Application of low cost IoT device for precise monitoring of Temperature and Humidity of Server Rack in Data Center

(TRACK: 2   Internet of Things)

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ABSTRACT

Internet of Things (IoT) refers to all the devices which are present in the world and connected to the Internet. The aim of IoT is to collect and share data between two devices using the Internet. The gathered data thus helps in further improvement of the system design. It is making tremendous progress in the past few years, and has proved itself very useful in realization of many low cost real life applications. It is going to bring many disruptions in computer network communication and data analytics in the coming years.

This paper introduces a low cost IoT model to precisely monitor the temperature and humidity of the server rack in the data centre. As data centers have huge servers, it is necessary to monitor and manage the temperature & humidity from the closest proximity for better accuracy and precision. Our system is configured using the DHT 11 (Digital Humidity and Temperature) sensor, Arduino Uno development board and ethernet shield on the hardware side with embedded C code. The test setup is connected to the network, the acquired data is uploaded to the cloud (Thingspeak platform, a mathworks family product) .The logged data, and graph can be viewed seamlessly on the Thingspeak platform. This paper summarizes the retrieval, recording, and processing of the acquired temperature and humidity data of the data center using a low cost temperature and humidity sensor. As the proposed model should be in compliance with the security standards of the work center, we preferred the communication with Ethernet shield over Wi-Fi network for live monitoring from anywhere around the world.

The paper starts with a brief introduction of IoT technology and then presents a glimpse of the components used along with its technical specifications. Moving forward, the paper provide the description of test setup, introduction of the cloud based real time database followed by the working model which gives a clear idea of how the system works. In future, this system can be interfaced with commercial Air Conditioners (ACs) for automatic temperature and humidity control, thus doing away with the requirement of precision ACs for Data Center applications.

1. INTRODUCTION

Internet of Things (IoT)

The term IoT was coined by Kevin Ashton in 1999 and later on officially introduced by ITU (International Telecommunication Union) in 2005. It is a network of things, embedded with software intelligence, sensors and connectivity to the internet. The basic idea of IoT is to monitor and control things from anywhere in the world.

Servers and data storage devices form a crucial part of any organization because all applications run on these servers and it should be available at all times. The ambient condition of this room must be protected from high temperature and humidity with an AC (Air Conditioner). The room temperature and humidity should be maintained at constant values around the clock. Hence there is a need for specialized cost effective tools to provide warning information regarding server room condition which can be monitored remotely. So we are opting for IoT to provide an active solution to keep data and devices safe.

The sensors collect the precise data and the same can be transmitted over the network with the help of IoT. Organizations can prepare themselves to acknowledge the capability of IoT technology which helps in data collection in real time and can be made available on cloud for forecasting and analyzing the data. This technology guides any organization to predict plans and avoid cost of production and risks in flexible ways.

The data is communicated over the cloud, then processed and has various applications to deal with it. Cloud technology is used to solve storage problems as it allows us to deal with big data efficiently. Along with storage capabilities, cloud also provides computational abilities and security. Prominent advantage of using cloud technology in IoT is that it is very cost effective and data is available anytime for any part of the world. Without cloud storage, IoT devices will be restricted to an organization or a particular area with limited memory for data storage.

2. SYSTEM OBJECTIVE

The main objective of this experiment is to use low cost sensors to monitor temperature and humidity on thingspeak cloud platform using the Arduino ethernet shield.

3. SYSTEM DETAILS

This system is configured using the DHT 11 sensor, Arduino UNO, Arduino ethernet shield , Thingspeak platform and are described compactly.

3.1 DHT 11 Sensor:

It is abbreviated as Digital Humidity and Temperature sensor, used for sensing temperature and humidity. To measure the surrounding air, it uses a thermistor and a capacitive humidity sensor. The temperature ranges from 0-50 C with a 2 – degree accuracy. The humidity range is between 20-80% with 5% accuracy. The sampling rate is 1 Hz that is 1 reading/sec, the operating voltage is 3-5 volts.

