
CIS 600

Internet Of Things : Application Development

Spring 2025

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Assignment - 3

Cloud-based IoT System

1. Brief Explanation :

To develop the cloud based IoT system :

- ➔ I first set up a new ThingSpeak channel with the name “Environmental Station” with three fields to store sensor data for the temperature, humidity and CO2.
- ➔ I then added a new MQTT Device in ThingSpeak named “VirtualStation1” which gave me the credentials generated which include Client ID, Username and Password. And using the built-in MQTT device manager in ThingSpeak, I linked the MQTT device to the channel for seamless MQTT communication.
- ➔ Then for the simulation of sensor data, I wrote a python script named “mqtt_thingspeak_publisher.py” which generates random virtual sensor data where the temperature ranges from -50 to 50 Celsius, humidity ranges from 0 to 100%, and CO2 levels ranges from 300 ppm to 2000 ppm. This python script publishes sensor data every 15 seconds using paho-mqtt library and also saves the sensor data locally in an auto generated “sensor_log.txt” file with timestamps.
- ➔ After running this python script, I was able to monitor real time data transmission through the live graphs of all three fields in the ThingSpeak channel dashboard’s private view.
- ➔ Then for the last five hour data, I wrote another python script named “last_5_hour_data.py” to extract and display the sensor data captured in the last 5 hours. This was done by parsing the locally saved “sensor_log.txt” file based on timestamps and specified filtering of fields (Temperature, Humidity, CO2) as needed.
- ➔ Throughout this process, I captured screenshots wherever needed at each important step to document the cloud-based IoT system’s development and successful execution.

2. Screenshots :

Channel Details :

The screenshot shows the 'Environmental Station' channel page on ThingSpeak. The channel ID is 2894215, the author is mwaa000036853410, and the access is private. The page includes tabs for Private View, Public View, Channel Settings, Sharing, API Keys, and Data Import / Export. There are buttons for Add Visualizations, Add Widgets, Export recent data, MATLAB Analysis, and MATLAB Visualization. The Channel Stats section indicates the channel was created about 3 hours ago and has 0 entries. Below the stats are three empty chart templates: Field 1 Chart (Temperature), Field 2 Chart (Humidity), and Field 3 Chart (CO2).

MQTT device details with credentials (Client ID, Username) :

The screenshot shows the 'Edit VirtualStation1' page on ThingSpeak. The page is divided into two main sections: Device Information and MQTT Credentials. The Device Information section includes fields for Name (VirtualStation1) and Description. The MQTT Credentials section includes fields for Client ID, Username, and Password, all containing the same alphanumeric string. Below the credentials is a section for 'Authorize channels to access' which includes a dropdown menu to select a channel, an 'Add Channel' button, and a table of authorized channels. The table has columns for 'Authorized Channel', 'Allow Publish', and 'Allow Subscribe'. The 'Environmental Station (2894215)' is listed as an authorized channel with both 'Allow Publish' and 'Allow Subscribe' checked. There are 'Save' and 'Cancel' buttons at the bottom.

Authorized Channel	Allow Publish	Allow Subscribe
Environmental Station (2894215)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

ThingSpeak dashboard graphs and channel status with real-time sensor updates :

ThingSpeak™ Channels Apps Devices Support Commercial Use How to Buy SP

Environmental Station

Channel ID: 2894215
Author: mwa0000036853410
Access: Private

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

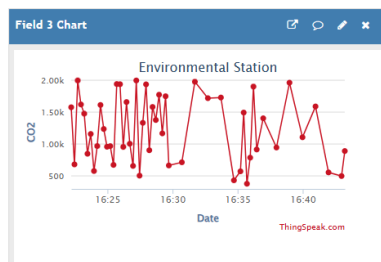
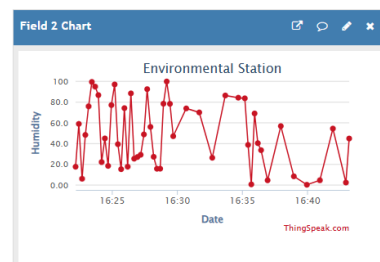
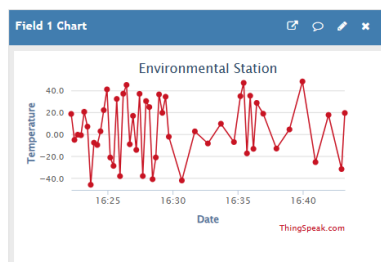
Add Visualizations Add Widgets Export recent data

