SCHOOL OF COMPUTING (SOC)

IOT CA2
Step-by-step Tutorial

DIPLOMA IN BUSINESS INFORMATION TECHNOLOGY
DIPLOMA IN INFORMATION TECHNOLOGY
DIPLOMA IN INFOCOMM SECURITY MANAGEMENT

ST0324 Internet of Things (IOT)

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Prepared for: Ms Dora Chua

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Section 1
Overview of project

A. Where we have uploaded our tutorial

Fill up the Google form here to submit your links and then paste the links here of your Youtube and tutorial document here as well.

http://bit.ly/1910s2iotca2

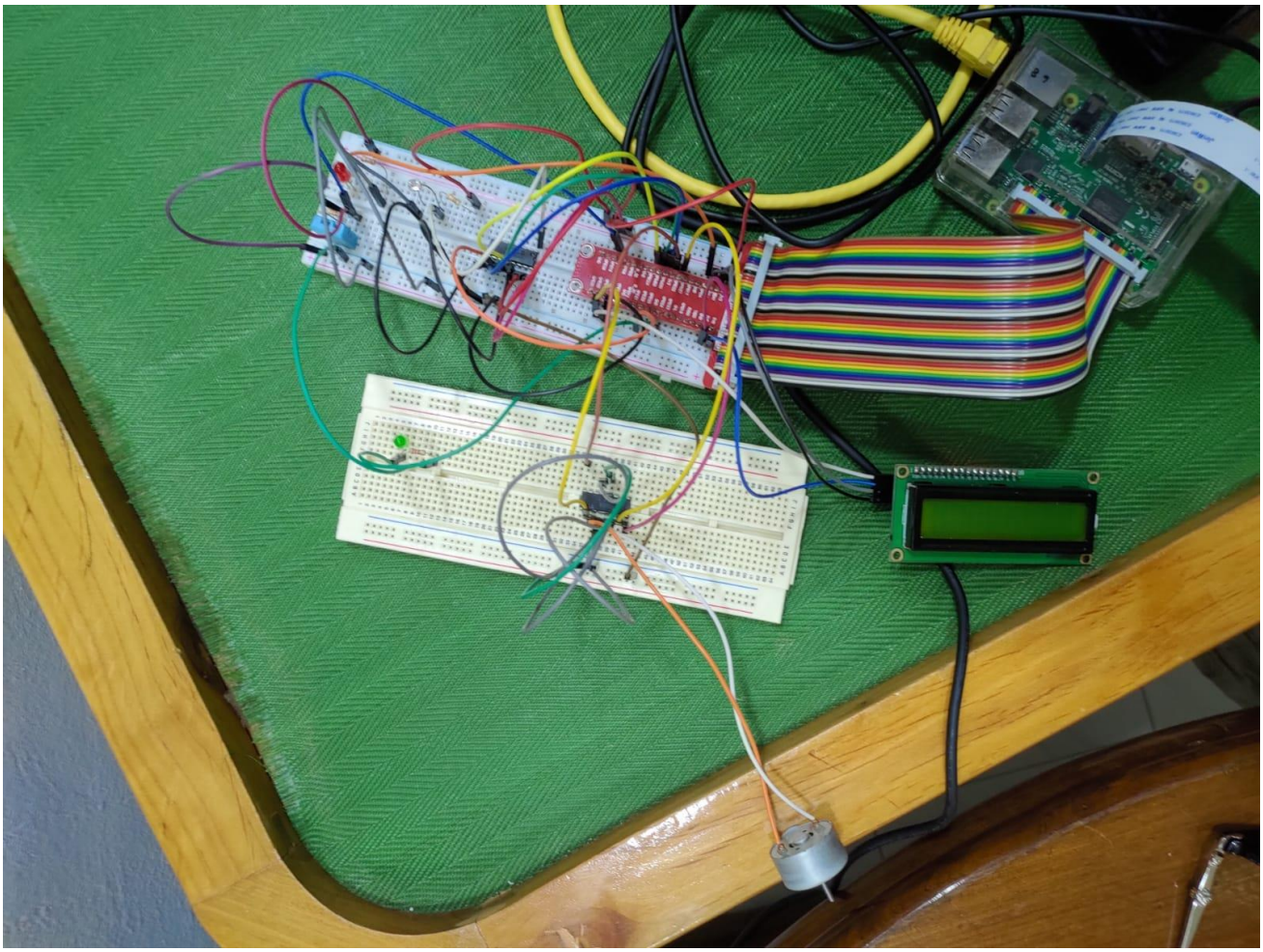
Youtube	https://www.youtube.com/watch?v=pMftiNG6bhg
Public tutorial link	https://github.com/PatriciabChan/IoTProject

B. What is the application about?

Our Project is called the HomeSystem which helps monitor the Home.