3.2 Arduino Uno Board:

It consists of a pre-programmed microcontroller. The IDE (Integrated Development Environment) of Arduino uses a C/C++ version and directly connects using a USB cable. It has 6 analog pins and the A0 pin is used for taking the data from the sensor. The operating voltage is 5 V, it uses an EEPROM of 1 KB . The Arduino board and the DHT11 sensor is shown in Figure (i) & (ii).

3.3 Ethernet Shield W5100:

The Arduino Ethernet Shield allows an Arduino board to connect to the internet. It is based on the Wiznet W5100 ethernet chip. The Wiznet W5100 provides a network (IP) stack capable of both TCP and UDP. It supports up to four simultaneous socket connections. The ethernet shield connects to an Arduino board using long wire-wrap headers which extend through the shield as shown in Figure (iii).

3.4 Arduino Uno Software:

It provides an environment to write code and it acts as an interface between the sensor and the web application. We have to upload the desired code and check for the result in the serial monitor.The Arduino IDE window is shown in Figure(iv).

3.5 Thing speak platform:

It is an open data platform for monitoring the data online, where we can set the data as private or public. It takes a minimum of 15 secs to update the readings. Using the Thingspeak site, we can monitor the data over the internet from anywhere and we can control our system over the internet using the channels and webpages provided by the Thingspeak platform. Simply saying, it "Collects" the data from the sensors, "Analyze and Visualize" the data and "Act" by triggering an action.

4. SYSTEM DESCRIPTION

The IoT expands the benefit of the internet to keep the devices connected to each other without human interaction all over the world. In this project, we are explaining how sensors collect data from the server rack of the data center and its implementation. To protect the server room and to maintain it in safe condition as recommended by Telecommunication infrastructure Standard for Data centers, the following criteria has to be maintained:

* Temperature 18-27º C.

* Maximum relative humidity: 60%.

* Maximum dew point: 15 º C (59 º F) .

* The maximum temperature change rate: 5 º C (9 º F) per hour.

The temperature and humidity must be kept accordingly with health standards of the server room in the following formula that can provide a warning automatically:

• If: temp => 30 º the system will provide notification (1)

• If: humid => 60 º the system will provide notification (2)

This IoT based project have three sections:

1. The DHT 11 sensor senses the temperature and humidity data from the surrounding air and the output is seen in the serial monitor..

2. A GUI is created for visualization of DHT 11 sensor's data as a suitable number in % for humidity and C for temperature scale using processing software.

3. The Ethernet shield transmits data to the Thingspeak server, analyzes the data and shows it in graphical form and it can be recorded in .csv format.

5. EXECUTION

5.1 Monitoring of Temperature & Humidity in Serial Monitor of Arduino IDE.

The Board Setup of DHT11 sensor and Arduino Uno board is as follows

1. The first pin 5V (+ pin) of DHT 11 is connected to the 5V pin of Arduino.

2. The second pin i.e., Out/Data pin is connected to A0 pin of Arduino.

3. The third pin i.e., GND (-) is connected to GND of Arduino.

The Type-B cable is used to connect the Arduino board to the computer via USB slot. In the Arduino IDE select the Arduino Uno from the board's manager. We have to select the concerned port , it automatically detects the board to the serial port (Arduino Uno). Though the Arduino has many inbuilt libraries, in order to interface the sensors their compatible libraries need to be included. Understanding the work of DHT 11 is more interesting to know because it determines the amount of humidity present in the air using capacitive measurement with the electrical conductors and non-conductive polymer film existing between it. This film collects the humidity of the air making changes in voltage levels between the two conducting plates and there is a substrate which absorbs water vapor and then releases ions which increases the conductivity between the electrode. The increase of humidity will decrease the resistance between electrodes then calculating the temperature by using a NTC(Negative Temperature Coefficient) thermistor which makes the resistance decrease with increase in temperature .