MATLAB Analysis MATLAB Visualization

Channel 4 of 4 < >

Channel Stats

Created: about 3 hours ago
Last entry: less than a minute ago
Entries: 85



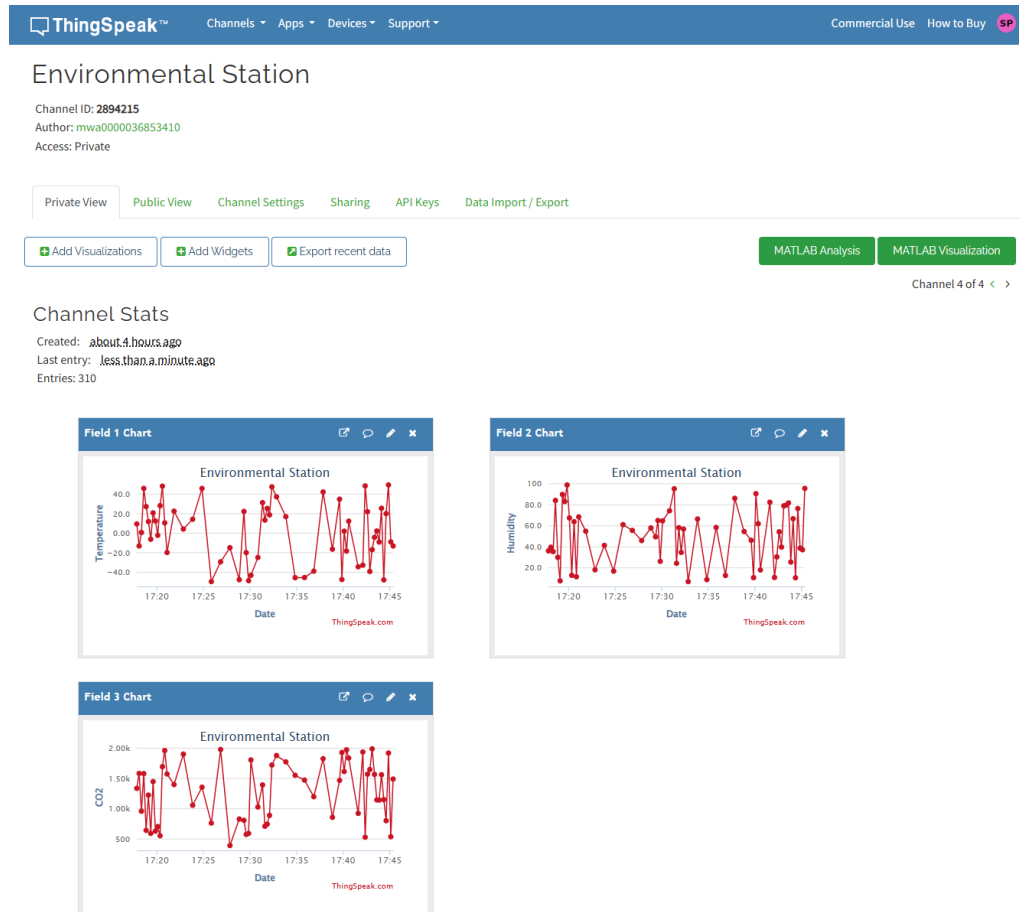
```
C:\Users\krish\Desktop\Spring 2025\IOT\Week10>python mqtt_thingspeak_publisher.py
C:\Users\krish\Desktop\Spring 2025\IOT\Week10>mqtt_thingspeak_publisher.py:46: DeprecationWarning: Callback API version 1 is deprecated, update to latest version
client = mqtt.Client(client_id=client_id, protocol=mqtt.MQTTv311)
Publishing sensor data to ThingSpeak...
Sent: field1=18.84&field2=17.74&field3=1577
Sent: field1=-4.86&field2=59.05&field3=680
Sent: field1=-0.17&field2=6.17&field3=1998
Sent: field1=-0.62&field2=-40.43&field3=1621
Sent: field1=-20.78&field2=-75.08&field3=1477
Sent: field1=-7.25&field2=99.52&field3=847
Sent: field1=-45.87&field2=94.99&field3=1158
Sent: field1=-7.44&field2=86.79&field3=576
Sent: field1=-9.58&field2=22.23&field3=968
Sent: field1=2.98&field2=45.06&field3=1613
Sent: field1=22.3&field2=18.55&field3=1236
Sent: field1=41.26&field2=77.17&field3=957
Sent: field1=-21.0&field2=97.08&field3=967
Sent: field1=-28.65&field2=39.48&field3=672
Sent: field1=32.53&field2=15.38&field3=1942
Sent: field1=-38.01&field2=74.24&field3=1939
Sent: field1=37.31&field2=17.81&field3=955
Sent: field1=45.33&field2=68.47&field3=1659
Sent: field1=-8.89&field2=25.51&field3=1004
Sent: field1=17.09&field2=27.09&field3=656
Sent: field1=-14.04&field2=29.28&field3=1998
Sent: field1=37.19&field2=48.9&field3=503
Sent: field1=-37.93&field2=92.54&field3=1333
Sent: field1=30.59&field2=56.16&field3=1937
Sent: field1=25.08&field2=27.32&field3=902
Sent: field1=-40.81&field2=15.8&field3=1582
Sent: field1=-20.94&field2=15.87&field3=1377
Sent: field1=36.67&field2=78.5&field3=1774
Sent: field1=19.82&field2=99.94&field3=1167
Sent: field1=34.55&field2=78.39&field3=1750
Sent: field1=-2.08&field2=47.10&field3=663
Sent: field1=32.21&field2=14.75&field3=1806
Sent: field1=39.82&field2=76.29&field3=1540
Sent: field1=-45.33&field2=74.52&field3=1631
Sent: field1=-41.95&field2=73.97&field3=713
Sent: field1=34.76&field2=40.98&field3=1459
Sent: field1=24.49&field2=30.88&field3=841
Sent: field1=25.66&field2=33.9&field3=974
Sent: field1=2.9&field2=70.11&field3=1978
Sent: field1=-14.5&field2=27.65&field3=1510
Sent: field1=-22.21&field2=86.91&field3=1703
Sent: field1=23.35&field2=59.42&field3=799
Sent: field1=-8.16&field2=26.38&field3=1720
Sent: field1=-29.79&field2=94.78&field3=762
Sent: field1=-39.41&field2=72.3&field3=1012
```

