Students

ENGR 114 Fall 2019

11/6/2019

Revised: 12/6/2019

***Humidity vs. Temperature***

***Problem Statement:***

This document goes through the steps for the hardware and software set-up to measure temperature and humidity with the use of the Adafruit Feather Huzzah microcontroller and the Digital Temperature and Humidity Sensor DHT22.

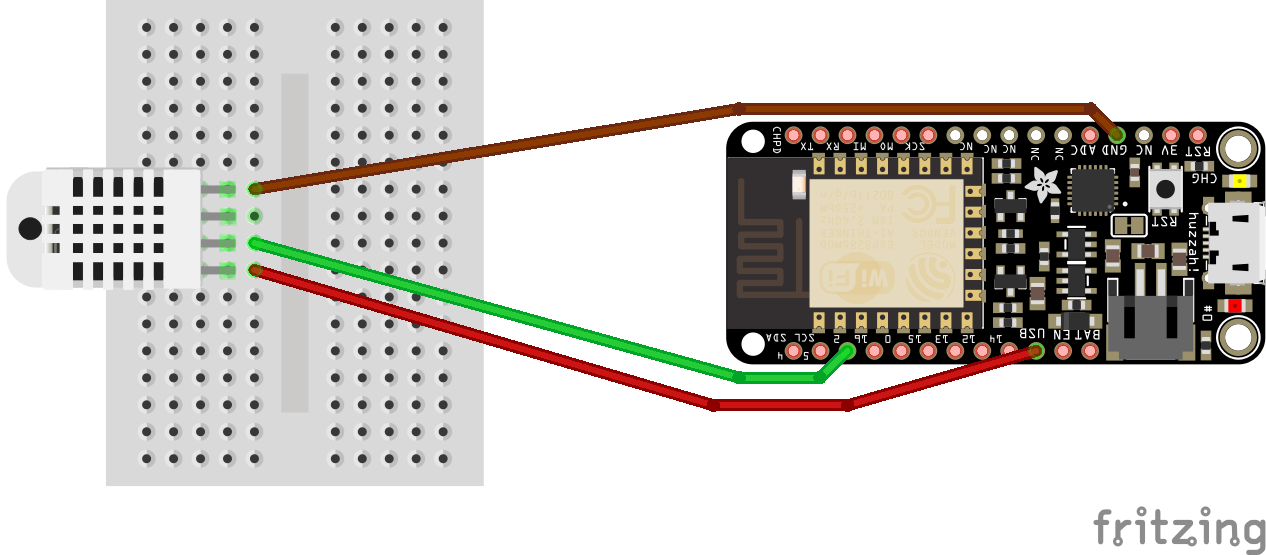
This project uses a closed system with the sensors placed inside to measure and record temperature and humidity.