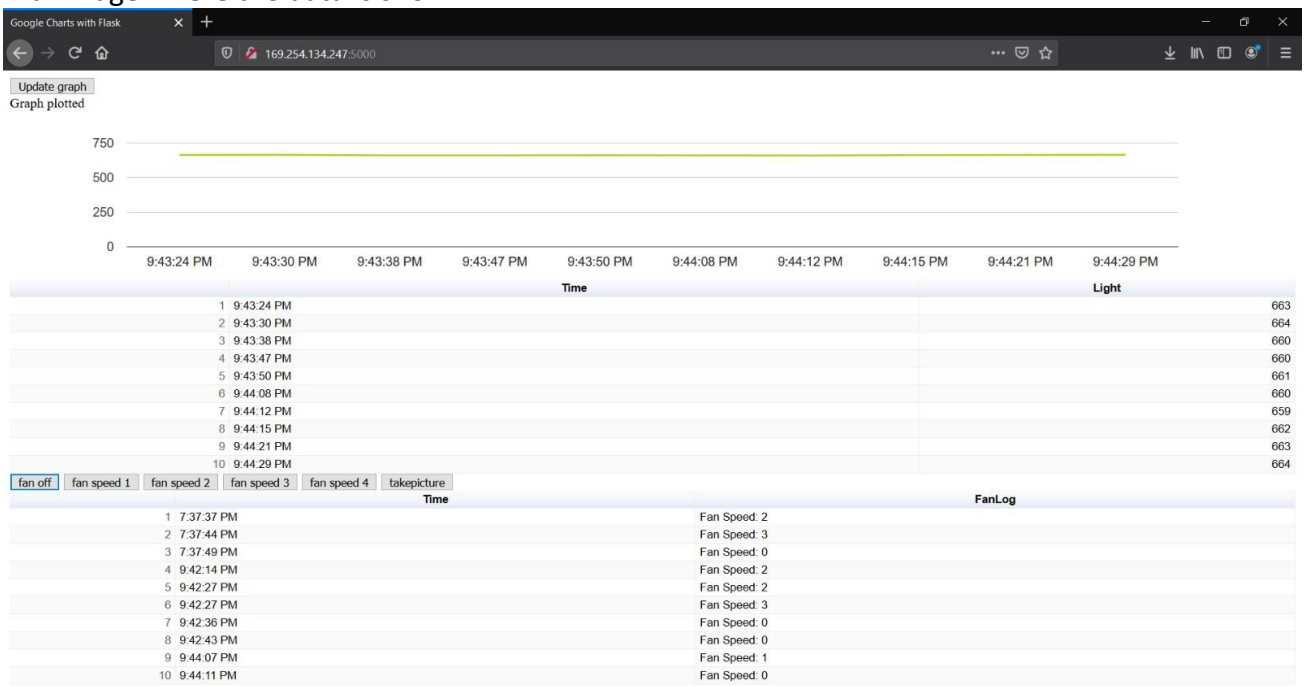
It monitors the Fan and Light System in the house, and with the user being able to see its status on the Web Interface.

C. How does the final RPI set-up looks like?



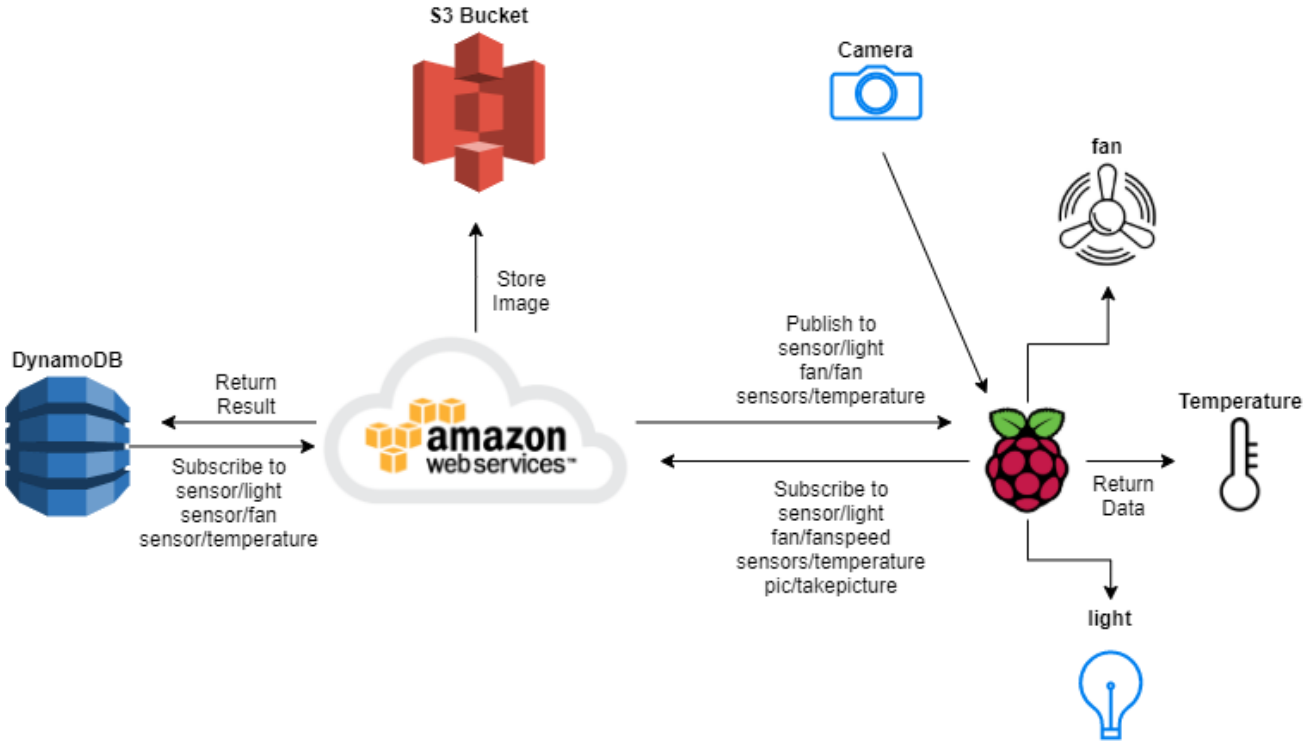
D. How does the web or mobile application look like?