This is how sensor data is stored locally in “sensor_log.txt” file :

```
sensor_log.txt
File Edit View

2025-03-26 16:55:07,-5.69,40.77,412
2025-03-26 16:55:22,-5.99,27.53,397
2025-03-26 16:55:37,26.24,71.31,1885
2025-03-26 16:55:52,-37.83,7.39,1690
2025-03-26 16:56:07,28.94,78.58,461
2025-03-26 16:56:22,44.2,39.68,635
2025-03-26 16:56:37,-10.37,68.87,697
2025-03-26 16:56:52,49.59,35.91,1085
2025-03-26 16:57:07,39.1,92.59,491
2025-03-26 16:57:22,28.21,50.43,308
2025-03-26 16:57:37,-12.43,12.45,409
2025-03-26 16:57:52,-4.44,60.7,664
2025-03-26 16:58:07,14.23,15.74,1363
2025-03-26 16:58:22,-39.81,29.86,790
2025-03-26 16:58:37,-12.22,55.34,1057
2025-03-26 16:58:52,-39.53,42.45,574
2025-03-26 16:59:07,35.43,50.21,980
2025-03-26 16:59:22,20.7,21.21,1921
2025-03-26 16:59:37,49.26,18.68,906
2025-03-26 16:59:52,-45.94,50.92,497
2025-03-26 17:00:07,46.31,10.8,535
2025-03-26 17:00:22,-43.95,99.0,736
2025-03-26 17:00:37,43.07,12.72,1950
2025-03-26 17:00:52,34.76,18.17,1338
2025-03-26 17:01:07,-41.52,95.74,1988
2025-03-26 17:01:22,27.91,17.5,779
2025-03-26 17:01:37,-12.52,47.05,1735
2025-03-26 17:01:52,-16.92,91.59,1083
2025-03-26 17:02:08,45.52,0.48,697
```

