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Course: CIS600 Internet of Things
Assignment: 3 – Cloud-Based IoT System

Step 1 - Creating the ThingSpeak Channel

Using ThingSpeak to set up a cloud-based backend was the initial step in creating the IoT system. In order to represent environmental sensor data, I made a new channel especially for this assignment and set it up with three fields:

Temperature (Field 1),
Humidity (Field 2),
and CO₂ levels (Field 3).

All sensor values from the virtual station would be published to this channel, which acts as the cloud storage location. In order to send data to this channel securely, I also made a note of the Write API Key.

Step 2 - Simulating Virtual Sensors in Python

Upon doing this, I developed a Python program that replicated a virtual environmental station. Under the program, I used Python's `random.uniform()` to develop random values of temperature, humidity, and CO₂. Examples were randomly produced as -50°C to 50°C for temperatures, 0% to 100% for humidity, and 300 ppm to 2000 ppm for CO₂ levels. The values under the program changed over and over again in an infinite loop that emulates real-time sensor values.

Step 3 - Sending Data Using ThingSpeak's HTTP API

Instead of MQTT (which was causing connectivity issues on my computer), I used ThingSpeak's HTTP REST API to send data from the Python script. I used Python's `requests` library to make HTTP POST requests to <https://api.thingspeak.com/update>. The API key and current values of all three sensors were sent in every request. The script was configured to send new data every 30 seconds, basically simulating a live IoT system sending data to the cloud.

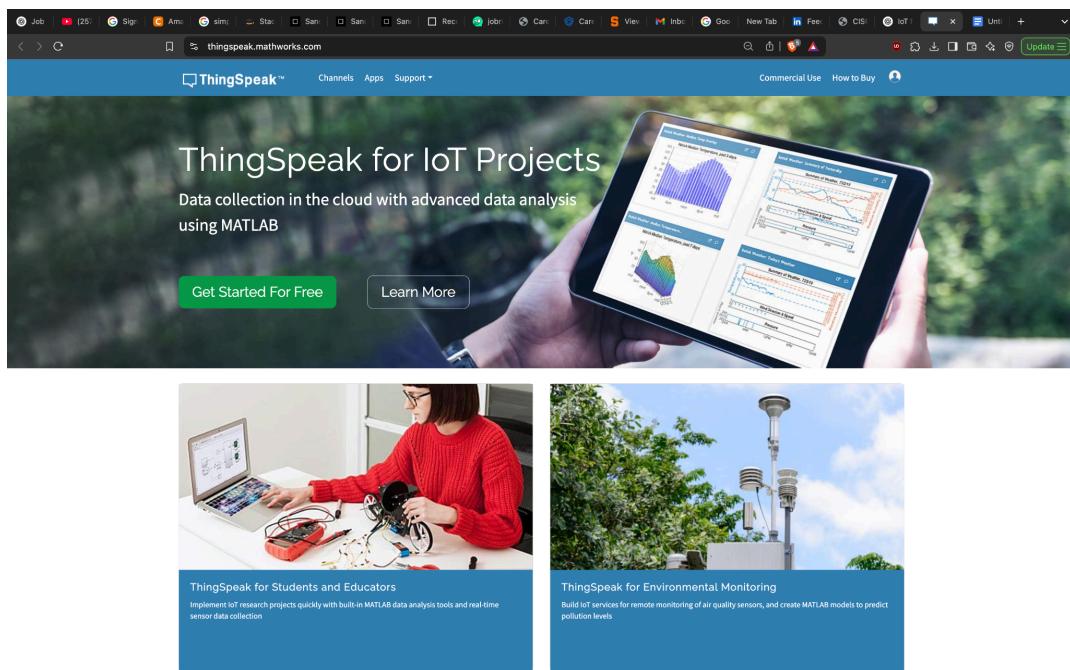
Step 4 - Visualizing Real-Time Data

After the successful transfer of data to ThingSpeak, I utilized the platform's inbuilt visualization features to present the sensor information. The platform automatically created time-series graphs for every variable, enabling the visualization of changes in the temperatures, humidity, and CO₂ levels through graphs that updated live. This process ensured that the data received from the virtual sensors were properly recorded, saved, and graphically presented in a timely manner to the cloud-based platform.

Step 5 - Retrieving Historical Data via API

To verify the system's ability to store and retrieve historical data, I used ThingSpeak's REST API to fetch data collected over the past five hours. This was done by constructing a URL with the correct parameters, including the channel ID, Read API Key, and a time window of 5 hours. The resulting JSON response contained all relevant readings from each sensor, which could be parsed or analyzed further. This demonstrated the backend's ability to support both live monitoring and time-series data analysis.

Screenshots -



thingspeak.mathworks.com/channels

ThingSpeak™

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My Channels

New Channel

Search by tag

Name: ESP32

Created: 2025-02-17 03:11

Updated: 2025-02-17 03:11

Private Public Setting Sharing API Keys Data Import / Export

Help

Collect data in a ThingSpeak channel from a device, from another channel, or from the web.

Click New Channel to create a new ThingSpeak channel.

Click on the column headers of the table to sort by the entries in that column or click on a tag to show channels with that tag.

Learn to [create channels](#), explore and transform data.

Learn more about [ThingSpeak Channels](#).

Examples

- [Arduino](#)
- [Arduino MKR1000](#)
- [ESP8266](#)
- [Raspberry Pi](#)
- [Netduino Plus](#)

Upgrade

Need to send more data faster?

Need to use ThingSpeak for a commercial project?

Upgrade

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New Channel

Name: Virtual Environment Station

Description:

Field 1: Temperature

Field 2: Humidity

Field 3: CO2

Field 4:

Field 5:

Field 6:

Field 7:

Field 8:

Metadata:

Tags: (Tags are comma separated)

Link to External Site: http://

Link to GitHub: https://github.com/

Help

Channels store all the data that a ThingSpeak application collects. Each channel includes eight fields that can hold any type of data, plus three fields for location data and one for status data. Once you collect data in a channel, you can use ThingSpeak apps to analyze and visualize it.