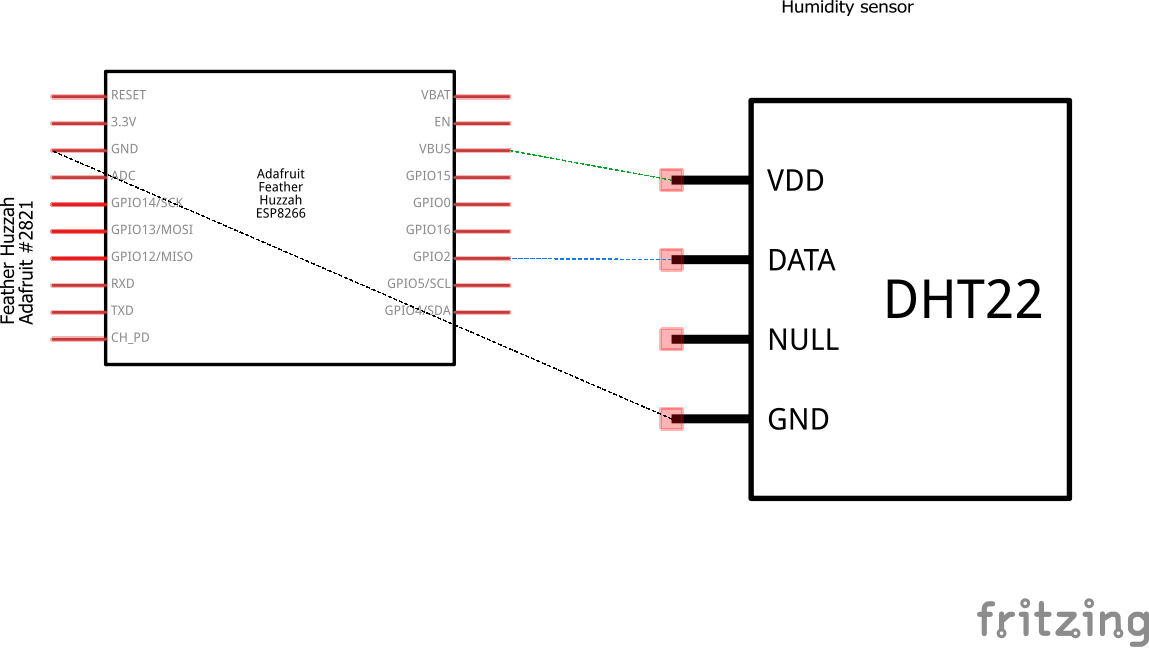
***Hardware Setup:***

*Bill of Materials*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Part Name | Purpose | Item Name | URL | Price (USD) |
| Adafruit Feather Huzzah  #2821 | Transmit arduino code | Microcontroller | <https://www.adafruit.com/product/2821?hidden=yes&main_page=product_info&products_id=2821&gclid=EAIaIQobChMIucK6gMmd5gIVfCCtBh2Q8ATgEAAYASAAEgIH9fD_BwE> | 16.95 |
| Digital Temperature and Humidity Sensor #[DHT22](https://www.amazon.com/gp/slredirect/picassoRedirect.html/ref=pa_sp_atf_industrial_sr_pg1_1?ie=UTF8&adId=A00612692CPY5JXXR7K4D&url=%2FHiLetgo-Digital-Temperature-Humidity-Replace%2Fdp%2FB01DA3C452%2Fref%3Dsr_1_1_sspa%3Fkeywords%3DAM2302%26qid%3D1574036080%26s%3Dindustrial%26sr%3D1-1-spons%26psc%3D1&qualifier=1574036080&id=6985604544883403&widgetName=sp_atf) | Measure change in humidity and temperature | Temperature and humidity sensor | <https://www.amazon.com/AZDelivery-Digital-Temperature-Humidity-Raspberry/dp/B07F86WXR7/ref=sr_1_8?crid=10YJBPVZBH0SW&keywords=am2302+temperature+%26+humidity+sensor&qid=1574037182&sprefix=AM2302+sensor%2Caps%2C272&sr=8-8> | 5.99 |
| USB micro-B Cable  #10215 | Connect computer to microcontroller | USB cable | <https://www.sparkfun.com/products/10215> | 4.95 |
| Jumper wires standard 7” M/M-30AWG (30pk)#11026 | Connect circuit board to sensor | Jumper wires | <https://www.sparkfun.com/products/11026> | 2.25 |
| Breadboard – Mini Modular (White)  #12043 | Connect microcontroller and sensor | Breadboard | <https://www.sparkfun.com/products/12043> | 3.95 |
| 1000 mL beaker #1000-1L | Hold water (increase humidity) | Glass beaker | <https://www.amazon.com/Pyrex-Glass-Griffin-Beaker-Measuring/dp/B005MIQ7QG/ref=sr_1_1?keywords=CORNING+1000ml+beaker&qid=1574041291&sr=8-1> | 17.99 |
| Aqua Culture 10 Gallon Empty Aquarium | House sensor and beaker | Aquarium | <https://www.amazon.com/Aqua-Culture-Aquarium-10-gallon/dp/B06XQQKDL8/ref=sr_1_7?crid=1DC48KGR93H98&keywords=10+gal+aquarium&qid=1574791013&sprefix=10+gal+aqu%2Caps%2C488&sr=8-7> | 22.97 |
| Thermolyne Cimarec 2 Lab Hot PlateHP46825 | Boil water | Hot Plate | <https://www.amazon.com/Barnstead-Thermolyne-HP46825-Cimarec-T128920/dp/B07Q6BW96V/ref=sr_1_1?keywords=thermalyne+cymarec+2+hot+plate&qid=1574791107&sr=8-1-spell> | 95.00 |
|  |  |  | Total | 170.05 |

*Hardware Schematics*





*Hookup Guide*

1.) On the microcontroller, we will attach a wire to the terminal labeled CND. On the opposite end, this wire needs to be connected to the terminal GND on the sensor.