Outputs for last five hour data :



```

C:\Users\krish\Desktop\Spring 2025\IOT\Week10>python mqtt_thingspeak_publisher.py
C:\Users\krish\Desktop\Spring 2025\IOT\Week10\mqtt_thingspeak_publisher.py:46: DeprecationWarning: Callback API version 1 is deprecated, update to latest version
  client = mqtt.Client(client_id=client_id, protocol=mqtt.MQTTv311)
Publishing sensor data to ThingSpeak...
[✓] Sent: field1=-5.69&field2=40.77&field3=412
[✓] Sent: field1=-5.99&field2=27.53&field3=397
[✓] Sent: field1=-26.24&field2=71.31&field3=1885
[✓] Sent: field1=-37.83&field2=7.39&field3=1690
[✓] Sent: field1=-28.94&field2=78.58&field3=461
[✓] Sent: field1=-44.2&field2=39.68&field3=635
[✓] Sent: field1=-10.37&field2=68.87&field3=697
[✓] Sent: field1=49.59&field2=35.91&field3=1085
[✓] Sent: field1=39.1&field2=92.59&field3=491
[✓] Sent: field1=28.21&field2=50.43&field3=308
[✓] Sent: field1=-12.43&field2=12.45&field3=409
[✓] Sent: field1=-4.44&field2=60.78&field3=664
[✓] Sent: field1=14.23&field2=15.74&field3=1363
[✓] Sent: field1=-39.81&field2=29.86&field3=790
[✓] Sent: field1=-12.22&field2=55.34&field3=1057
[✓] Sent: field1=-39.53&field2=42.45&field3=574
[✓] Sent: field1=35.43&field2=50.21&field3=980
[✓] Sent: field1=20.7&field2=21.21&field3=1921
[✓] Sent: field1=49.26&field2=18.68&field3=906
[✓] Sent: field1=-45.94&field2=50.92&field3=497
[✓] Sent: field1=46.31&field2=10.88&field3=535
[✓] Sent: field1=43.95&field2=99.0&field3=736
[✓] Sent: field1=43.07&field2=12.72&field3=1950
[✓] Sent: field1=34.76&field2=18.17&field3=1330
[✓] Sent: field1=41.52&field2=95.74&field3=1988
[✓] Sent: field1=-27.91&field2=17.5&field3=779
[✓] Sent: field1=-12.52&field2=47.05&field3=1735
[✓] Sent: field1=-16.92&field2=91.59&field3=1083
[✓] Sent: field1=45.52&field2=0.48&field3=697
[✓] Sent: field1=42.05&field2=7.8&field3=456
[✓] Sent: field1=29.28&field2=92.14&field3=1283
[✓] Sent: field1=1.41&field2=4.31&field3=1913
[✓] Sent: field1=27.59&field2=58.94&field3=362
[✓] Sent: field1=5.39&field2=10.89&field3=1548
[✓] Sent: field1=-10.84&field2=81.31&field3=398
[✓] Sent: field1=-32.99&field2=71.28&field3=1465
[✓] Sent: field1=35.11&field2=90.54&field3=1834
[✓] Sent: field1=-20.77&field2=97.88&field3=606
[✓] Sent: field1=-13.66&field2=0.06&field3=1593
[✓] Sent: field1=-36.95&field2=83.17&field3=1078
[✓] Sent: field1=-46.7&field2=3.84&field3=493
[✓] Sent: field1=18.69&field2=45.68&field3=1215
[✓] Sent: field1=14.8&field2=81.89&field3=463
[✓] Sent: field1=-31.26&field2=12.99&field3=1441
[✓] Sent: field1=46.98&field2=79.66&field3=1570
[✓] Sent: field1=-37.98&field2=29.9&field3=1154

