the streaming data using IOT sensors and data analysis tool such as ThingSpeak. The performance of the this project is faster, efficient and effective for weather analysis compared to existing systems. Like this we can collect, track and analyze any type of streaming data for better performance, speed and efficient way.

### 9.2 Future Scope

The Project can be extended for analysis of

- I . Carbon dioxide(CO2)level of a particular location or any number locations.
- II. To find Wind speed in given location or any number locations.
- III. To find Environment pressure rate at given location or any number locations.
- IV. To find the Soil moisturizer level in cropping fields.

We can extend this project for

 $\star$  Web interfaces.  $\star$  Mobile applications.

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