Main Page where the data is shown.



E. System architecture of our system

Provide a hand-drawn or computer-drawn system architecture diagram please. Example given below.



F. Evidence that we have met basic requirements

Provide bullet list to describe how your group has met basic requirements

Requirement	Evidence
Used three sensors	Used sensors : 1 Light Sensor 1 Temperature Sensor Motor
Used MQTT	Our MQTT endpoint --> Example of data sent through MQTT : Sensors/temperature Sensors/light Fan/fan
Stored data in cloud	Stored Light Data in AWS DynamoDB Stored Fan Speed Data in AWS DynamoDB Stored Temperature Data in AWS DynamoDB Stored Images using AWS S3

Used cloud service	AWS S3 to store images DynamoDB to store data
Provide real-time sensor value / status	Show the real-time value of sensors : - Light - Temperature - Fan Speedactu
Provide historical sensor value/ status	Show historical value of sensors : - Light - Temperature - Fan Speed
Control actuator****	Placed button on webpage to control actuator

G. Bonus features on top of basic requirements

Provide bullet list of the bonus features you have added on top of basic requirements

-

A. Quick-start guide (Readme first)

Give a few lines of basic instructions on how I need to run your app, e.g

1) First connect hardware as in Section C
2) Login to aws to create tables,rules and roles under IOTCore
3) Create 3 tables under DynamoDB for light sensor,temperature sensor and fanlog
4) Create a unique bucket under aws S3
5) Run CA2IOT.py
6) Run server.py
7) Open webpage of the server.py <ipaddress of pi>:5000 in webbrowser
   okiee

Section 2
Hardware requirements

Hardware checklist

Item **	Quantity
Raspberry Pi	1
DHT11 Temperature & Humidity Sensor	1
LCD Display	1
Motor	1
L293D IC Chip	1
MCP3008	1
Light sensor	1
10k resistors	1

Hardware setup instructions

Follow the reference for the motor connection and connect the bottom row of the diagram only, yellow jumper wires to pin 20 and 22 respectively. From L293D to raspberri pi

Connect the DHT11 to pin 19
Connect motor to L293D
Connect the light sensor and resistor to MCP3008
From MCP3008 connect it to raspberri pi

Connect LED to pin 24
Connect LCD panel
There should be a Pi camera connected already otherwise connect a raspberry pi camera.

Fritzing Diagram

Paste a Fritzing diagram of your setup here

You can get the Fritzing software at Blackboard Labs folder (third link from top)