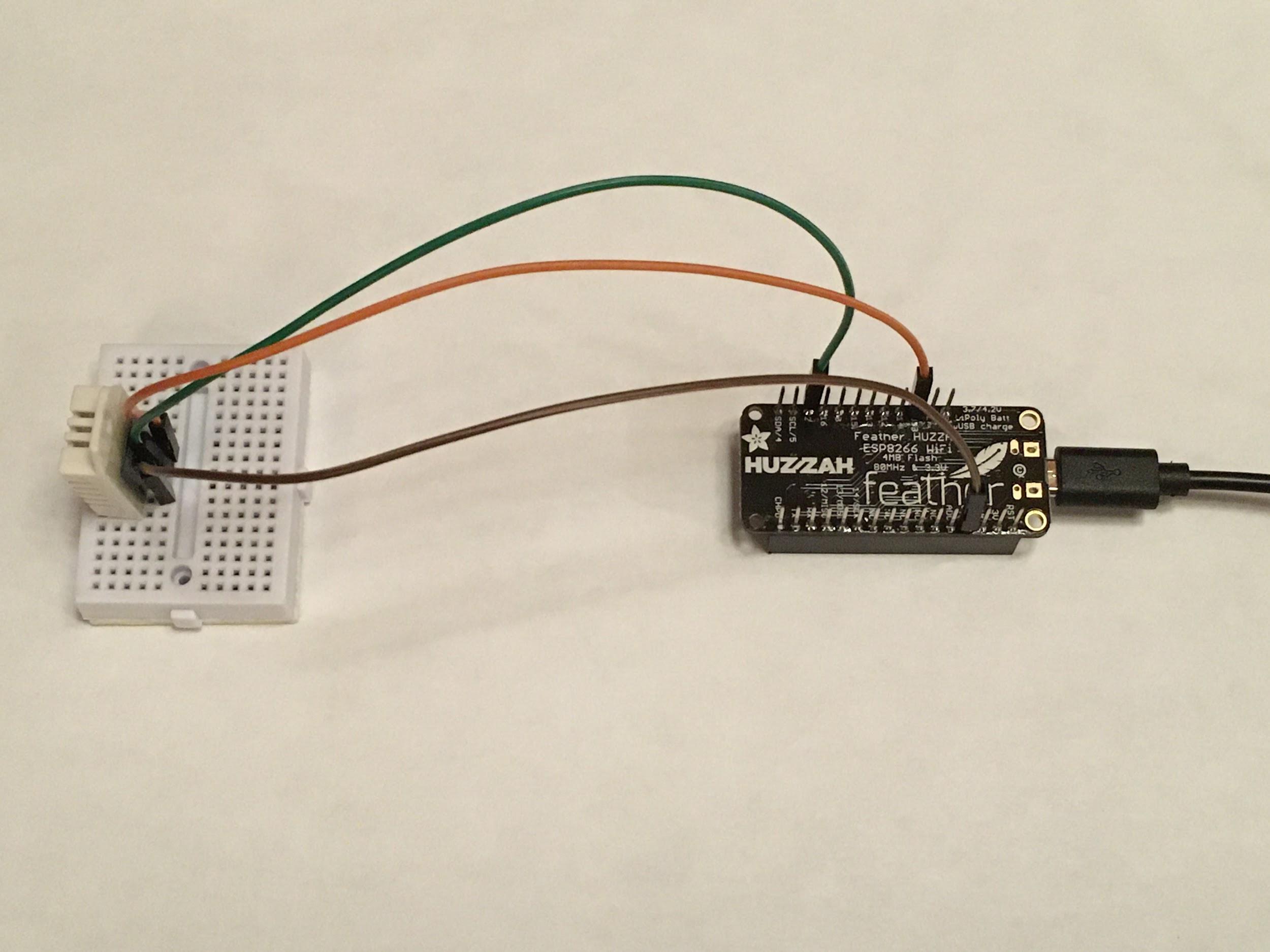
2.) Next, we will attach a wire to terminal labeled 2 on the microcontroller. On the opposite end, this wire needs to be connected to the terminal DTA on the sensor.