The next step is to write the code, verify, upload and compile it. The concerned serial port window opens up and the sensed temperature and humidity are displayed for every 5 seconds with a baud rate of 9600. Thus, the Temperature and Humidity data is measured and verified in the serial monitor as shown in the Figure (v).

5.2 Creation of GUI.

To create a better user experience and ease of use, we created the temperature and humidity meters using the "Processing" software of the Arduino family. The code is compiled and the output is displayed in the GUI as shown in Figure (vi).

5.3 Channeling DHT11 sensor data to ThingSpeak IoT Platform using Arduino Ethernet Shield.

We are using the thingspeak open-source application to monitor the data on the internet. This application will fetch data from Arduino through a channel template. In the Thingspeak website (https://thingspeak.com), we have to login and create a channel named DHT11 (private channel) with two fields namely Temperature and Humidity. Note down the channel ID and the generated Write API key, which is to be used in the code. In the Arduino IDE add the channel ID and write API key in the code wherever required, verify and upload the code. The serial monitor displays the sensed data which is communicated to thingspeak as represented in Figure (vii).

In the Thingspeak, click on my channels and see the DHT11 channel (private view) with field 1 as Temperature and field 2 as Humidity. The DHT11 data is communicated over the temperature & humidity channel respectively and gets updated for every 15 secs. A numeric display of temperature & humidity widget is also created. The figure (viii & ix) shows the results of the DHT11 data on Thingspeak platform and the Arduino board setup in the server rack of the data center respectively. The DHT 11 data can also be recorded from Thingspeak and downloaded in CSV format as shown in Figure (x).

6. RESULTS

The temperature & humidity of the server rack in the data center is measured using Arduino Uno, W5100 Ethernet Shield, DHT11 and is communicated to the Thingspeak IoT platform , so that it can be viewed from anywhere in the world. In short, this system can help to facilitate the monitoring environment data of server rack and is able to alert the user if the data exceeds permitted limit. Users can also check the daily monitoring of the parameters. It is observed that there is a difference between the ambient room

temperature and the server rack temperature and we are able to monitor precisely the temperature and humidity of the server rack when compared to the room temperature.

7. CONCLUSION &   FUTURE SCOPE

Thus by using the IoT, we are able to monitor and store the data over cloud and it gives precise reading. The human effort is minimized i.e., There is no need for physical monitoring of servers. The Thingspeak channel is used in private view for achieving enhanced security. Finally, this system saves a lot of time by uploading data automatically without human intervention.

This device can be further used for automatically controlling the AC temperature with the use of a smart switch. A threshold value of temperature and humidity is set and the device triggers a notification or email whenever the temperature or humidity value crosses the threshold. Thereby alerting the concerned authorities and automatically regulating the AC.