```

Outputs from last_5_hour_data.py (Temperature) :

```

C:\Users\krish\Desktop\Spring 2025\IOT\Week10>python last_5_hour_data.py
2025-03-26 16:55:07 - Temperature: -5.69
2025-03-26 16:55:22 - Temperature: -5.99
2025-03-26 16:55:37 - Temperature: 26.24
2025-03-26 16:55:52 - Temperature: -37.83
2025-03-26 16:56:07 - Temperature: 28.04
2025-03-26 16:56:22 - Temperature: 44.2
2025-03-26 16:56:37 - Temperature: -10.37
2025-03-26 16:56:52 - Temperature: 49.59
2025-03-26 16:57:07 - Temperature: 39.1
2025-03-26 16:57:22 - Temperature: 28.21
2025-03-26 16:57:37 - Temperature: -12.43
2025-03-26 16:57:52 - Temperature: -4.44
2025-03-26 16:58:07 - Temperature: 14.23
2025-03-26 16:58:22 - Temperature: -39.81
2025-03-26 16:58:37 - Temperature: -12.22
2025-03-26 16:58:52 - Temperature: -39.53
2025-03-26 16:59:07 - Temperature: 35.43
2025-03-26 16:59:22 - Temperature: 20.7
2025-03-26 16:59:37 - Temperature: 49.26
2025-03-26 16:59:52 - Temperature: -45.94
2025-03-26 17:00:07 - Temperature: 46.31
2025-03-26 17:00:22 - Temperature: -43.95
2025-03-26 17:00:37 - Temperature: 43.07
2025-03-26 17:00:52 - Temperature: 34.76
2025-03-26 17:01:07 - Temperature: -41.52
2025-03-26 17:01:22 - Temperature: 27.91
2025-03-26 17:01:37 - Temperature: -12.52
2025-03-26 17:01:52 - Temperature: -16.92
2025-03-26 17:02:08 - Temperature: 45.52
2025-03-26 17:02:23 - Temperature: 42.05
2025-03-26 17:02:38 - Temperature: 29.28
2025-03-26 17:02:53 - Temperature: 1.41
2025-03-26 17:03:08 - Temperature: 27.59
2025-03-26 17:03:23 - Temperature: 5.39
2025-03-26 17:03:38 - Temperature: -10.84
2025-03-26 17:03:53 - Temperature: -32.99
2025-03-26 17:04:08 - Temperature: 35.11
2025-03-26 17:04:23 - Temperature: -20.77
2025-03-26 17:04:38 - Temperature: -13.66
2025-03-26 17:04:53 - Temperature: -36.95
2025-03-26 17:05:08 - Temperature: -46.7
2025-03-26 17:05:23 - Temperature: 18.69
2025-03-26 17:05:38 - Temperature: 14.8
2025-03-26 17:05:53 - Temperature: -31.26
2025-03-26 17:06:08 - Temperature: 46.98
2025-03-26 17:06:23 - Temperature: -37.98
2025-03-26 17:06:38 - Temperature: -14.24
2025-03-26 17:06:53 - Temperature: -33.82
2025-03-26 17:07:08 - Temperature: -46.51
2025-03-26 17:07:23 - Temperature: -19.95
2025-03-26 17:07:38 - Temperature: -17.57
2025-03-26 17:07:53 - Temperature: 43.32
2025-03-26 17:08:08 - Temperature: -8.23
2025-03-26 17:08:23 - Temperature: -14.5
2025-03-26 17:08:38 - Temperature: 9.07
2025-03-26 17:08:53 - Temperature: 28.44
2025-03-26 17:09:08 - Temperature: -26.53
2025-03-26 17:09:23 - Temperature: -39.28