Channel Settings

- Percentage complete: Calculated based on data entered into the various fields of a channel. Enter the name, description, location, URL, video, and tags to complete your channel.
- Channel Name: Enter a unique name for the ThingSpeak channel.
- Description: Enter a description of the ThingSpeak channel.
- Field#: Check the box to enable the field, and enter a field name. Each ThingSpeak channel can have up to 8 fields.
- Metadata: Enter information about channel data, including JSON, XML, or CSV data.
- Tags: Enter keywords that identify the channel. Separate tags with commas.
- Link to External Site: If you have a website that contains information about your ThingSpeak channel, specify the URL.
- Show Channel Location:
 - Latitude: Specify the latitude position in decimal degrees. For example, the latitude of the city of London is 51.5072.
 - Longitude: Specify the longitude position in decimal degrees. For example, the longitude of the city of London is -0.1275.
 - Elevation: Specify the elevation position meters. For example, the elevation of the city of London is 35.052.
- Video URL: If you have a YouTube™ or Vimeo® video that displays your channel information, specify the full path of the video URL.
- Link to GitHub: If you store your ThingSpeak code on GitHub®, specify the GitHub repository URL.

Using the Channel

You can get data into a channel from a device, website, or another ThingSpeak channel. You can then visualize data and transform it using ThingSpeak Apps.

See [Get Started with ThingSpeak](#) for an example of measuring dew point from a weather station that acquires data from an Arduino® device.

Learn More

ThingSpeak™

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Virtual Environment Station

Channel ID: 2892196
Author: mwa0000036850203
Access: Private

Private View Public View Channel Settings Sharing API Keys Data Import / Export

Write API Key

Key: Q0U2EQ2GNOYVVKHX

Generate New Write API Key

Read API Keys

Key: WE2BEWXKRRZ8D8JO

Note:

Save Note Delete API Key

Add New Read API Key

Help

API keys enable you to write data to a channel or read data from a private channel. API keys are auto-generated when you create a new channel.

API Keys Settings

- Write API Key: Use this key to write data to a channel. If you feel your key has been compromised, click Generate New Write API Key.
- Read API Keys: Use this key to allow other people to view your private channel feeds and charts. Click Generate New Read API Key to generate an additional read key for the channel.
- Note: Use this field to enter information about channel read keys. For example, add notes to keep track of users with access to your channel.

API Requests

Write a Channel Feed
GET https://api.thingspeak.com/update?api_key=Q0U2EQ2GNOYVVKHX&field1=0

Read a Channel Feed
GET https://api.thingspeak.com/channels/2892196/feeds.json?api_key=WE2BEW

Read a Channel Field
GET https://api.thingspeak.com/channels/2892196/fields/1.json?api_key=WE2BE

Read Channel Status Updates
GET https://api.thingspeak.com/channels/2892196/status.json?api_key=WE2BE

EXPLORER OPEN EDITOR... 1 unsaved

virtual_sensor_http.py

```

1 import requests
2 import random
3 import time
4
5 write_api_key = "Q0U2EQ2GNOYVVKHX"
6 channel_url = "https://api.thingspeak.com/update"
7
8 while True:
9     temperature = round(random.uniform(-50, 50), 2)
10    humidity = round(random.uniform(0, 100), 2)
11    co2 = round(random.uniform(300, 2000), 2)
12
13    response = requests.post(channel_url, params={
14        'api_key': write_api_key,
15        'field1': temperature,
16        'field2': humidity,
17        'field3': co2
18    })
19
20    print("Posted:", temperature, humidity, co2, "| Response:", response.text)
21    time.sleep(30)
22

```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

/Users/saichakradharkola/anaconda3/bin/python "/Users/saichakradharkola/Desktop/IOT/Assignment 3/virtual_sensor_http.py"
(base) saichakradharkola-MacBook-Air:Assignment 3 % /Users/saichakradharkola/anaconda3/bin/python "/Users/saichakradharkola/Desktop/IOT/Assignment 3/virtual_sensor_http.py"
Posted: 46.0 99.1 434.82 | Response: 1

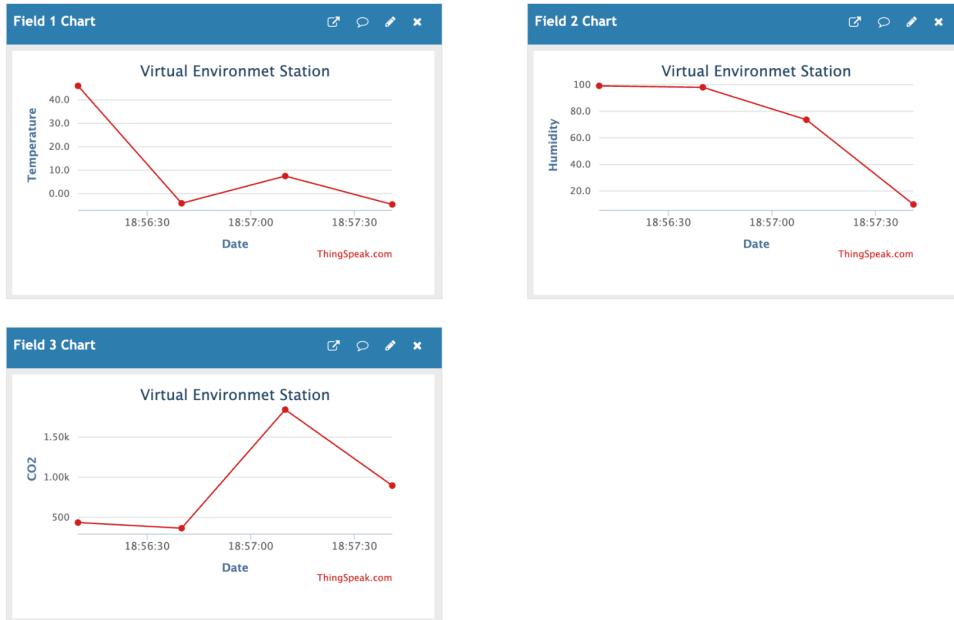
Ln 5, Col 36 Spaces: 4 UTF-8 ↴ Python 3.11.4 ('base': conda) ⌂ ⌂