ACKNOWLEDGEMENT

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FIGURES
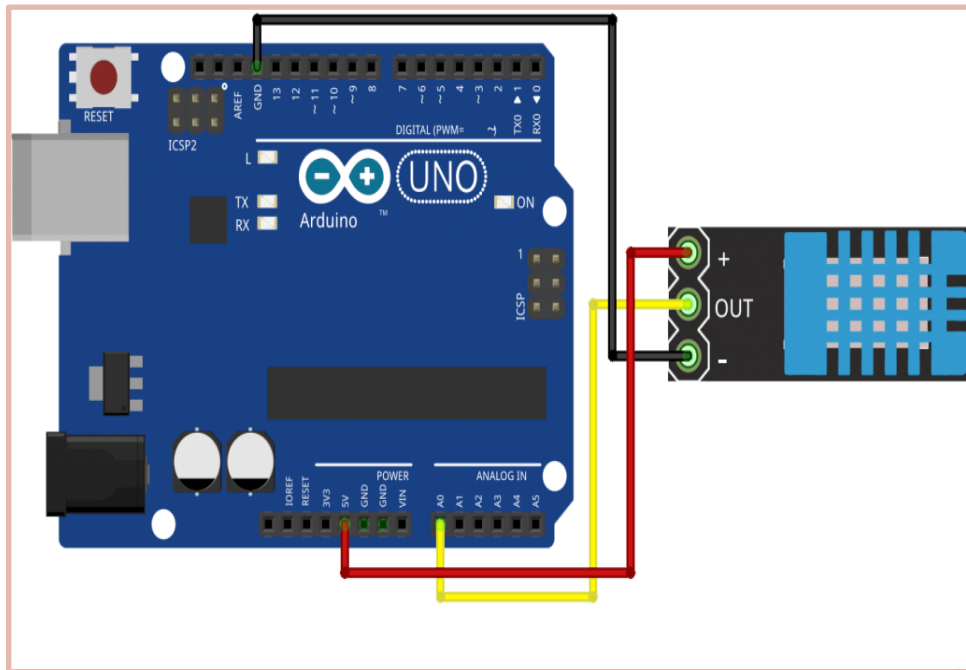
Figure (i) - Schematic diagram of Arduino and DHT11