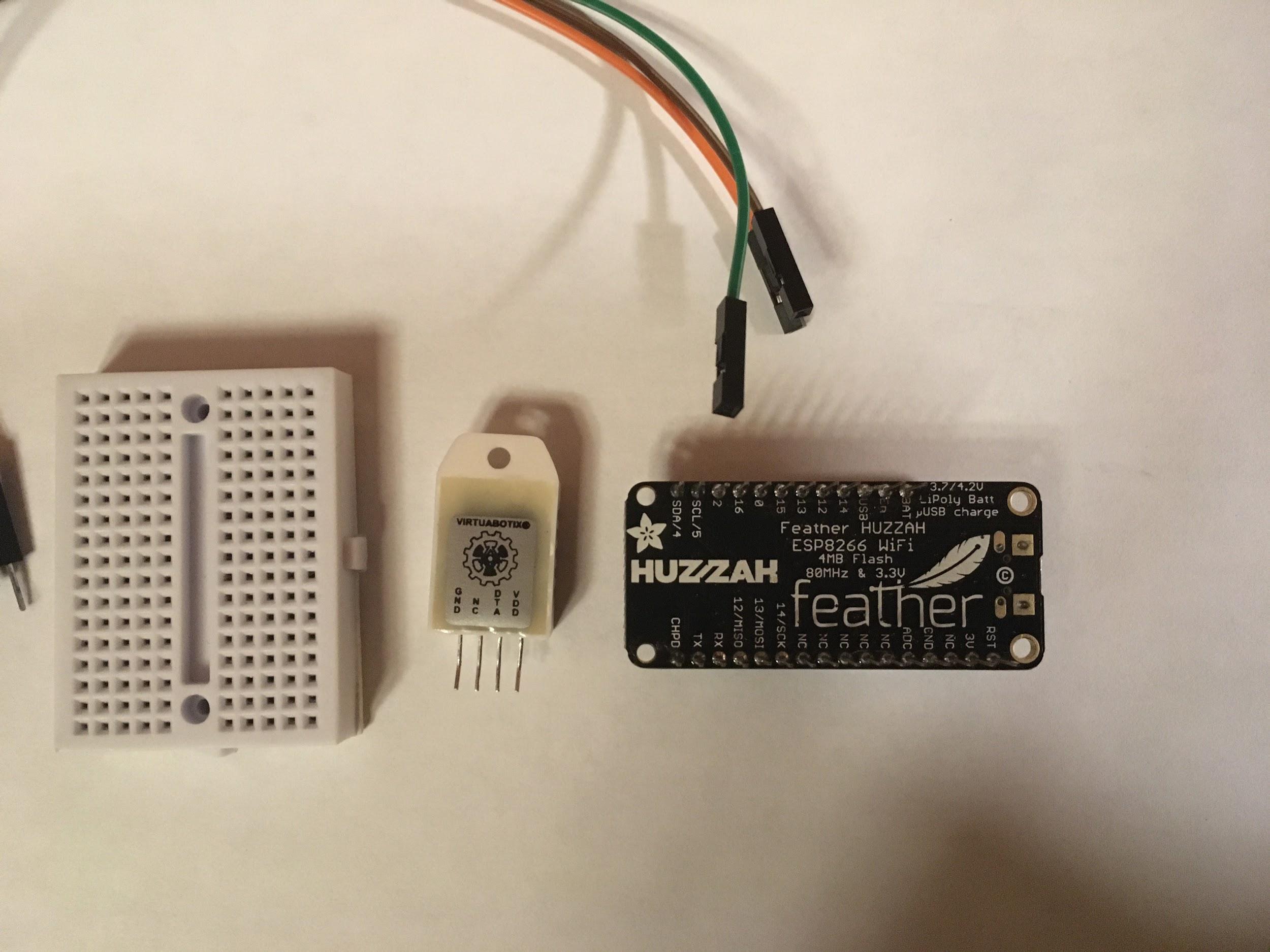
3.) Lastly, we need to attach a wire to the terminal labeled USB on the microcontroller. On the opposite end, this same wire needs to be attached to the terminal labeled VDD on the sensor.

