PR101: IoT Weather Station
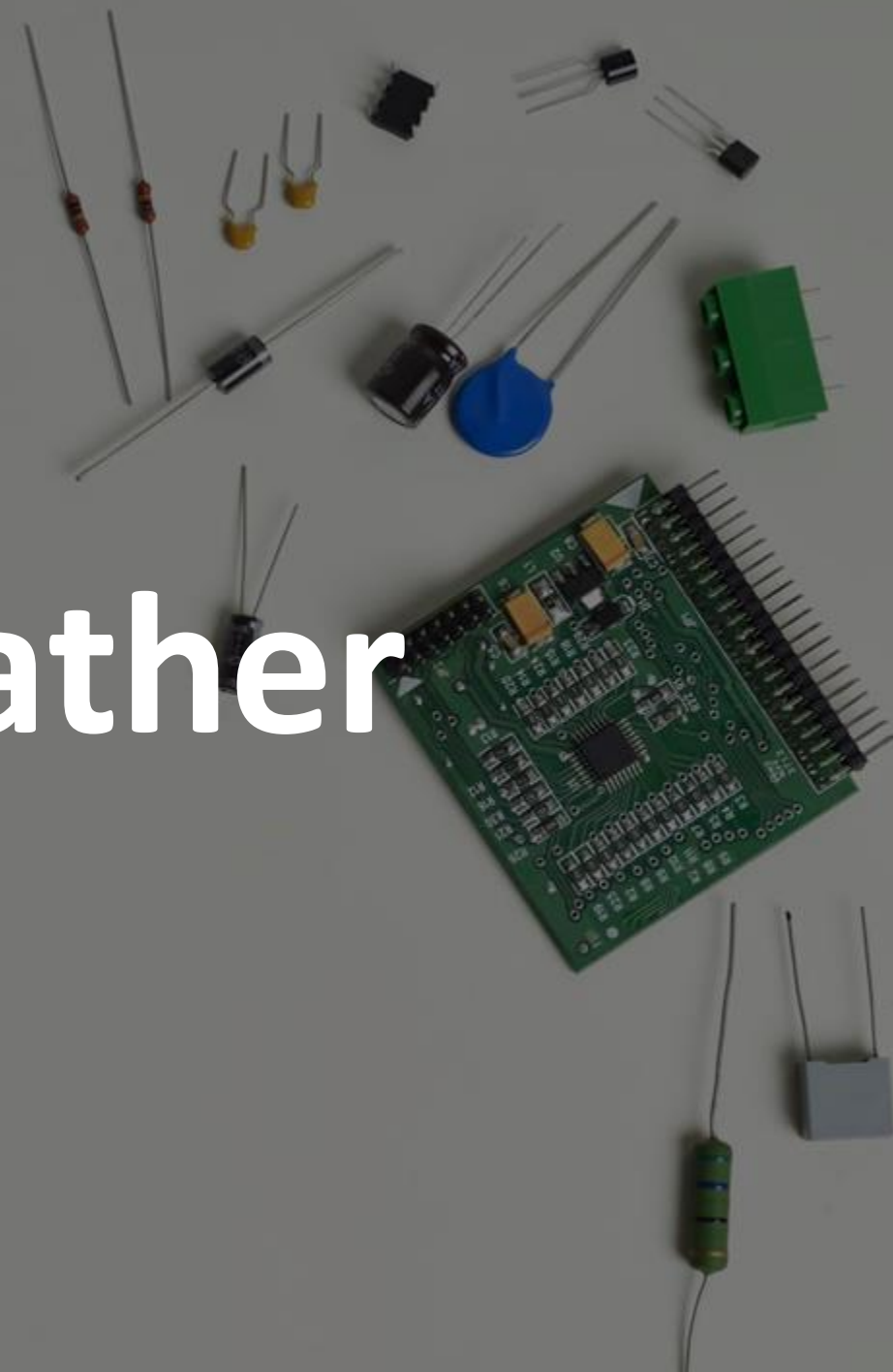
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What is IoT?