OUTLINE TIMELINE ⌂ ⌂ 0 △ 0



Channel Stats

Created: [16 minutes ago](#)
Last entry: [less than a minute ago](#)
Entries: 4



Watch

Virtual Environment Station

Channel ID: 2892196
Author: [mwa0000036850203](#)
Access: Public

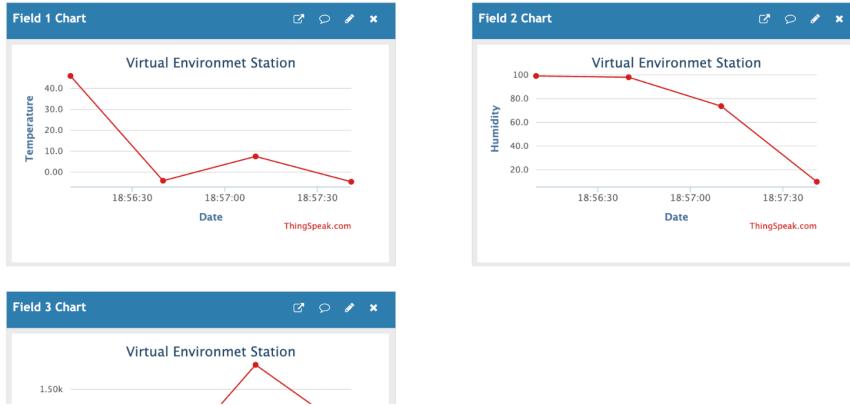
[Private View](#) [Public View](#) [Channel Settings](#) [Sharing](#) [API Keys](#) [Data Import / Export](#)

[+ Add Visualizations](#) [+ Add Widgets](#) [Export recent data](#) [GitHub](#)

[MATLAB Analysis](#) [MATLAB Visualization](#)

Channel Stats

Created: [16 minutes ago](#)
Last entry: [less than a minute ago](#)
Entries: 4



api.thingspeak.com/channels/2892196/feeds.json?api_key=YOUR_READ_API_KEY&hours=5

```
{"channel":{"id":2892196,"name":"Virtual Environment Station","latitude":"0.0","longitude":"0.0","field1":"Temperature","field2":"Humidity","field3":"CO2","created_at":"2025-03-25T22:58:03Z","last_entry_id":7,"feeds":[{"created_at":"2025-03-25T22:56:10Z","entry_id":1,"field1":"46.0","field2":"99.1","field3":"434.82"}, {"created_at":"2025-03-25T22:56:40Z","entry_id":2,"field1":"-4.07","field2":"98.0","field3":"364.37"}, {"created_at":"2025-03-25T22:57:10Z","entry_id":3,"field1":"-7.54","field2":"73.63","field3":"1844.24"}, {"created_at":"2025-03-25T22:57:41Z","entry_id":4,"field1":"-4.56","field2":"99.93","field3":"896.09"}, {"created_at":"2025-03-25T22:58:11Z","entry_id":5,"field1":"-9.41","field2":"11.76","field3":"1436.26"}, {"created_at":"2025-03-25T22:58:41Z","entry_id":6,"field1":"-43.74","field2":"29.53","field3":"814.73"}, {"created_at":"2025-03-25T22:59:11Z","entry_id":7,"field1":"20.97","field2":"37.7","field3":"940.98"}]}
```

api.thingspeak.com/channels/2892196/feeds/last.json

```
{"created_at":"2025-03-25T23:00:11Z","entry_id":9,"field1":"-23.15","field2":"25.65","field3":"1478.85"}
```

Private View Public View Channel Settings Sharing API Keys Data Import / Export

Add Visualizations Add Widgets Export recent data GitHub MATLAB Analysis MATLAB Visualization

Channel Stats

Created: 18 minutes ago
Last entry: Less than a minute ago
Entries: 9

Field 1 Chart
Virtual Environment Station
Temperature vs Date
Field 2 Chart
Virtual Environment Station
Humidity vs Date
Field 3 Chart
Virtual Environment Station
CO2 vs Date

EXPLORER OPEN EDITOR... 1 unsaved Welcome virtual_sensor_http.py

```
1 import requests
2 import random
3 import time
4
5 write_api_key = "08U2E02GN0YVVKHXR"
6 channel_url = "https://api.thingspeak.com/update"
7
8 while True:
9     temperature = round(random.uniform(-50, 50), 2)
10    humidity = round(random.uniform(0, 100), 2)
11    co2 = round(random.uniform(0, 2000), 2)
12
13    response = requests.post(channel_url, params={
14        'api_key': write_api_key,
15        'field1': temperature,
16        'field2': humidity,
17        'field3': co2
18    })
19
20    print("Posted:", temperature, humidity, co2, "| Response:", response.text)
21    time.sleep(30)
22
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

```
(base) saichakradharkola@Sais-MacBook-Air:~/Desktop/IOT/Assignment 3% /Users/saichakradharkola/anaconda3/bin/python "/Users/saichakradharkola/Desktop/IOT/Assignment 3/virtual_sensor_http.py"
Posted: 46.0 99.1 434.82 | Response: 1
Posted: 4.07 98.0 364.37 | Response: 2
Posted: 7.54 73.63 1844.24 | Response: 3
Posted: -4.56 99.93 896.09 | Response: 4
Posted: -9.41 11.76 1436.26 | Response: 5
Posted: -43.74 29.53 814.73 | Response: 6
Posted: 20.97 37.7 1478.85 | Response: 7
Posted: -23.15 25.65 1478.85 | Response: 8
Posted: -23.15 25.65 1478.85 | Response: 9
```

api.thingspeak.com/channels/2892196/fields/3.json?api_key=YOUR_READ_API_KEY&hours=5