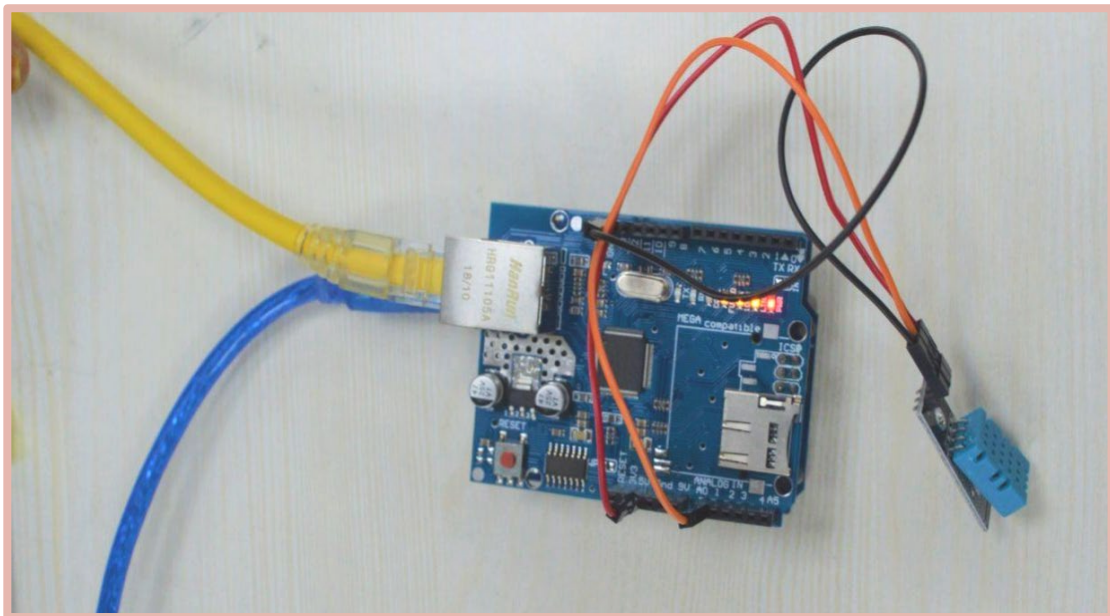
Figure (ii) - Pin connections of the Arduino and DHT11
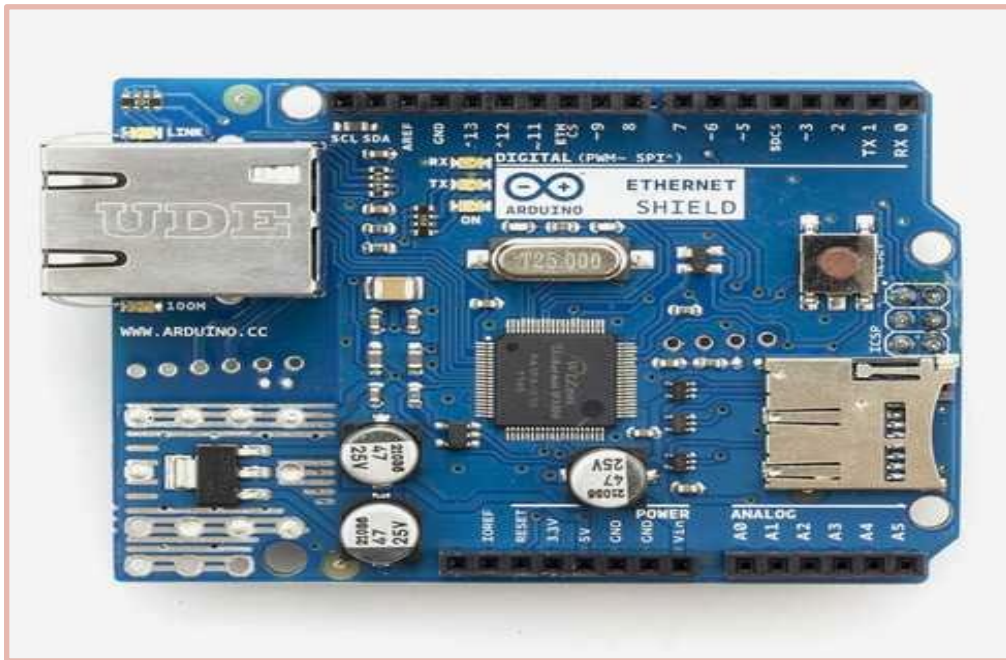
Figure (iii) - Ethernet Shield W5100