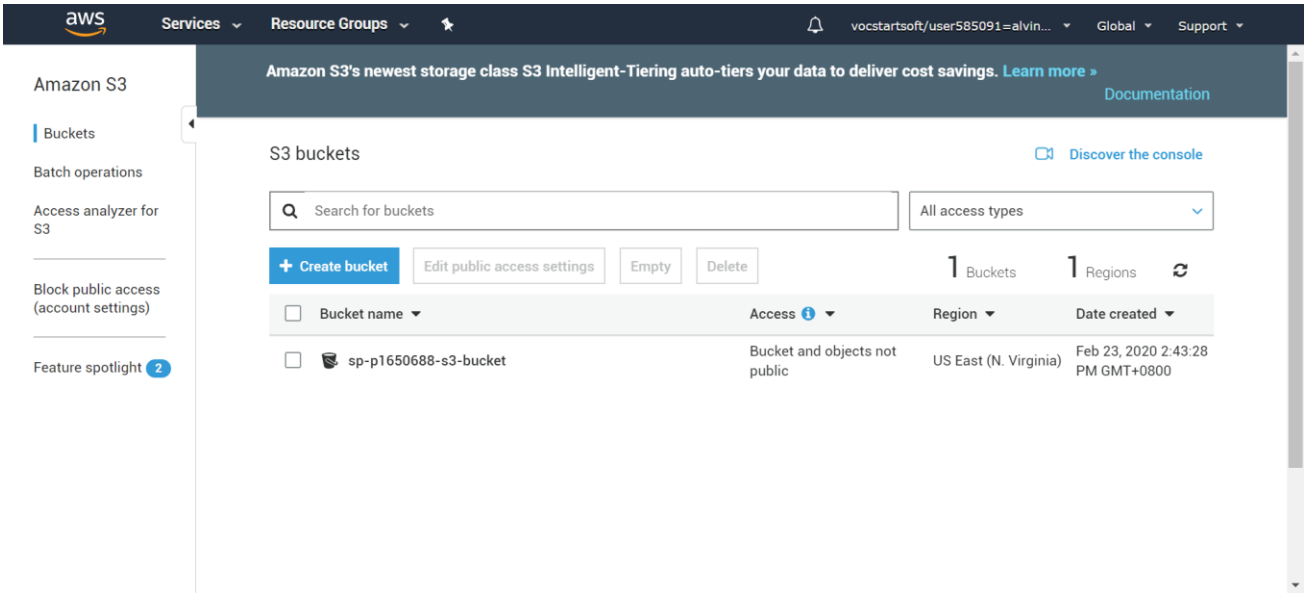
Section 3
Software Requirements

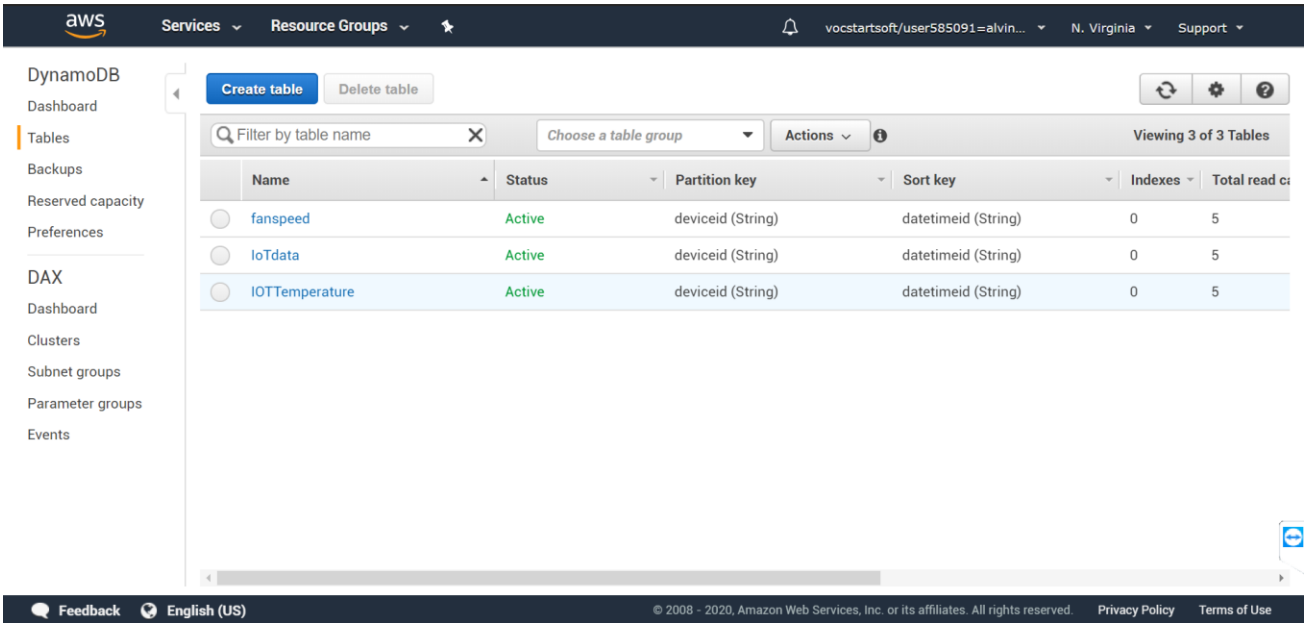
Software checklist

If your applications needs the user to install additional Python or other libraries, pleasse provide here. A simple one like this is sufficient.

1. AWSIoTPythonSDK.MQTTLib library
2. gpiozero library
3. boto3 library
4. botocore library
5. json library
6. flash library

Software setup instructions





Most libraries are pre-installed. Only botocore needs to be created.
Do these 2 commands
Sudo pip install botocore
Sudo pip install awscli
Sudo pip install awscli –upgrade
Sudo pip install boto3 –- upgrade
Sudo pip install botocore –upgrade
Download the Security keys upon creation.
Run CA2IOT.py