4.) The microcontroller can now be connected to a computer USB port using a microUSB cable.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Part | Pin | Connector | Pin | Part |
| Circuit board | USB | Orange wire | VDD | Sensor |
| Circuit board | GND | Brown wire | GND | Sensor |
| Circuit board | 2 | Green wire | DTA | Sensor |
| Sensor |  | Direct | Align with wires | Breadboard |

*Images*





***Code:***

*Python Code*

# python\_code.py

## Authors: Students

## Last Revision: 12/4/2019

## This code is used to read data from an arduino Temperature and Humidity sensor, then upload that data to a thingspeal account.

## Then the data is called from that account and plotted.

# Imports

**import** serial

**import** time

**import** numpy **as** np

**import** pandas **as** pd

**import** requests

**import** matplotlib.pyplot **as** plt

%matplotlib inline

# opens the serial connection with arduino

ser = serial.Serial('COM3', 9600)

time.sleep(1)

# create empty lists to append data to

data\_hum=[]

data\_temp=[]

# ask the user for how many data points they would like

data\_str = input('How many data points would you like?: ')

data\_int = int(data\_str)

# ask the user how long they would like to record data for

time\_str = input('How many seconds would you like to collect data for?:')

time\_int = int(time\_str)

# calculate appropriate interval over the user's desired time based on the number of data points

time\_interval = time\_int/data\_int

# Read data from serial output

**for** i **in** range(data\_int):

b = ser.readline() # read a byte string line from Arduino's serial output

b\_string = b.decode() # decode byte string into regular Python string

string = b\_string.rstrip() # strip r/n/

hum = string[0:5] # index out humidity data

temp = string[6:] # index out temperature data

data\_hum.append(hum) # append humidity data to list

data\_temp.append(temp) # append temperature data to list

time.sleep(time\_interval) # pause appropriate interval before next loop

ser.close() # close the serial connection with arduino

# print the lists to verify data before upload

print(data\_hum)

print(data\_temp)

### failsafe if decoding error occurs. Run "ser.close()" then re-run prior cell

ser.close()

# upload temperature data to thingspeak

**for** i **in** range(data\_int):

base\_url = "https://api.thingspeak.com/update?api\_key="

api\_key = "XXXXXXXXXXXXXXXX"

temp\_mid\_url\_2 ='&field1=' # temperature field number

temp\_index = data\_temp[i] # index out the appropriate data based on iteration of loop

temp\_url = base\_url + api\_key + temp\_mid\_url\_2 + temp\_index # create url with data point

r\_temp = requests.get(temp\_url) # upload data point to thingspeak

time.sleep(15) # pause to account for thingspeak upload rate

# upload humidity data to thingspeak

**for** i **in** range(data\_int):

base\_url = "https://api.thingspeak.com/update?api\_key="

api\_key = "XXXXXXXXXXXXXXXX"

hum\_mid\_url\_1 ='&field1=' # humidity field number

hum\_index = data\_hum[i] # index out the appropriate data based on iteration of loop

hum\_url = base\_url + api\_key + hum\_mid\_url\_1 + hum\_index # create url with data point

r\_hum = requests.get(hum\_url) # upload data point to thingspeak

time.sleep(15) # pause to account for thingspeak upload rate

# ask user many data points they would like

n\_str = input('How many data points would you like?: ')

# create URL for Humidity

base\_url = 'https://api.thingspeak.com/channels/'

hum\_channel\_num = '908572'

temp\_channel\_num = '928892'

mid\_url = '/fields/'

end\_url = '.csv?results='

hum\_field\_num = '1' # appropriate field number for humidity

temp\_field\_num = '1' # appropriate field number for temp.