- Internet of Things
  - The Internet of things is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.
  - Famous Examples :
    - Smart Mobiles
    - Smart refrigerators
    - Smart watches
    - Smart fire alarm
    - Smart door lock
    - Smart Bicycle
    - Medical sensors
    - Fitness trackers
    - Smart security system

Introduction

A weather station can be described as an instrument or device , which provides us with the information of the weather in our neighboring environment. For example it can provide us with details about the surrounding temperature , barometric pressure , humidity , etc.

SUPPLIES:

1. Raspberry Pi V3

2. DHT22 Temperature and Relative Humidity Sensor

4. DS18B20 Waterproof Temperature Sensor

5. Resistor 4K7 ohm

6. BMP180 Barometric Pressure, Temperature and Altitude Sensor

7. UV Sensor

8. **MCP3008 ADC** (Analog to Digital Convertor) with **SPI Interface**

Sensor Details

1. DHT22 : Temperature and Humidity Sensor

- Can read temperature readings from –40C to +125C
- Accuracy – 0.5C
- Samples every 2 sec.
- It has 4 pins :
  1. Vcc ==> 3.3V
  2. Data ==> GPIO 16
  3. Not Connect
  4. Gnd ==> Gnd

Humidity Sensing Component

NTC Temeperature Sensor
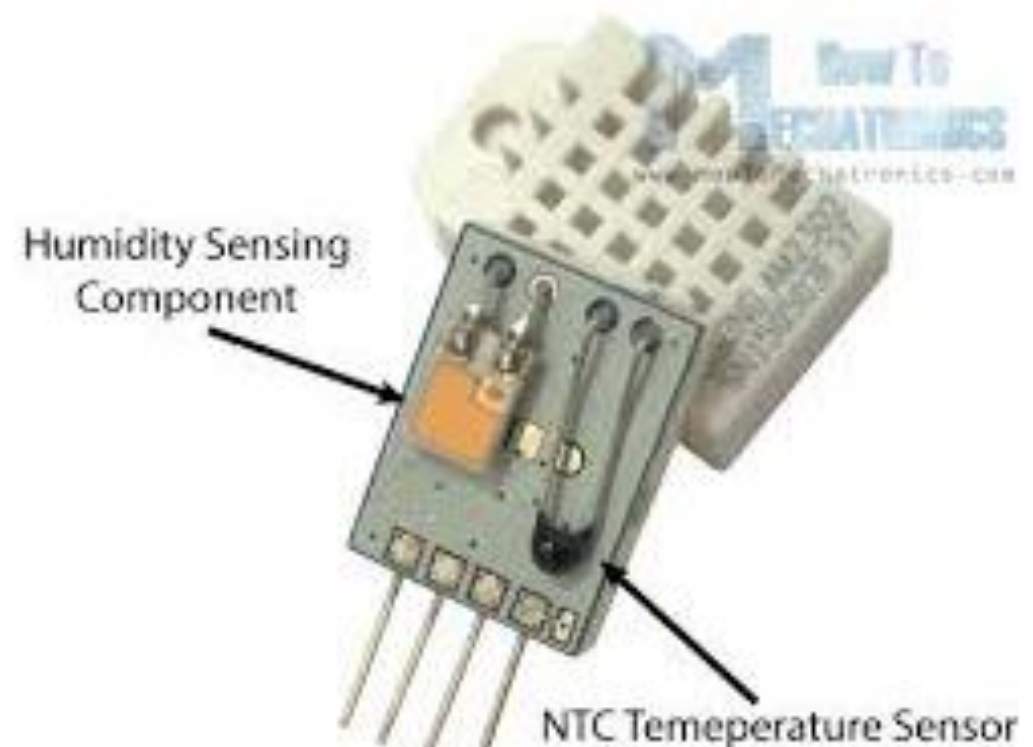
2. DS18B20 : Temperature Sensor

- Single digit pin sensor
- 12 bit precision
- Works in (3-5) V
- Uses 1-Wire communication system

•The sensor has 3 wires:
  1. Black : GND
  2. Red : VCC
  3. Yellow : 1-Wire Data