Section 4
Source codes

All source codes, including Python, HTML files etc

server.py

```
from AWSIoTPythonSDK.MQTTLib import AWSIoTMQTTClient
from flask import Flask, render_template, jsonify, request,Response
from gpiozero import Motor, Buzzer, LED, InputDevice, Button, MCP3008
from rpi_lcd import LCD
from time import sleep
import mysql.connector
import sys

import json
import numpy
import datetime
```

```
import decimal

import gevent
import gevent.monkey
from gevent.pywsgi import WSGIServer
from picamera import PiCamera
import time, datetime
import boto3
import botocore

s3 = boto3.resource('s3')
from rpi_lcd import LCD

app = Flask(__name__)

import dynamodb
import dynamodbfanlog
import dynamodbtemperature
import jsonconverter as jsonc

# Custom MQTT message callback
def customCallback(client, userdata, message):
    print("Received a new message: ")
    print(message.payload)
    print("from topic: ")
    print(message.topic)
    print("--------------\n\n")

lcd = LCD()
motor2 = Motor(20,22, pwm = True)

full_path = '/home/pi/Desktop/image1.jpg'
file_name = 'image1.jpg'

host = "a3c16s480tb79n-ats.iot.us-east-1.amazonaws.com"
rootCAPath = "rootca.pem"
certificatePath = "certificate.pem.crt"
privateKeyPath = "private.pem.key"

BUCKET = 'sp-p1650688-s3-bucket' # replace with your own unique bucket name
location = {'LocationConstraint': 'us-east-1'}
file_path = "/home/pi/Desktop"
file_name = "test.jpg"
best_bet_item = "Unknown"


my_rpi = AWSIoTMQTTClient("PubSub-p1650688")
my_rpi.configureEndpoint(host, 8883)
my_rpi.configureCredentials(rootCAPath, privateKeyPath, certificatePath)
```

```
my_rpi.configureOfflinePublishQueueing(-1)  # Infinite offline Publish queueing
my_rpi.configureDrainingFrequency(2)  # Draining: 2 Hz
my_rpi.configureConnectDisconnectTimeout(10)  # 10 sec
my_rpi.configureMQTTOperationTimeout(5)  # 5 sec

# Connect and subscribe to AWS IoT
my_rpi.connect()
my_rpi.subscribe("sensors/light", 1, customCallback)
my_rpi.subscribe("sensors/temperature", 1, customCallback)
sleep(2)

def takepicture():
        takePhoto(file_path, file_name)
        bucket = 'sp-p1650688-s3-bucket' # replace with your own unique bucket name
        exists = True
        s3.meta.client.head_bucket(Bucket=bucket)
        s3.Object(bucket, file_name).put(Body=open(full_path, 'rb'))
        print("File uploaded")

def takePhoto(file_path,file_name):
    with PiCamera() as camera:
        #camera.resolution = (1024, 768)
        full_path = file_path + "/" + file_name
        camera.capture(full_path)
        sleep(3)




@app.route("/takepicture/picture")
def takepictureroute():
    takepicture()
    print"test"
    return 'ok'

global currentfanspeed
@app.route("/writeMotor0/motoroff")
def fanoff():
    currentfanspeed = 0
    motor2.stop()
    uploadfanstatus("Fan Speed: " + str(currentfanspeed))
    return'ok'
@app.route("/writeMotor1/motorspeed1")
def fanspeed1():
    motor2.backward(speed=0.25)
    currentfanspeed = 1
    uploadfanstatus("Fan Speed: " +str(currentfanspeed))
```

```
    return'ok'
@app.route("/writeMotor2/motorspeed2")
def fanspeed2():
    motor2.backward(speed=0.50)
    currentfanspeed = 2
    uploadfanstatus("Fan Speed: " +  str(currentfanspeed))
    return'ok'
@app.route("/writeMotor3/motorspeed3")
def fanspeed3():
    motor2.backward(speed=0.75)
    currentfanspeed = 3
    uploadfanstatus("Fan Speed: " + str(currentfanspeed))
    return'ok'
@app.route("/writeMotor4/motorspeed4")
def fanspeed4():
    motor2.backward(speed=1)
    currentfanspeed = 4
    uploadfanstatus("Fan Speed: " + str(currentfanspeed))
    return'ok'
@app.route("/writeMotor5/motorauto")
def fanspeedauto():
    print("test")

def uploadfanstatus(speedvalue):
    message = {}
    message["deviceid"] = "deviceid_Alvin_pat"
    import datetime as datetime
    now = datetime.datetime.now()
    message["datetimeid"] = now.isoformat()
    message["value"] = speedvalue
    import json
    my_rpi.publish("fan/fanspeed", json.dumps(message), 1)

@app.route("/api/getdata",methods=['POST','GET'])
def apidata_getdata():
    if request.method == 'POST' or request.method == 'GET':
        try:
            data = {'chart_data': jsonc.data_to_json(dynamodb.get_data_from_dynamodb
()),
             'title': "IOT Data"}
            return jsonify(data)

        except:
            import sys
            print(sys.exc_info()[0])
            print(sys.exc_info()[1])

@app.route("/api/getfandata",methods=['POST','GET'])
```

```
def apidata_getfandata():
    if request.method == 'POST' or request.method == 'GET':
        try:
            data = {'chart_data': jsonc.data_to_json(dynamodbfanlog.get_data_from_dy
namodb()),
             'title': "Fan Logs"}
            return jsonify(data)

        except:
            import sys
            print(sys.exc_info()[0])
            print(sys.exc_info()[1])

@app.route("/api/gettemperature",methods=['POST','GET'])
def apidata_gettemperature():
    if request.method == 'POST' or request.method == 'GET':
        try:
            data = {'chart_data': jsonc.data_to_json(dynamodbtemperature.get_data_fr
om_dynamodb()),
             'title': "temperate Logs"}
            return jsonify(data)

        except:
            import sys
            print(sys.exc_info()[0])
            print(sys.exc_info()[1])


@app.route("/")
def home():
    return render_template("index.html")




app.run(debug=True,host="0.0.0.0")
```