```
{"channel":{"id":2892196,"name":"Virtual Environment Station","latitude":"0.0","longitude":"0.0","fields":[{"field1":"Temperature","field2":"Humidity","field3":"CO2","created_at":"2025-03-25T22:42:22Z","updated_at":"2025-03-25T22:58:03Z","last_entry_id":10,"feeds":[{"created_at":"2025-03-25T22:56:10Z","entry_id":1,"field3":"434.82"}, {"created_at":"2025-03-25T22:56:40Z","entry_id":2,"field3":"364.37"}, {"created_at":"2025-03-25T22:57:10Z","entry_id":3,"field3":"1844.24"}, {"created_at":"2025-03-25T22:57:41Z","entry_id":4,"field3":"896.09"}, {"created_at":"2025-03-25T22:58:11Z","entry_id":5,"field3":"1436.26"}, {"created_at":"2025-03-25T22:58:41Z","entry_id":6,"field3":"814.73"}, {"created_at":"2025-03-25T22:59:11Z","entry_id":7,"field3":"940.98"}, {"created_at":"2025-03-25T22:59:41Z","entry_id":8,"field3":"1708.78"}, {"created_at":"2025-03-25T23:00:11Z","entry_id":9,"field3":"1478.85"}, {"created_at":"2025-03-25T23:00:41Z","entry_id":10,"field3":"1155.97"}]}
```

virtual_sensor_http.py

```
virtual_sensor_http.py
1 import requests
2 import random
3 import time
4
5 write_api_key = "00UEQGNQYVVKH"
6 channel_url = "https://api.thingspeak.com/update"
7
8 while True:
9     temperature = round(random.uniform(-50, 50), 2)
10    humidity = round(random.uniform(0, 100), 2)
11    co2 = round(random.uniform(0, 2000), 2)
12
13    response = requests.post(channel_url, params={
14        'api_key': write_api_key,
15        'field1': temperature,
16        'field2': humidity,
17        'field3': co2
18    })
19
20    print("Posted:", temperature, humidity, co2, "| Response:", response.text)
21    time.sleep(30)
22
```

PROBLEMS **OUTPUT** **DEBUG CONSOLE** **TERMINAL**

```
(base) saichakradharkola@Saic-MacBook-Air:~/Desktop/IOT/Assignment 3/virtual_sensor_http.py
Posted: 46.48 98.44 154.41 | Response: 1
Posted: -28.07 98.0 154.37 | Response: 2
Posted: 7.54 73.63 1844.24 | Response: 3
Posted: 15.56 9.93 164.69 | Response: 4
Posted: 0.41 98.0 1426.56 | Response: 5
Posted: -43.74 29.53 814.73 | Response: 6
Posted: 28.97 37.7 948.98 | Response: 7
Posted: -23.15 25.65 1478.85 | Response: 8
Posted: -23.15 25.65 1478.85 | Response: 9
Posted: 15.56 50.89 1155.97 | Response: 10
Posted: -23.15 25.65 1478.85 | Response: 11
Posted: 22.57 61.36 1112.17 | Response: 12
Posted: 22.12 56.84 1112.42 | Response: 13
Posted: -5.32 96.37 1617.24 | Response: 14
Posted: 28.78 8.27 1565.88 | Response: 15
Posted: 28.78 8.27 1565.88 | Response: 16
Posted: -41.96 67.13 1196.17 | Response: 17
Posted: -34.03 48.79 1443.54 | Response: 18
Posted: -24.09 3.47 323.34 | Response: 19
Posted: -24.09 3.47 323.34 | Response: 20
```

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Channel Stats

Created: 23 minutes ago
Last entry: less than a minute ago
Entries: 20

Field 1 Chart **Field 2 Chart** **Field 3 Chart**

Virtual Environment Station

Temperature

Virtual Environment Station

Humidity

Virtual Environment Station

CO2

ThingSpeak™

Commercial Use How to Buy

Private View Public View Channel Settings Sharing API Keys Data Import / Export

Add Visualizations Add Widgets Export recent data GitHub

MATLAB Analysis MATLAB Visualization

Channel 2 of 2 < >

Channel Stats

Created: 24 minutes ago
Last entry: less than a minute ago
Entries: 20

Field 1 Chart Virtual Environment Station

Field 2 Chart Virtual Environment Station

Field 3 Chart Virtual Environment Station

EXPLORER

OPEN EDITOR... 1 Unsaved

Welcome

virtual_sensor_http.py

```

1 import requests
2 import random
3 import time
4
5 write_api_key = "08U2EO2GNOYVVKHX"
6 channel_url = "https://api.thingspeak.com/update"
7
8 while True:
9     temperature = round(random.uniform(-50, 50), 2)
10    humidity = round(random.uniform(0, 100), 2)
11    co2 = round(random.uniform(300, 2000), 2)
12
13    response = requests.post(channel_url, params={
14        'api_key': write_api_key,
15        'field1': temperature,
16        'field2': humidity,
17        'field3': co2
18    })
19
20    print("Posted: ", temperature, humidity, co2, "| Response:", response.text)
21    time.sleep(30)
22

```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