Figure (iv) - Arduino IDE window
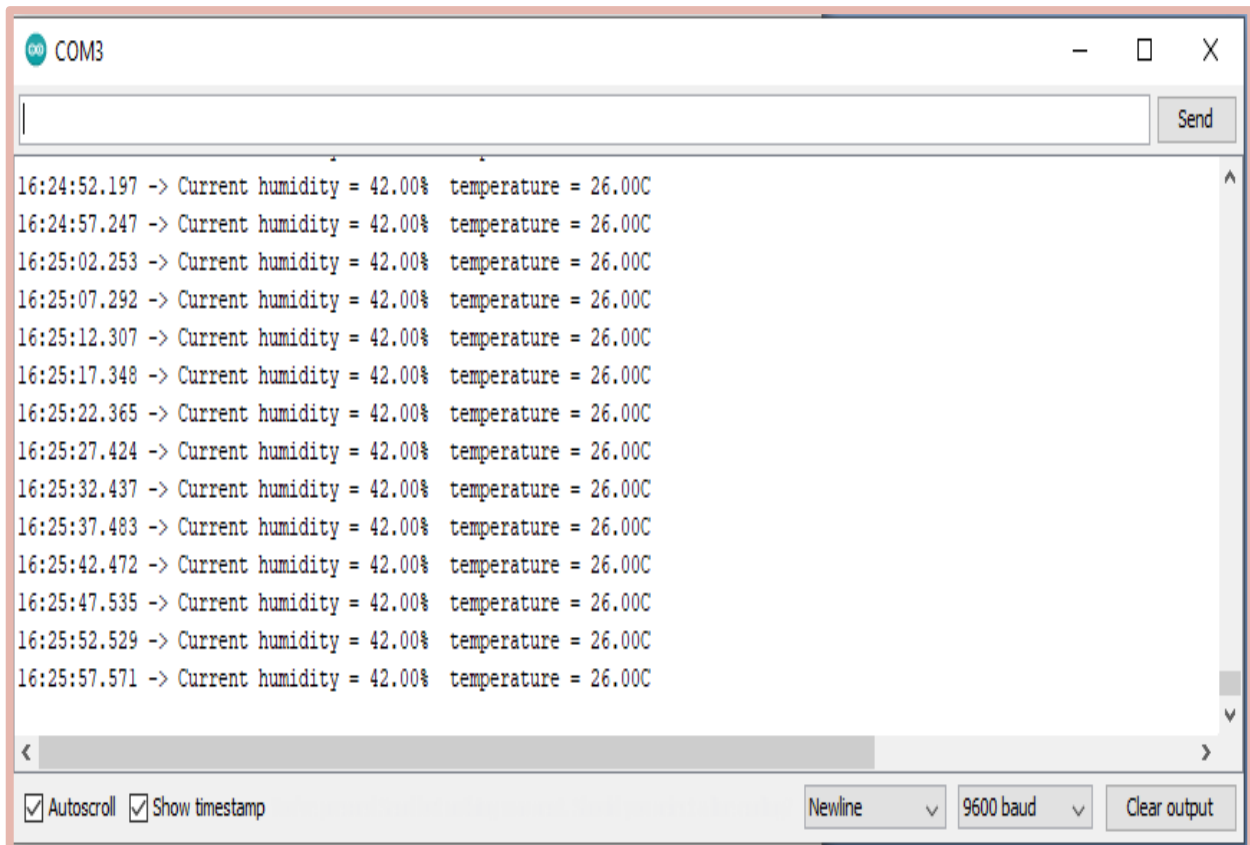
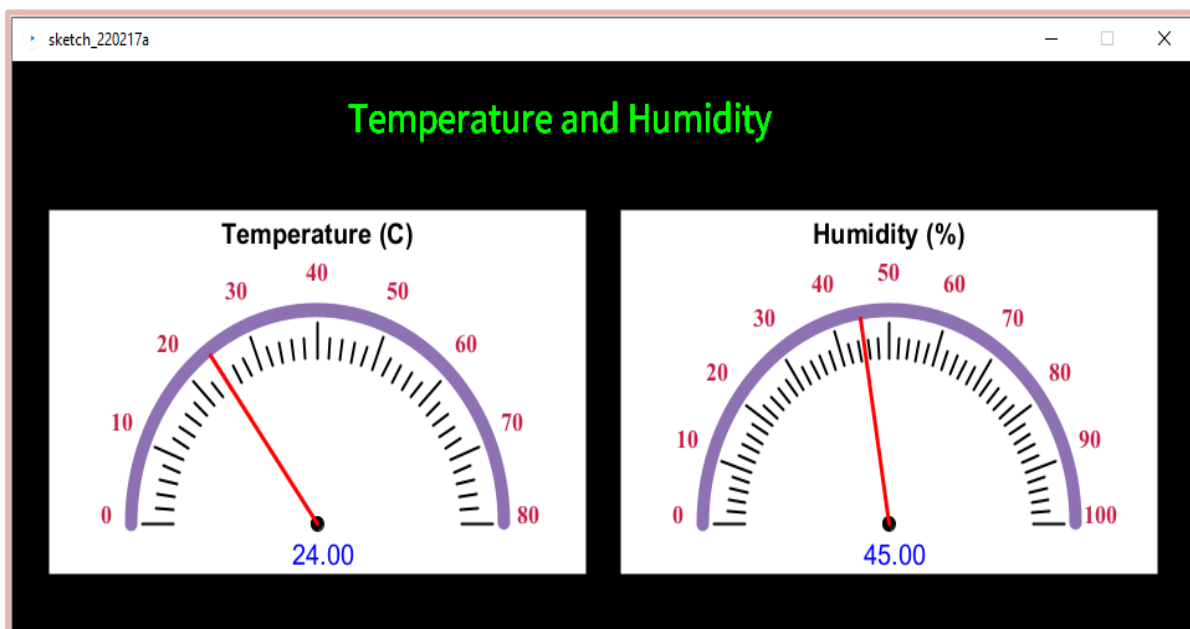