CA2IOT.py

```
# Import SDK packages
from AWSIoTPythonSDK.MQTTLib import AWSIoTMQTTClient
from time import sleep
from gpiozero import Motor, Buzzer, LED, InputDevice, Button, MCP3008
from signal import pause
import sys
import Adafruit_DHT
from rpi_lcd import LCD
```

```
import time, datetime
import boto3
import botocore

s3 = boto3.resource('s3')
motor2 = Motor(20,22, pwm = True)
adc = MCP3008(channel=0)
temppin = 19
lcd = LCD()
led = LED(24)
full_path = '/home/pi/Desktop/image1.jpg'
file_name = 'image1.jpg'


# Custom MQTT message callback
def customCallback(client, userdata, message):
    print("Received a new message: ")
    print(message.payload)
    print("from topic: ")
    print(message.topic)
    print("--------------\n\n")

def lighttemperature():
    humidity, temperature = Adafruit_DHT.read_retry(11, temppin)
    print('Temp: {:.1f} C'.format(temperature))
    print('Humidity: {:.1f}'.format(humidity))
    return temperature


def displaytime(hour2,minutes2):
    hour_as_string = str(hour2)
    h1_as_string = str(minutes2)
    lcd.text(hour_as_string, 1)
    lcd.text(h1_as_string, 2)


host = "a3c16s480tb79n-ats.iot.us-east-1.amazonaws.com"
rootCAPath = "rootca.pem"
certificatePath = "certificate.pem.crt"
privateKeyPath = "private.pem.key"

my_rpi = AWSIoTMQTTClient("PubSub-p1812345")
my_rpi.configureEndpoint(host, 8883)
my_rpi.configureCredentials(rootCAPath, privateKeyPath, certificatePath)

my_rpi.configureOfflinePublishQueueing(-1)  # Infinite offline Publish queueing
my_rpi.configureDrainingFrequency(2)  # Draining: 2 Hz
my_rpi.configureConnectDisconnectTimeout(10)  # 10 sec
my_rpi.configureMQTTOperationTimeout(5)  # 5 sec
```

```
# Connect and subscribe to AWS IoT
my_rpi.connect()
my_rpi.subscribe("sensors/light", 1, customCallback)
my_rpi.subscribe("sensors/temperature", 1, customCallback)
sleep(2)

# Publish to the same topic in a loop forever
loopCount = 0
while True:
    now = datetime.datetime.now()
    hour = now.hour
    minute = now.minute
    h1 = hour/10
    h2 = hour % 10
    m1 = minute /10
    m2 = minute % 10

    displaytime(hour,minute)
    light = round(1024-(adc.value*1024))
    temperature2 = lighttemperature()


    message = {}
    message["deviceid"] = "deviceid_Alvin_pat"
    import datetime as datetime
    now = datetime.datetime.now()
    message["datetimeid"] = now.isoformat()
    message["value"] = light
    import json
    my_rpi.publish("sensors/light", json.dumps(message), 1)

    message2 = {}
    message2["deviceid"] = "deviceid_Alvin_pat"
    now = datetime.datetime.now()
    message2["datetimeid"] = now.isoformat()
    message2["value"] = temperature2
    my_rpi.publish("sensors/temperature", json.dumps(message2), 1)

sleep(5)
```

aws.py

```
# Import SDK packages
from AWSIoTPythonSDK.MQTTLib import AWSIoTMQTTClient
from time import sleep
```

```
from gpiozero import MCP3008
import sys
import Adafruit_DHT
from time import sleep
adc = MCP3008(channel=0)
pin = 19


# Custom MQTT message callback
def customCallback(client, userdata, message):
      print("Received a new message: ")
      print(message.payload)
      print("from topic: ")
      print(message.topic)
      print("--------------\n\n")







host = "a3c16s480tb79n-ats.iot.us-east-1.amazonaws.com"
rootCAPath = "rootca.pem"
certificatePath = "certificate.pem.crt"
privateKeyPath = "private.pem.key"

my_rpi = AWSIoTMQTTClient("P1650688")
my_rpi.configureEndpoint(host, 8883)
my_rpi.configureCredentials(rootCAPath, privateKeyPath, certificatePath)

my_rpi.configureOfflinePublishQueueing(-1)  # Infinite offline Publish queueing
my_rpi.configureDrainingFrequency(2)  # Draining: 2 Hz
my_rpi.configureConnectDisconnectTimeout(10)  # 10 sec
my_rpi.configureMQTTOperationTimeout(5)  # 5 sec

# Connect and subscribe to AWS IoT
my_rpi.connect()
my_rpi.subscribe("sensors/light", 1, customCallback)
sleep(2)

# Publish to the same topic in a loop forever
loopCount = 0
while True:
      light = round(1024-(adc.value*1024))
      loopCount = loopCount+1
      message = {}
      message["deviceid"] = "deviceid_dorachua"
      import datetime as datetime
```

```
      now = datetime.datetime.now()
      message["datetimeid"] = now.isoformat()
      message["value"] = light
      import json
      my_rpi.publish("sensors/light", json.dumps(message), 1)
      humidity, temperature = Adafruit_DHT.read_retry(11, pin)
      print('Temp: {:.1f} C'.format(temperature))
      print('Humidity: {:.1f}'.format(humidity))

      sleep(5)
```