```

Posted: 9.41 11.76 1436.26 | Response: 5
Posted: -43.74 29.53 814.73 | Response: 6
Posted: 28.97 37.7 948.98 | Response: 7
Posted: -23.15 29.78 1000.08 | Response: 8
Posted: -23.15 25.65 1478.85 | Response: 9
Posted: 15.56 58.89 1155.97 | Response: 10
Posted: 26.57 61.59 1468.17 | Response: 11
Posted: 26.57 61.59 1468.17 | Response: 12
Posted: 22.12 56.84 1112.42 | Response: 13
Posted: 22.12 56.84 1112.42 | Response: 13
Posted: 34.97 37.37 1617.24 | Response: 14
Posted: 34.97 37.37 1617.24 | Response: 15
Posted: 28.78 8.27 1565.88 | Response: 16
Posted: -41.96 67.13 1196.17 | Response: 17
Posted: -41.96 67.13 1196.17 | Response: 17
Posted: -34.03 48.79 1443.54 | Response: 19
Posted: -24.09 3.47 323.34 | Response: 20
Posted: -24.09 3.47 323.34 | Response: 20
Posted: -27.15 18.64 702.17 | Response: 21
Posted: -48.74 26.84 1854.54 | Response: 23
Posted: -19.52 1.92 1762.78 | Response: 24
Posted: -19.52 68.45 1762.78 | Response: 25
Posted: -28.23 17.34 1788.04 | Response: 26
Posted: 18.58 38.09 1993.12 | Response: 27
Posted: 18.58 38.09 1993.12 | Response: 27
Posted: -42.87 32.77 895.69 | Response: 29
Posted: 48.62 49.17 1379.46 | Response: 30
Posted: 48.62 49.17 1379.46 | Response: 31
Posted: 0.57 72.28 453.5 | Response: 32
Posted: -22.48 14.59 1931.68 | Response: 33
Posted: -1.08 76.59 1986.77 | Response: 34

```

OUTLINE TIMELINE

```

< > C   api.thingsspeak.com/channels/2892196/feeds.json?api_key=YOUR_READ_API_KEY&hours=5
Pretty-print □
{
  "channel": {
    "id": "2892196",
    "name": "Virtual Environment Station",
    "latitude": "0.0",
    "longitude": "0.0",
    "field1": "Temperature",
    "field2": "Humidity",
    "field3": "CO2",
    "created_at": "2025-03-25T22:42:22Z",
    "updated_at": "2025-03-25T22:56:03Z",
    "last_entry_id": 34,
    "feeds": [
      {
        "created_at": "2025-03-25T22:56:10Z",
        "entry_id": 1,
        "field1": "-4.67",
        "field2": "98.0",
        "field3": "364.37"
      },
      {
        "created_at": "2025-03-25T22:57:10Z",
        "entry_id": 2,
        "field1": "-7.54",
        "field2": "73.63",
        "field3": "1044.24"
      },
      {
        "created_at": "2025-03-25T22:57:41Z",
        "entry_id": 3,
        "field1": "-4.56",
        "field2": "9.93",
        "field3": "896.09"
      },
      {
        "created_at": "2025-03-25T22:58:11Z",
        "entry_id": 4,
        "field1": "9.41",
        "field2": "11.76",
        "field3": "1436.26"
      },
      {
        "created_at": "2025-03-25T22:58:41Z",
        "entry_id": 5,
        "field1": "-43.74",
        "field2": "29.53",
        "field3": "814.73"
      },
      {
        "created_at": "2025-03-25T22:59:11Z",
        "entry_id": 6,
        "field1": "28.97",
        "field2": "37.71",
        "field3": "940.98"
      },
      {
        "created_at": "2025-03-25T22:59:41Z",
        "entry_id": 8,
        "field1": "28.99",
        "field2": "42.44",
        "field3": "1708.78"
      },
      {
        "created_at": "2025-03-25T23:00:11Z",
        "entry_id": 9,
        "field1": "-23.15",
        "field2": "25.65",
        "field3": "1478.85"
      },
      {
        "created_at": "2025-03-25T23:00:41Z",
        "entry_id": 10,
        "field1": "15.56",
        "field2": "50.89",
        "field3": "1155.97"
      },
      {
        "created_at": "2025-03-25T23:01:11Z",
        "entry_id": 11,
        "field1": "-12.24",
        "field2": "35.16",
        "field3": "414.18"
      },
      {
        "created_at": "2025-03-25T23:01:42Z",
        "entry_id": 12,
        "field1": "26.57",
        "field2": "61.59",
        "field3": "1488.17"
      },
      {
        "created_at": "2025-03-25T23:02:12Z",
        "entry_id": 13,
        "field1": "22.12",
        "field2": "58.84",
        "field3": "1112.42"
      },
      {
        "created_at": "2025-03-25T23:02:42Z",
        "entry_id": 14,
        "field1": "-5.32",
        "field2": "96.37",
        "field3": "1617.24"
      },
      {
        "created_at": "2025-03-25T23:03:12Z",
        "entry_id": 15,
        "field1": "34.97",
        "field2": "13.84",
        "field3": "1209.95"
      },
      {
        "created_at": "2025-03-25T23:03:42Z",
        "entry_id": 16,
        "field1": "20.78",
        "field2": "8.27",
        "field3": "1565.08"
      },
      {
        "created_at": "2025-03-25T23:04:12Z",
        "entry_id": 17,
        "field1": "-41.96",
        "field2": "67.13",
        "field3": "1196.17"
      },
      {
        "created_at": "2025-03-25T23:04:43Z",
        "entry_id": 18,
        "field1": "37.42",
        "field2": "68.1",
        "field3": "834.9"
      },
      {
        "created_at": "2025-03-25T23:05:13Z",
        "entry_id": 19,
        "field1": "-34.03",
        "field2": "48.79",
        "field3": "1443.54"
      },
      {
        "created_at": "2025-03-25T23:05:43Z",
        "entry_id": 20,
        "field1": "-24.09",
        "field2": "3.47",
        "field3": "323.34"
      },
      {
        "created_at": "2025-03-25T23:06:13Z",
        "entry_id": 21,
        "field1": "45.38",
        "field2": "88.82",
        "field3": "386.23"
      },
      {
        "created_at": "2025-03-25T23:06:43Z",
        "entry_id": 22,
        "field1": "-27.15",
        "field2": "18.64",
        "field3": "702.17"
      },
      {
        "created_at": "2025-03-25T23:07:13Z",
        "entry_id": 23,
        "field1": "-40.74",
        "field2": "26.84",
        "field3": "1854.54"
      },
      {
        "created_at": "2025-03-25T23:07:43Z",
        "entry_id": 24,
        "field1": "-19.54",
        "field2": "15.92",
        "field3": "1762.78"
      },
      {
        "created_at": "2025-03-25T23:08:14Z",
        "entry_id": 25,
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        "field2": "68.12",
        "field3": "1439.94"
      },
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        "created_at": "2025-03-25T23:08:44Z",
        "entry_id": 26,
        "field1": "-28.23",
        "field2": "17.34",
        "field3": "1788.04"
      },
      {
        "created_at": "2025-03-25T23:09:14Z",
        "entry_id": 27,
        "field1": "18.58",
        "field2": "38.09",
        "field3": "1993.12"
      },
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        "entry_id": 28,
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        "field2": "17.81",
        "field3": "1394.44"
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      {
        "created_at": "2025-03-25T23:10:14Z",
        "entry_id": 29,
        "field1": "-42.87",
        "field2": "32.77",
        "field3": "895.69"
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        "entry_id": 30,
        "field1": "48.62",
        "field2": "49.17",
        "field3": "1379.46"
      },
      {
        "created_at": "2025-03-25T23:11:15Z",
        "entry_id": 31,
        "field1": "15.0",
        "field2": "67.46",
        "field3": "973.53"
      },
      {
        "created_at": "2025-03-25T23:11:45Z",
        "entry_id": 32,
        "field1": "0.52",
        "field2": "72.85",
        "field3": "453.5"
      },
      {
        "created_at": "2025-03-25T23:12:15Z",
        "entry_id": 33,
        "field1": "-22.48",
        "field2": "14.59",
        "field3": "1931.68"
      },
      {
        "created_at": "2025-03-25T23:12:45Z",
        "entry_id": 34,
        "field1": "-1.08",
        "field2": "76.59",
        "field3": "1906.77"
      }
    ]
  }
}

```