results\_num = n\_str # number of datapoints, saved as a string

hum\_url = base\_url + hum\_channel\_num + mid\_url + hum\_field\_num + end\_url + results\_num # create url for humidity

temp\_url = base\_url + temp\_channel\_num + mid\_url + temp\_field\_num + end\_url + results\_num # create url for temperature

# print urls

print(f'The Temperature url is {temp\_url}')

print(f'The Humidity url is {hum\_url}')

# use pandas to read data from thingspeak

r\_hum = pd.read\_csv(hum\_url)

r\_temp = pd.read\_csv(temp\_url)

# clean data and display array

r\_hum\_array = np.array(r\_hum)

r\_hum\_array\_clean = r\_hum\_array[:,-1:-2:-1]

r\_temp\_array = np.array(r\_temp)

r\_temp\_array\_clean = r\_temp\_array[:,-1:-2:-1]

# creates a list of x-axis values that represents the time at each point based on user input

x = []

**for** i **in** range(0, time\_int,time\_interval):

x.append(i)

# plot Humidity with customizations

fig, ax = plt.subplots()

ax.plot(x, r\_hum\_array\_clean,'r',linewidth=1)

ax.set\_xlabel('Time (seconds)')

ax.set\_ylabel('Humidity(%)')

ax.set\_title('Humidity in a Closed System')

plt.show()

# plot Temperature with customizations

fig, ax = plt.subplots()

ax.plot(x,r\_temp\_array\_clean,'r',linewidth=1)

ax.set\_xlabel('Time (seconds)')

ax.set\_ylabel('Temperature (C)')

ax.set\_title('Temperature in a Closed System')

plt.show()

*Arduino Code*

*/\**

*Arduino Humidity Sensor*

*By students*

*Fall 2019*

*ENGR114*

*Code that demonstrates the usage of Adafruit's libaries with the Feather HUZZAH ESP8266 board with the DHT22 sensor to output Humidity and Temperature values.*

*Code is based off the example code in the DHT library.*

*https://pimylifeup.com/arduino-humidity-sensor-dht22/*

*Requires the following libraries to be installed.*

*DHT Sensor Library: https://github.com/adafruit/DHT-sensor-library*

*Adafruit Unified Sensor Library : https://github.com/adafruit/Adafruit\_Sensor*

*Insert this URl in preferences then install through board manager to use Feather Huzzah ESP8266 board as microcontroller.*

*http://arduino.esp8266.com/stable/package\_esp8266com\_index.json*

*\*/*

*#include <DHT.h> //Include the DHT library.*

*#include<Adafruit\_Sensor.h> //Include the Sensor library for adafruit driver*

*#define dataPin 2 //Define the type data pin*

*#define DHTType DHT22 //Define the DHT sensor (DHT11, or DHT22)*

*//Instantiate the dht class with our data pin and DHT type.*

*DHT dht = DHT(dataPin, DHTType);*

*void setup() {*

*Serial.begin(9600); //Start the serial interface on 9600*

*dht.begin(); //Call the begin class in the dht object*

*}*

*void loop() {*

*delay(1000); // Delay for 1 seconds as the DHT22 sampling rate is 0.5Hz*

*float h = dht.readHumidity(); //read the humidity from the sensor*

*float t = dht.readTemperature(); // Read temperature as Celsius (the default), insert true as a parameter for fahrenheit*

*// Check for any errors, if there is, display error and restart.*

*if (isnan(h) || isnan(t)) {*

*Serial.println("Failed to read from the DHT sensor, check wiring.");*

*return;*

*}*

*//Print out the humidity and temperature as seperate strings with a space inbetween*