```

Outputs from last_5_hour_data.py (Humidity) :

```

C:\Users\krish\Desktop\Spring 2025\IOT\Week10>python last_5_hour_data.py
2025-03-26 16:55:07 - Humidity: 40.77
2025-03-26 16:55:22 - Humidity: 27.53
2025-03-26 16:55:37 - Humidity: 71.31
2025-03-26 16:55:52 - Humidity: 7.39
2025-03-26 16:56:07 - Humidity: 78.58
2025-03-26 16:56:22 - Humidity: 39.68
2025-03-26 16:56:37 - Humidity: 68.67
2025-03-26 16:56:52 - Humidity: 35.91
2025-03-26 16:57:07 - Humidity: 92.59
2025-03-26 16:57:22 - Humidity: 50.43
2025-03-26 16:57:37 - Humidity: 12.45
2025-03-26 16:57:52 - Humidity: 60.7
2025-03-26 16:58:07 - Humidity: 15.74
2025-03-26 16:58:22 - Humidity: 29.86
2025-03-26 16:58:37 - Humidity: 55.34
2025-03-26 16:58:52 - Humidity: 42.45
2025-03-26 16:59:07 - Humidity: 50.21
2025-03-26 16:59:22 - Humidity: 21.21
2025-03-26 16:59:37 - Humidity: 18.68
2025-03-26 16:59:52 - Humidity: 50.92
2025-03-26 17:00:07 - Humidity: 10.8
2025-03-26 17:00:22 - Humidity: 99.0
2025-03-26 17:00:37 - Humidity: 12.72
2025-03-26 17:00:52 - Humidity: 18.17
2025-03-26 17:01:07 - Humidity: 95.74
2025-03-26 17:01:22 - Humidity: 17.5
2025-03-26 17:01:37 - Humidity: 47.05
2025-03-26 17:01:52 - Humidity: 91.59
2025-03-26 17:02:08 - Humidity: 0.48
2025-03-26 17:02:23 - Humidity: 7.8
2025-03-26 17:02:38 - Humidity: 92.14
2025-03-26 17:02:53 - Humidity: 4.31
2025-03-26 17:03:08 - Humidity: 58.94
2025-03-26 17:03:23 - Humidity: 10.89
2025-03-26 17:03:38 - Humidity: 81.31
2025-03-26 17:03:53 - Humidity: 71.26
2025-03-26 17:04:08 - Humidity: 90.54
2025-03-26 17:04:23 - Humidity: 97.88
2025-03-26 17:04:38 - Humidity: 0.06
2025-03-26 17:04:53 - Humidity: 83.17
2025-03-26 17:05:08 - Humidity: 3.84
2025-03-26 17:05:23 - Humidity: 45.68
2025-03-26 17:05:38 - Humidity: 81.89
2025-03-26 17:05:53 - Humidity: 12.99
2025-03-26 17:06:08 - Humidity: 79.66
2025-03-26 17:06:23 - Humidity: 29.9
2025-03-26 17:06:38 - Humidity: 51.01
2025-03-26 17:06:53 - Humidity: 56.25
2025-03-26 17:07:08 - Humidity: 31.08
2025-03-26 17:07:23 - Humidity: 1.17
2025-03-26 17:07:38 - Humidity: 41.12
2025-03-26 17:07:53 - Humidity: 40.27
2025-03-26 17:08:08 - Humidity: 17.57
2025-03-26 17:08:23 - Humidity: 64.9
2025-03-26 17:08:38 - Humidity: 43.52
2025-03-26 17:08:53 - Humidity: 16.97
2025-03-26 17:09:08 - Humidity: 40.27
2025-03-26 17:09:23 - Humidity: 47.66