```

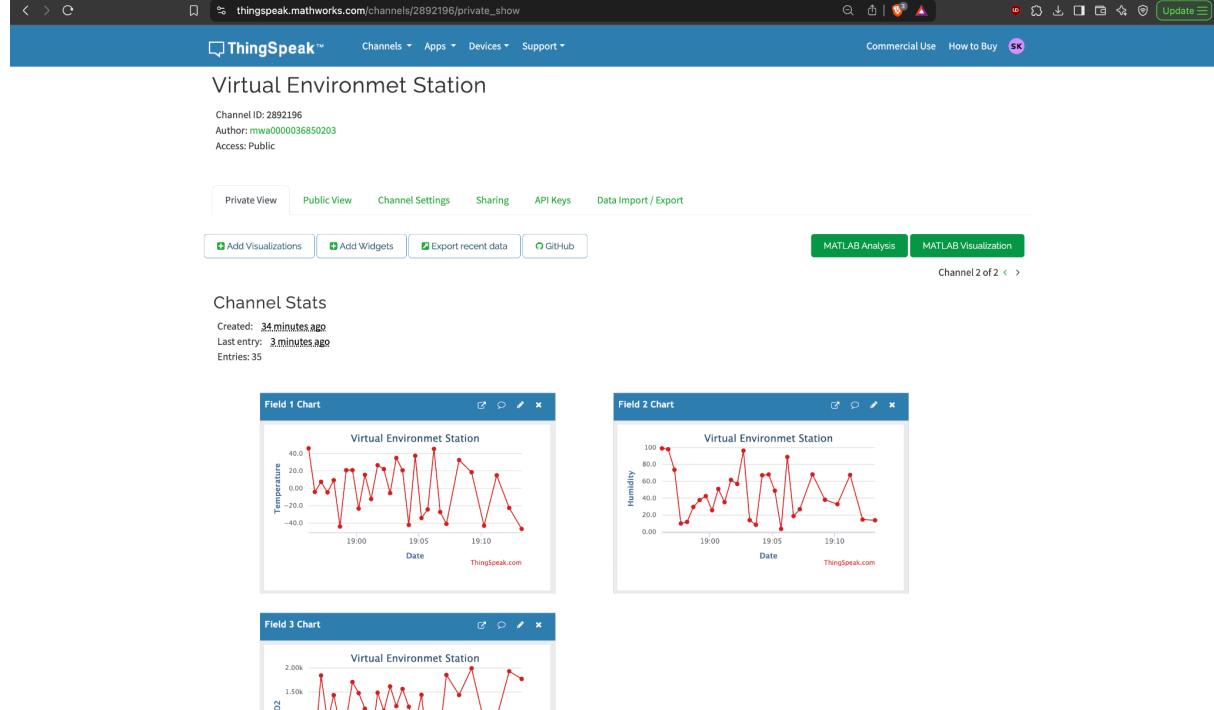
< > C   api.thingsspeak.com/channels/2892196/fields/3.json?api_key=YOUR_READ_API_KEY&hours=5
Pretty-print □
{
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    "name": "Virtual Environment Station",
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    "longitude": "0.0",
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    "field2": "Humidity",
    "field3": "CO2",
    "created_at": "2025-03-25T22:42:22Z",
    "updated_at": "2025-03-25T22:56:03Z",
    "last_entry_id": 35,
    "feeds": [
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        "created_at": "2025-03-25T22:56:10Z",
        "entry_id": 1,
        "field3": "434.82"
      },
      {
        "created_at": "2025-03-25T22:57:10Z",
        "entry_id": 2,
        "field3": "364.37"
      },
      {
        "created_at": "2025-03-25T22:58:11Z",
        "entry_id": 3,
        "field3": "1844.24"
      },
      {
        "created_at": "2025-03-25T22:59:11Z",
        "entry_id": 4,
        "field3": "896.09"
      },
      {
        "created_at": "2025-03-25T22:59:41Z",
        "entry_id": 5,
        "field3": "1436.26"
      },
      {
        "created_at": "2025-03-25T23:00:11Z",
        "entry_id": 6,
        "field3": "9.93"
      },
      {
        "created_at": "2025-03-25T23:00:41Z",
        "entry_id": 7,
        "field3": "940.98"
      },
      {
        "created_at": "2025-03-25T23:01:11Z",
        "entry_id": 8,
        "field3": "1708.78"
      },
      {
        "created_at": "2025-03-25T23:01:42Z",
        "entry_id": 9,
        "field3": "1478.85"
      },
      {
        "created_at": "2025-03-25T23:02:12Z",
        "entry_id": 10,
        "field3": "1155.97"
      },
      {
        "created_at": "2025-03-25T23:02:42Z",
        "entry_id": 11,
        "field3": "414.18"
      },
      {
        "created_at": "2025-03-25T23:03:12Z",
        "entry_id": 12,
        "field3": "1488.17"
      },
      {
        "created_at": "2025-03-25T23:03:42Z",
        "entry_id": 13,
        "field3": "1112.42"
      },
      {
        "created_at": "2025-03-25T23:04:12Z",
        "entry_id": 14,
        "field3": "1209.95"
      },
      {
        "created_at": "2025-03-25T23:04:43Z",
        "entry_id": 15,
        "field3": "1196.17"
      },
      {
        "created_at": "2025-03-25T23:05:13Z",
        "entry_id": 16,
        "field3": "1443.54"
      },
      {
        "created_at": "2025-03-25T23:05:43Z",
        "entry_id": 17,
        "field3": "323.34"
      },
      {
        "created_at": "2025-03-25T23:06:13Z",
        "entry_id": 18,
        "field3": "386.23"
      },
      {
        "created_at": "2025-03-25T23:06:43Z",
        "entry_id": 19,
        "field3": "702.17"
      },
      {
        "created_at": "2025-03-25T23:07:13Z",
        "entry_id": 20,
        "field3": "1854.54"
      },
      {
        "created_at": "2025-03-25T23:07:43Z",
        "entry_id": 21,
        "field3": "1617.24"
      },
      {
        "created_at": "2025-03-25T23:08:14Z",
        "entry_id": 22,
        "field3": "1439.94"
      },
      {
        "created_at": "2025-03-25T23:08:44Z",
        "entry_id": 23,
        "field3": "1762.78"
      },
      {
        "created_at": "2025-03-25T23:09:14Z",
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      },
      {
        "created_at": "2025-03-25T23:09:44Z",
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      },
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      },
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      {
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        "entry_id": 29,
        "field3": "453.5"
      },
      {
        "created_at": "2025-03-25T23:12:15Z",
        "entry_id": 30,
        "field3": "1931.68"
      },
      {
        "created_at": "2025-03-25T23:12:45Z",
        "entry_id": 31,
        "field3": "1906.77"
      }
    ]
  }
}

```