dynamodb.py

```
def get_data_from_dynamodb():
    try:
            import boto3
            from boto3.dynamodb.conditions import Key, Attr

            dynamodb = boto3.resource('dynamodb', region_name='us-east-1')
            table = dynamodb.Table('IoTdata')

            startdate = '2020-02'

            response = table.query(
                KeyConditionExpression=Key('deviceid').eq('deviceid_Alvin_pat')
                                       & Key('datetimeid').begins_with(startdate),
                ScanIndexForward=False
            )

            items = response['Items']

            n=10 # limit to last 10 items
            data = items[:n]
            data_reversed = data[::-1]

            return data_reversed

    except:
        import sys
        print(sys.exc_info()[0])
        print(sys.exc_info()[1])


if __name__ == "__main__":
    get_data_from_dynamodb()
```

dynamodbfanlog.py

```
def get_data_from_dynamodb():
    try:
            import boto3
            from boto3.dynamodb.conditions import Key, Attr

            dynamodb = boto3.resource('dynamodb', region_name='us-east-1')
            table = dynamodb.Table('fanspeed')

            startdate = '2020-02'

            response = table.query(
                KeyConditionExpression=Key('deviceid').eq('deviceid_Alvin_pat')
                                       & Key('datetimeid').begins_with(startdate),
                ScanIndexForward=False
            )

            items = response['Items']

            n=10 # limit to last 10 items
            data = items[:n]
            data_reversed = data[::-1]

            return data_reversed

    except:
        import sys
        print(sys.exc_info()[0])
        print(sys.exc_info()[1])


if __name__ == "__main__":
    get_data_from_dynamodb()
```

dynamodbtemperature.py

```
def get_data_from_dynamodb():
    try:
            import boto3
            from boto3.dynamodb.conditions import Key, Attr
```

```
            dynamodb = boto3.resource('dynamodb', region_name='us-east-1')
            table = dynamodb.Table('IoTdata')

            startdate = '2020-02'

            response = table.query(
                KeyConditionExpression=Key('deviceid').eq('deviceid_Alvin_pat')
                                       & Key('datetimeid').begins_with(startdate),
                ScanIndexForward=False
            )

            items = response['Items']

            n=10 # limit to last 10 items
            data = items[:n]
            data_reversed = data[::-1]

            return data_reversed

    except:
        import sys
        print(sys.exc_info()[0])
        print(sys.exc_info()[1])


if __name__ == "__main__":
    get_data_from_dynamodb()
```

jsonconverter.py

```
from decimal import Decimal
import json
import datetime
import numpy

class GenericEncoder(json.JSONEncoder):

    def default(self, obj):
        if isinstance(obj, numpy.generic):
            return numpy.asscalar(obj)
        elif isinstance(obj, Decimal):
            return str(obj)
        elif isinstance(obj, datetime.datetime):
            return obj.strftime('%Y-%m-%d %H:%M:%S')
```

```
        elif isinstance(obj, Decimal):
            return float(obj)
        else:
            return json.JSONEncoder.default(self, obj)

def data_to_json(data):
    json_data = json.dumps(data,cls=GenericEncoder)
    print(json_data)
    return json_data
```