Figure (v) - DHT 11 data output on serial monitor.
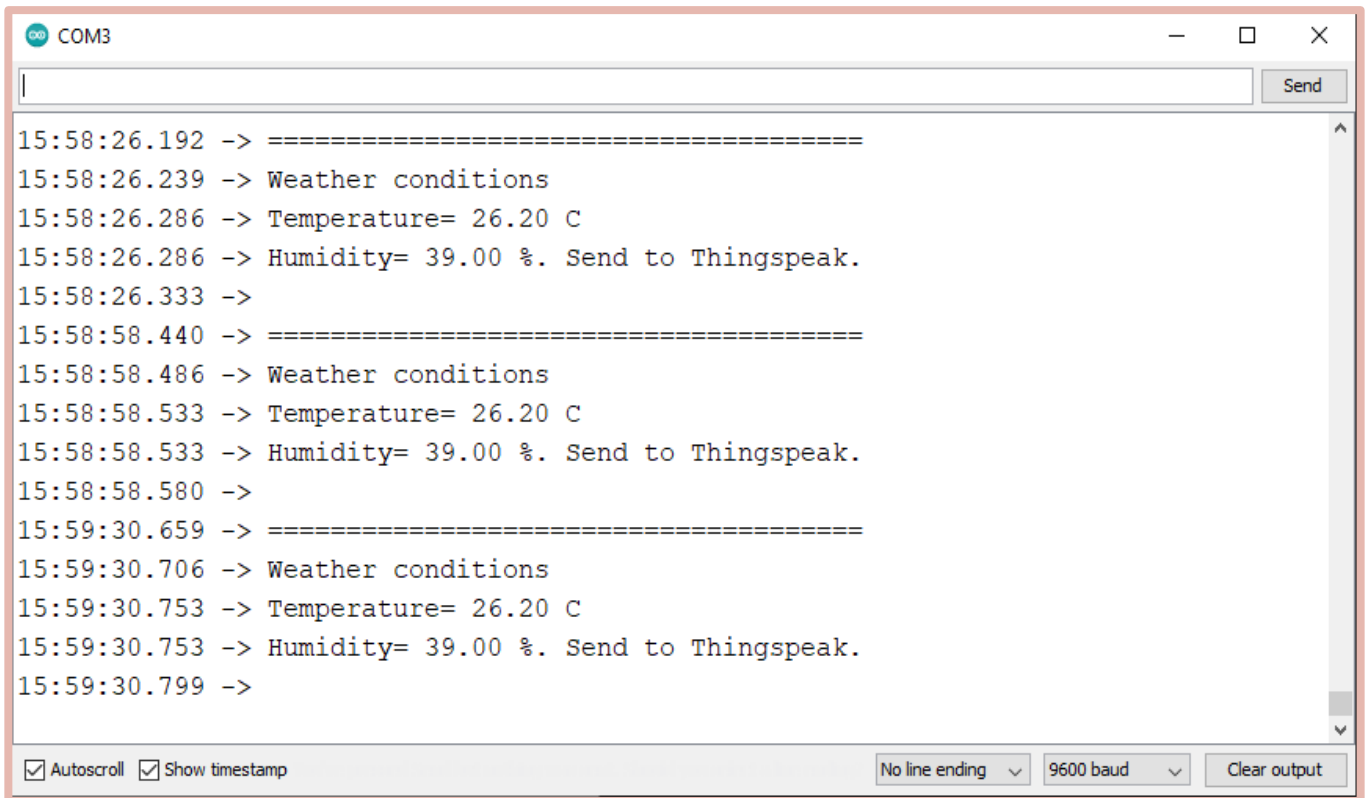