```

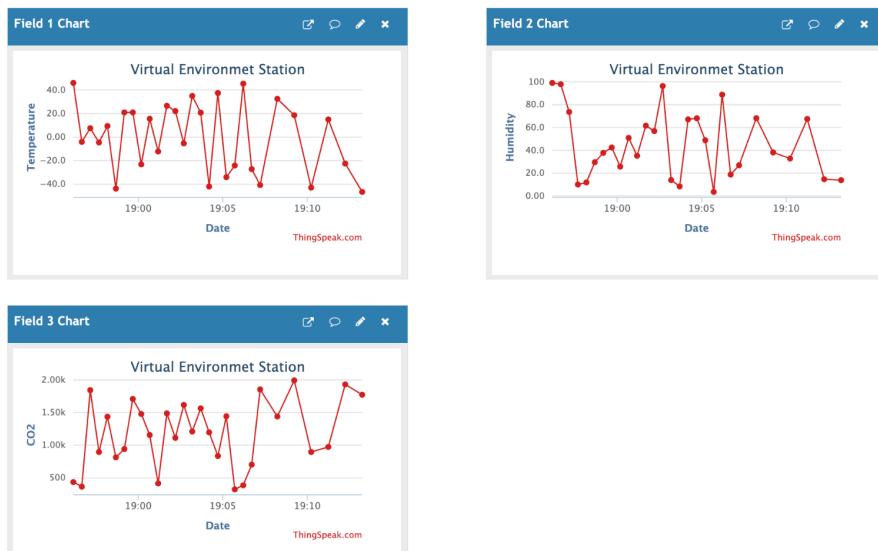
< > C   thingspeak.mathworks.com/channels/2892196/private_show
Pretty-print □
{
  "channel": {
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    "name": "Virtual Environment Station",
    "latitude": "0.0",
    "longitude": "0.0",
    "field1": "Temperature",
    "field2": "Humidity",
    "field3": "CO2",
    "created_at": "2025-03-25T22:42:22Z",
    "updated_at": "2025-03-25T22:56:03Z",
    "last_entry_id": 35,
    "feeds": [
      {
        "created_at": "2025-03-25T22:56:10Z",
        "entry_id": 1,
        "field3": "434.82"
      },
      {
        "created_at": "2025-03-25T22:57:10Z",
        "entry_id": 2,
        "field3": "364.37"
      },
      {
        "created_at": "2025-03-25T22:58:11Z",
        "entry_id": 3,
        "field3": "1844.24"
      },
      {
        "created_at": "2025-03-25T22:59:11Z",
        "entry_id": 4,
        "field3": "896.09"
      },
      {
        "created_at": "2025-03-25T22:59:41Z",
        "entry_id": 5,
        "field3": "1436.26"
      },
      {
        "created_at": "2025-03-25T23:00:11Z",
        "entry_id": 6,
        "field3": "9.93"
      },
      {
        "created_at": "2025-03-25T23:00:41Z",
        "entry_id": 7,
        "field3": "940.98"
      },
      {
        "created_at": "2025-03-25T23:01:11Z",
        "entry_id": 8,
        "field3": "1708.78"
      },
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        "entry_id": 9,
        "field3": "1478.85"
      },
      {
        "created_at": "2025-03-25T23:02:12Z",
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      },
      {
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        "field3": "414.18"
      },
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      {
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      },
      {
        "created_at": "2025-03-25T23:04:12Z",
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        "field3": "1209.95"
      },
      {
        "created_at": "2025-03-25T23:04:43Z",
        "entry_id": 15,
        "field3": "1196.17"
      },
      {
        "created_at": "2025-03-25T23:05:13Z",
        "entry_id": 16,
        "field3": "1443.54"
      },
      {
        "created_at": "2025-03-25T23:05:43Z",
        "entry_id": 17,
        "field3": "323.34"
      },
      {
        "created_at": "2025-03-25T23:06:13Z",
        "entry_id": 18,
        "field3": "386.23"
      },
      {
        "created_at": "2025-03-25T23:06:43Z",
        "entry_id": 19,
        "field3": "702.17"
      },
      {
        "created_at": "2025-03-25T23:07:13Z",
        "entry_id": 20,
        "field3": "1854.54"
      },
      {
        "created_at": "2025-03-25T23:07:43Z",
        "entry_id": 21,
        "field3": "1617.24"
      },
      {
        "created_at": "2025-03-25T23:08:14Z",
        "entry_id": 22,
        "field3": "1439.94"
      },
      {
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      },
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        "entry_id": 25,
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        "field3": "895.69"
      },