index.html

```
<!doctype html>
<head>
    <style> #chartDiv {width:100%;}</style>
    <title>Google Charts with Flask</title>
    <script type="text/javascript" src="https://code.jquery.com/jquery-
3.2.1.js"></script>
    <script type="text/javascript" src="https://www.gstatic.com/charts/loader.js"></
script>
    <script type="text/javascript">
         google.charts.load('current', {'packages':['corechart','table']});
        // Set a callback to run when the Google Visualization API is loaded.
        google.charts.setOnLoadCallback(googlecharts_is_ready);

        var chart;
        var chart2;
        var graphdata;
        var graphdata2;

        function reset_status_messages(){
            $("#status").html("")
            $("#status2").html("")
        }

        function googlecharts_is_ready(){
            $("#buttonloadchart").show()
            $("#buttonloadchart").click()
            $("#status").html("Google charts is ready")
        }

        function loadChart(){
               getData_and_drawChart()
        }
```

```
function getData_and_drawChart(){
    getNewData()
}


function getNewData(){
    $("#status").html("Fetching data to plot graph...");

    jQuery.ajax({
        url: "/api/getdata" ,
        type: 'POST',
        error: function(jqXHR,textStatus, errorThrown ){
             console.log("Error while ajax:" + textStatus)
        },
        success: function(ndata, textStatus, xhr){
            //console.log(ndata)

            //console.log(ndata.chart_data)
            $("#status").html("Data fetched! Now plotting graph!");
            chartdata = ndata.chart_data
            graphdata = createDataTable(chartdata)
            drawLineChart(graphdata)
            drawDataTable(graphdata)
            $("#status").html("Graph plotted");
        }//end success
    });//end ajax
  } //end getNewData

  function getNewData2(){
    $("#status2").html("Fetching data to plot graph...");

    jQuery.ajax({
        url: "/api/getfandata" ,
        type: 'POST',
        error: function(jqXHR,textStatus, errorThrown ){
             console.log("Error while ajax:" + textStatus)
        },
        success: function(ndata, textStatus, xhr){
            //console.log(ndata)

            //console.log(ndata.chart_data)
            chartdata2 = ndata.chart_data
            graphdata2 = createDataTable2(chartdata2)
            drawDataTable2(graphdata2)
        }//end success
    });//end ajax
  } //end getNewData
```

```
        function turnofffan() {
            $.ajax({
                url: "/writeMotor0/motoroff",
                success: function (result) {

                }
            })
        }

        function fanspeed1() {
            $.ajax({
                url: "/writeMotor1/motorspeed1",
                success: function (result){

                }
            })
        }
        function fanspeed2() {
            $.ajax({
                url: "/writeMotor2/motorspeed2",
                success: function (result){

                }
            })
        }
        function fanspeed3() {
            $.ajax({
                url: "/writeMotor3/motorspeed3",
                success: function (result){

                }
            })
        }

        function takepicture()
        {
            $.ajax({
                url: "/takepicture/picture",
                success: function (result){

                }
            })
        }

        function fanspeed4() {
            $.ajax({
                url: "/writeMotor4/motorspeed4",
                success: function (result){
```

```
                }
            })
        }

        function createDataTable(newdata){
            graphdata = new google.visualization.DataTable();
            graphdata.addColumn('string', 'Time');
            graphdata.addColumn('number', 'Light');
            var newdata = JSON.parse(newdata);

            for (index=0;index<newdata.length;index++){

                datetime = (newdata[index].datetimeid)
                datetime = datetime.substring(0, 19) //+ "+0000"
                jsdatetime = new Date(Date.parse(datetime));
                jstime = jsdatetime.toLocaleTimeString();
                light = parseInt(newdata[index].value);
                graphdata.addRows([[jstime,light]]);
            }//end for
            return graphdata
        }

        function createDataTable2(newdata2){
            graphdata2 = new google.visualization.DataTable();
            graphdata2.addColumn('string', 'Time');
            graphdata2.addColumn('string', 'FanLog');
            var newdata2 = JSON.parse(newdata2);

            for (index=0;index<newdata2.length;index++){

                datetime2 = (newdata2[index].datetimeid)
                datetime2 = datetime2.substring(0, 19) //+ "+0000"
                jsdatetime2 = new Date(Date.parse(datetime2));
                jstime2 = jsdatetime2.toLocaleTimeString();
                fanlog = newdata2[index].value;
                graphdata2.addRows([[jstime2,fanlog]]);
            }//end for
            return graphdata2
        }

        function drawDataTable2(graphdata2){
            var table2 = new google.visualization.Table(document.getElementById('tab
le_div2'));
            table2.draw(graphdata2, {showRowNumber: true, width: '100%', height: '10
0%'});

        }//end drawTable
```

```
        function drawDataTable(graphdata2){
            var table = new google.visualization.Table(document.getElementById('tabl
e_div'));
            table.draw(graphdata, {showRowNumber: true, width: '100%', height: '100%
'});

        }//end drawTable
        function drawLineChart(graphdata) {
            chart = new google.visualization.LineChart(
            document.getElementById('chart_div'));
            chart.draw(graphdata, {legend: 'none', vAxis: {baseline: 0},
                colors: ['#A0D100']});
            return
        } //end drawChart

        $(document).ready(function(){
            reset_status_messages()

            setInterval(function () {
                loadChart()
                getNewData2()
            }, 10000);
        });

</script>

</head>
<body>
        <input id="buttonloadchart" type="button" onclick="loadChart()" value="Updat
e graph">
        <div id="status"></div>
        <div id="chart_div" style="width:100%"></div>
        <div id="table_div" style="width:100%"></div>
        <input id="fanspeedoff" type="button" onclick="turnofffan()" value="fan off"
>
        <input id="fanspeed1" type="button" onclick="fanspeed1()" value="fan speed 1
">
        <input id="fanspeed2" type="button" onclick="fanspeed2()" value="fan speed 2
">
        <input id="fanspeed3" type="button" onclick="fanspeed3()" value="fan speed 3
">
        <input id="fanspeed4" type="button" onclick="fanspeed4()" value="fan speed 4
">
        <input id="takepicture" type="button" onclick="takepicture()" value="takepic
ture">
        <div id="table_div2" style="width:100%"></div>
```

```
</body>
</html>
```

Section 5
Task List

A table listing members names and the parts of the assignment they worked on

Name of member	Part of project worked on	Contribution percentage
Alvin Tan Liang Yee	HTML server.py CA2IOT.py dynamodb.py dynamofanlog.py dynamotemperature.py jsonconverter.py Documentation Creation of AWS DynamoDB Creation of AWS S3 Hardware Setup	60%
Patriciab Chan Shi Hui	HTML server.py CA2IOT.py dynamodb.py dynamofanlog.py dynamotemperature.py jsonconverter.py Documentation Hardware Setup	40%

Section 7
References

https://medium.com/@Keithweaver_/controlling-dc-motors-using-python-with-a-raspberry-pi-40-pin-f6fa891dc3d

-- End of CA2 Step-by-step tutorial --