Figure (vi) - The meter display of the DHT 11 data.

Figure (vii) - Serial monitor output of DHT 11 to be uploaded on thingspeak

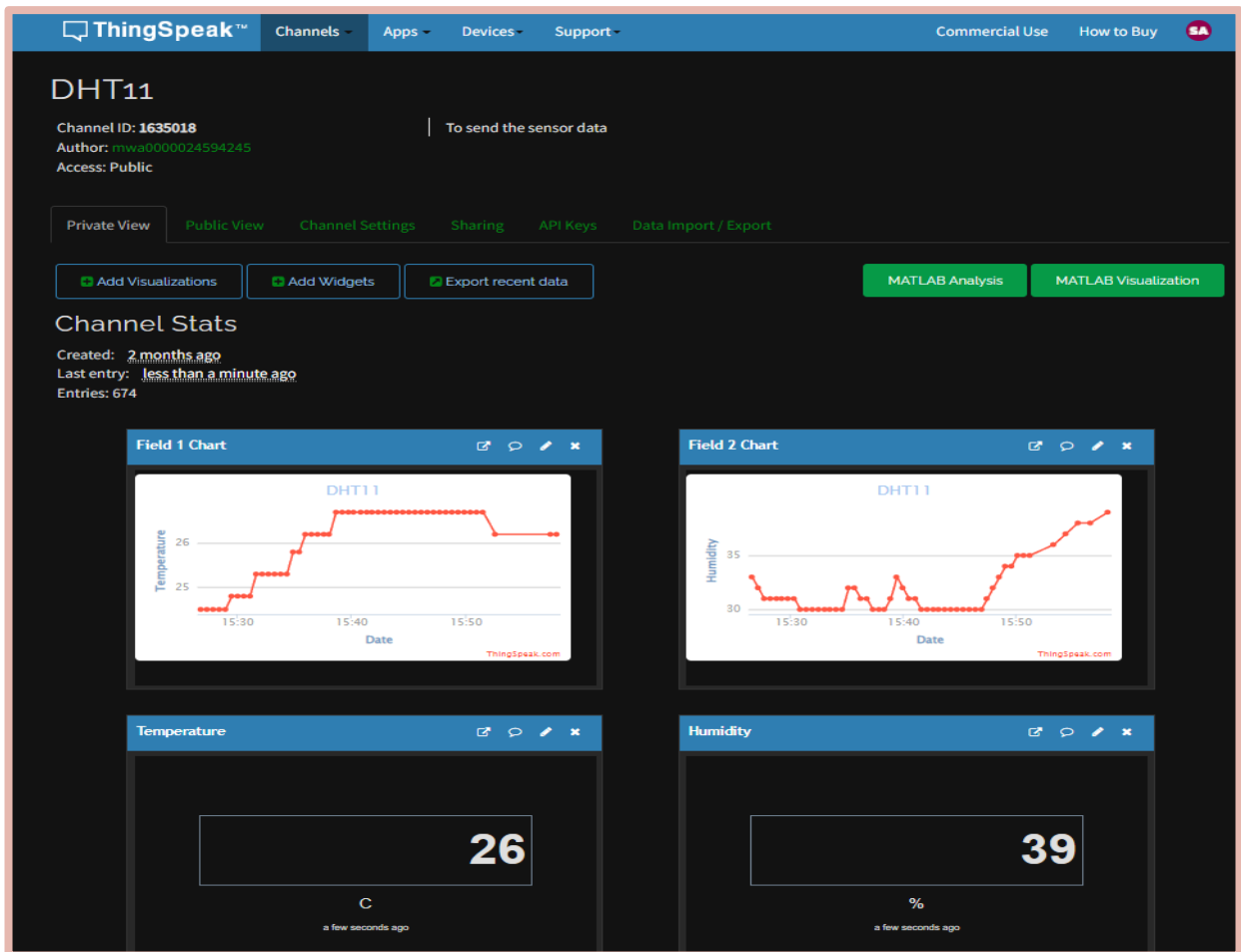Figure (viii) - The Arduino board and DHT11 setup in the server rack of the Data center.

Figure (ix) - DHT 11 data uploaded on Thingspeak platform.

Figure (x) - Recorded DHT 11 data downloaded from Thingspeak in CSV format.