*// This seperates the data into seperate values that are indexable*

*Serial.print(String(h));*

*Serial.print(" ");*

*Serial.print(String(t));*

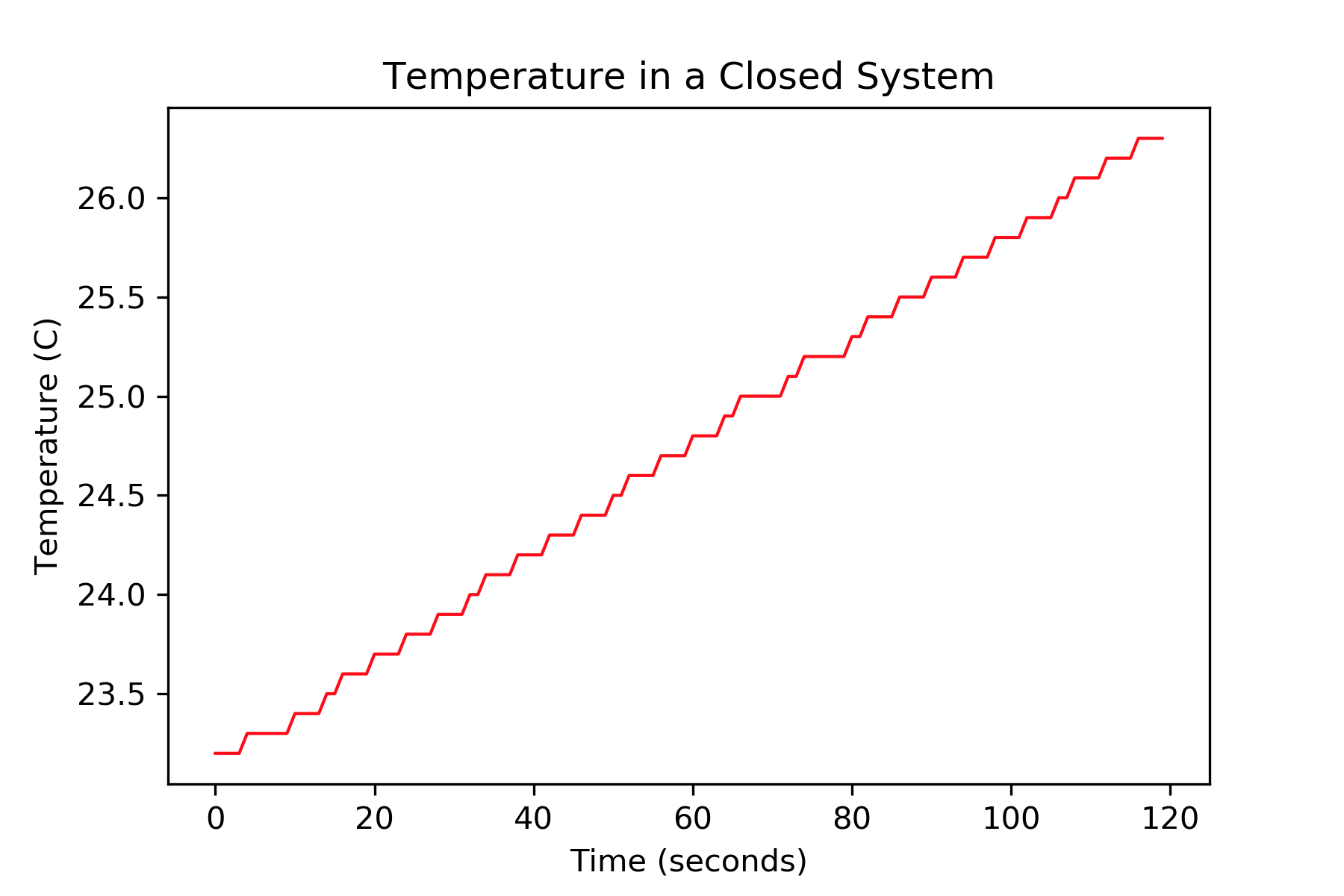
*//Print new line command*

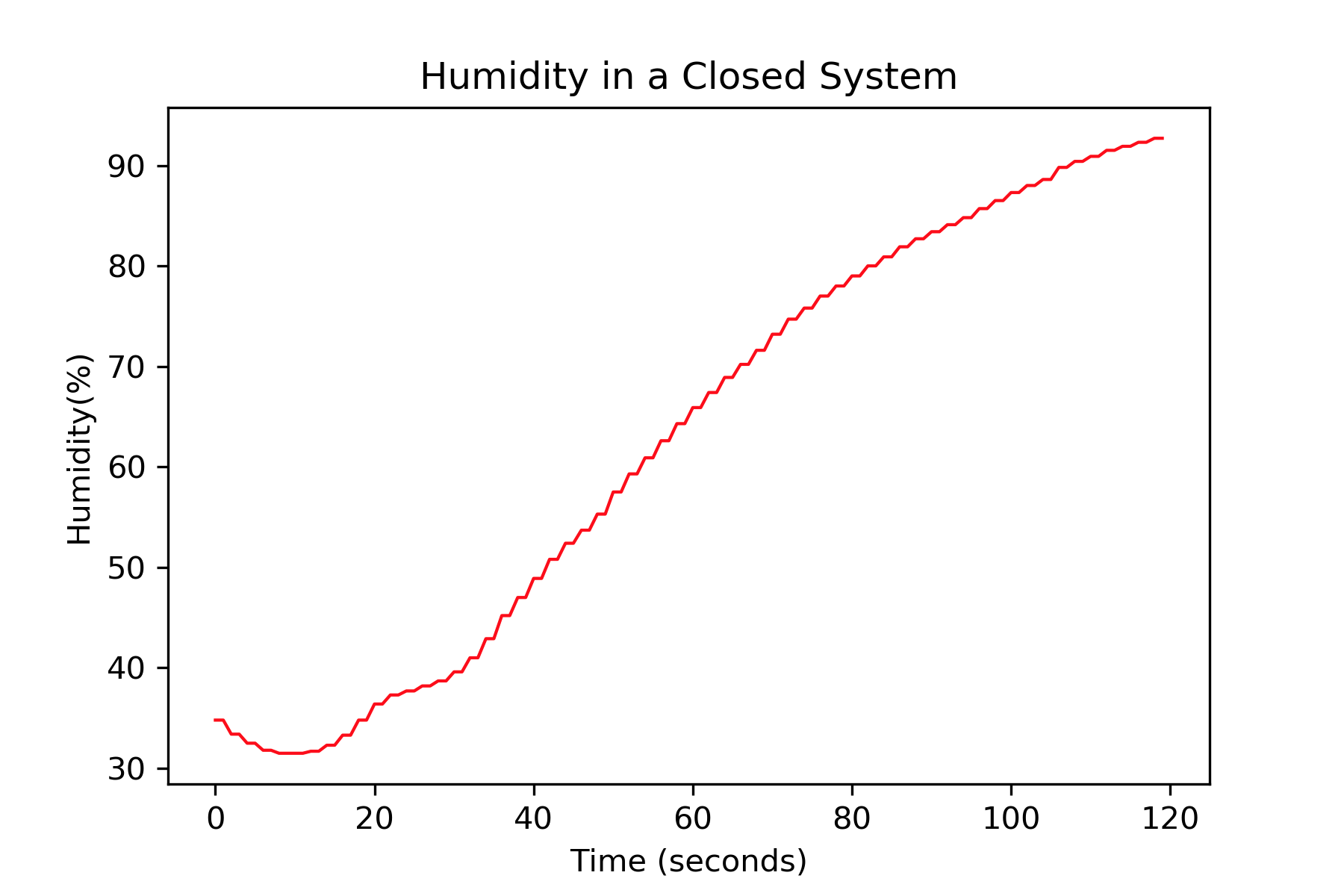
*Serial.println();*

*}*

***Results:***

The arduino code collects the data from the temperature/humidity sensor. Then Python code takes that data and uploads it to thingspeak.com. Another of code then downloads the data from thingspeak.com, cleans it into an array that is then plotted (shown below).





***Future Work:***

Additional work could be done to enable data to be collected only when given parameters (temperature and pressure) were to be met. This could also be integrated into an App for mobile devices or an HMI.

Further wiring and housing and mounting would also be needed for permanent mounting and protecting the microcontroller from the surrounding environments.

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A "Standard Interface" means an interface that either is an official

standard defined by a recognized standards body, or, in the case of

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The "System Libraries" of an executable work include anything, other

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"Major Component", in this context, means a major essential component

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work) run the object code and to modify the work, including scripts to

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if neither you nor any third party retains the ability to install

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