```

Outputs from last_5_hour_data.py (CO2) :

```

C:\Users\krish\Desktop\Spring 2025\IOT\Week10>python last_5_hour_data.py
2025-03-26 16:55:07 - Co2: 412
2025-03-26 16:55:22 - Co2: 397
2025-03-26 16:55:37 - Co2: 1885
2025-03-26 16:55:52 - Co2: 1690
2025-03-26 16:56:07 - Co2: 461
2025-03-26 16:56:22 - Co2: 635
2025-03-26 16:56:37 - Co2: 697
2025-03-26 16:56:52 - Co2: 1085
2025-03-26 16:57:07 - Co2: 491
2025-03-26 16:57:22 - Co2: 308
2025-03-26 16:57:37 - Co2: 409
2025-03-26 16:57:52 - Co2: 664
2025-03-26 16:58:07 - Co2: 1363
2025-03-26 16:58:22 - Co2: 790
2025-03-26 16:58:37 - Co2: 1057
2025-03-26 16:58:52 - Co2: 574
2025-03-26 16:59:07 - Co2: 980
2025-03-26 16:59:22 - Co2: 1921
2025-03-26 16:59:37 - Co2: 906
2025-03-26 16:59:52 - Co2: 497
2025-03-26 17:00:07 - Co2: 535
2025-03-26 17:00:22 - Co2: 736
2025-03-26 17:00:37 - Co2: 1950
2025-03-26 17:00:52 - Co2: 1138
2025-03-26 17:01:07 - Co2: 1988
2025-03-26 17:01:22 - Co2: 779
2025-03-26 17:01:37 - Co2: 1735
2025-03-26 17:01:52 - Co2: 1083
2025-03-26 17:02:08 - Co2: 697
2025-03-26 17:02:23 - Co2: 456
2025-03-26 17:02:38 - Co2: 1283
2025-03-26 17:02:53 - Co2: 1913
2025-03-26 17:03:08 - Co2: 362
2025-03-26 17:03:23 - Co2: 1548
2025-03-26 17:03:38 - Co2: 398
2025-03-26 17:03:53 - Co2: 1465
2025-03-26 17:04:08 - Co2: 1834
2025-03-26 17:04:23 - Co2: 606
2025-03-26 17:04:38 - Co2: 1593
2025-03-26 17:04:53 - Co2: 1078
2025-03-26 17:05:08 - Co2: 493
2025-03-26 17:05:23 - Co2: 1215
2025-03-26 17:05:38 - Co2: 463
2025-03-26 17:05:53 - Co2: 1441
2025-03-26 17:06:08 - Co2: 1570
2025-03-26 17:06:23 - Co2: 1154
2025-03-26 17:06:38 - Co2: 1478
2025-03-26 17:06:53 - Co2: 1159
2025-03-26 17:07:08 - Co2: 926
2025-03-26 17:07:23 - Co2: 1056
2025-03-26 17:07:38 - Co2: 1749
2025-03-26 17:07:53 - Co2: 676
2025-03-26 17:08:08 - Co2: 1749
2025-03-26 17:08:23 - Co2: 1799
2025-03-26 17:08:38 - Co2: 1800
2025-03-26 17:08:53 - Co2: 1080
2025-03-26 17:09:08 - Co2: 357
2025-03-26 17:09:23 - Co2: 1992

```

3. GitHub Repository URL :

<https://github.com/sivaramakrishna6768/iot-mqtt-simulation>

4. Reflection :

- ➔ The hands-on experience I had while finishing this assignment made me much more familiar with the entire lifecycle of a cloud-based IoT system - from simulating sensor data values to the integration in the cloud and past data inspection.
- ➔ One of the challenges I faced during this process was configuring MQTT correctly, especially when the new paho-mqtt library created an unexpected callback API version error. This made me dig deeper into the documentation and update the client configuration to satisfy the requirements. This was a reminder for me that the libraries evolve and that it is important to be updated.
- ➔ ThingSpeak was simple and fun to use. Looking at the actual sensor data transmitted in real-time on the graphs in the dashboard was highly satisfying and made me feel that this IoT system was authentic and real. Also developing a local logging system gave me a better understanding of the offline storage of data as well as filtering the data based on time and required fields which can be truly helpful in the future.
- ➔ The most interesting part of the assignment was the way I could emulate the environment data in a realistic manner using the random module in python. I felt as if it was an ideal virtual weather station. It made the assignment not only learning oriented but also fun.
- ➔ Overall, the assignment strengthened my knowledge by making me understand the importance of data flow, cloud communication protocols like MQTT, and live and historic data handling which are all important aspects in the building of cloud based IoT systems in real life.