      {
        "created_at": "2025-03-25T23:11:15Z",
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      },
      {
        "created_at": "2025-03-25T23:11:45Z",
        "entry_id": 29,
        "field3": "453.5"
      },
      {
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        "entry_id": 30,
        "field3": "1931.68"
      },
      {
        "created_at": "2025-03-25T23:12:45Z",
        "entry_id": 31,
        "field3": "1906.77"
      }
    ]
  }
}

```



Channel Stats

Created: 34 minutes ago
Last entry: 3 minutes ago
Entries: 35



thingspeak.mathworks.com/channels/2892196

ThingSpeak™

Commercial Use How to Buy

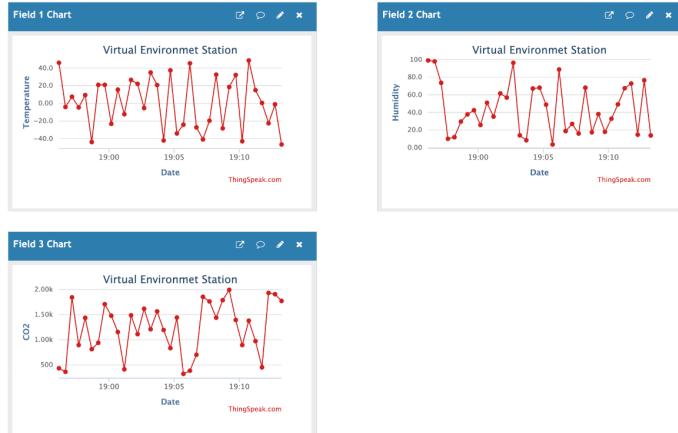
Private View Public View Channel Settings Sharing API Keys Data Import / Export

Add Visualizations Add Widgets Export recent data GitHub

MATLAB Analysis MATLAB Visualization

Channel Stats

Created: 34 minutes ago
Last entry: 3 minutes ago
Entries: 35



```
saichakradharkola -- zsh -- 167x47
Last login: Tue Mar 25 18:48:12 on ttys000
(base) saichakradharkola@Sais-MacBook-Air ~ % pip install paho-mqtt
Collecting paho-mqtt
  Obtaining dependency information for paho-mqtt from https://files.pythonhosted.org/packages/c4/cb/00451c3cf31790287768bb12c6bec834f5d292eaf3022afc88e14b8afc94/paho_mqtt-2.1.0-py3-none-any.whl.metadata
    Downloading paho_mqtt-2.1.0-py3-none-any.whl.metadata (23 kB)
    Downloading paho_mqtt-2.1.0-py3-none-any.whl (67 kB)
       67.2/67.2 kB 3.5 MB/s eta 0:00:00
Installing collected packages: paho-mqtt
Successfully installed paho-mqtt-2.1.0
(base) saichakradharkola@Sais-MacBook-Air ~ % ping mqtt.thingSpeak.com
ping: cannot resolve mqtt.thingSpeak.com: Unknown host
(base) saichakradharkola@Sais-MacBook-Air ~ %
```

GitHub URL - [IOT Assignment 3](#)

Reflection -

This Assignment afforded a valuable hands-on experience in understanding the operation of cloud-based IoT systems. I initially aimed to use the MQTT protocol for publishing data to ThingSpeak but encountered DNS resolution issues preventing successful connection to the MQTT broker. After investigating the issue through testing and checking the network and local DNS configurations, I reasoned the issue would be the network limitations or local DNS setup issues. To continue with an effective approach, I decided to use ThingSpeak's HTTP API instead. Using this alternative meant I was able to simulate real-time sensor data streaming with Python and, in the process, simplified the procedure and ensured reliable connectivity.

The Assignment promoted the acquisition of practical skills in virtual sensor simulating, data transfer to a cloud backend, and access and visualization of the data. I enjoyed in particular seeing the live updates on the graph on ThingSpeak, adding to the realness in the project. I also gained the ability to access historical sensor data through ThingSpeak's REST API, a skill that will be valuable in carrying out time-series analysis. In short, the assignment gave me a solid foundation in IoT development and illustrated the ability to develop flexible, cloud-based systems with both ease and scalability.