3. BMP180 : Temperature and Pressure sensor

- Low Power, low Weight Sensor
- Can be used with mobile device also
- Based on I^{2}C serial Protocol
- It has 4 pins :
  1. Vin ==> 3.3V
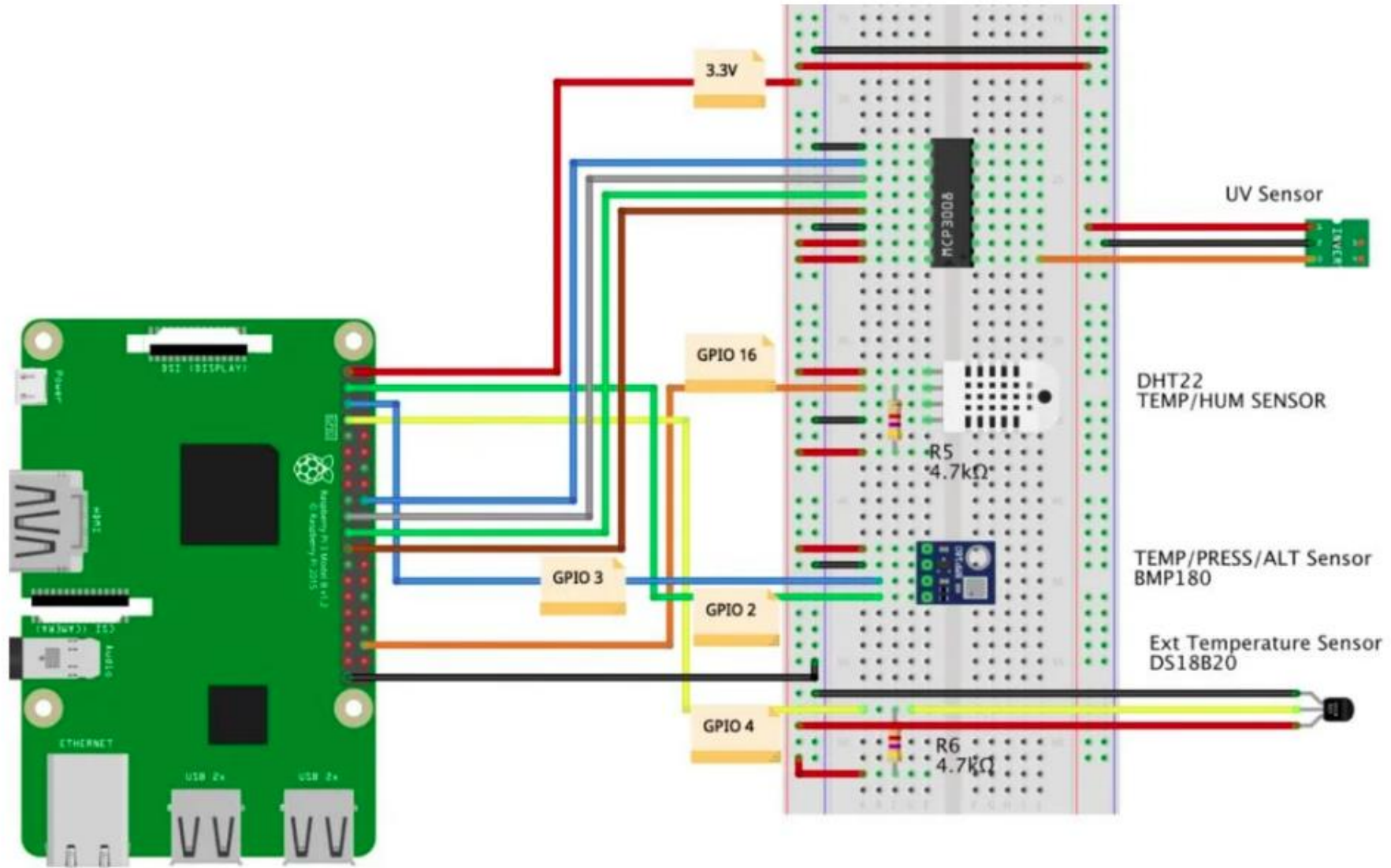 1. GND ==> GND
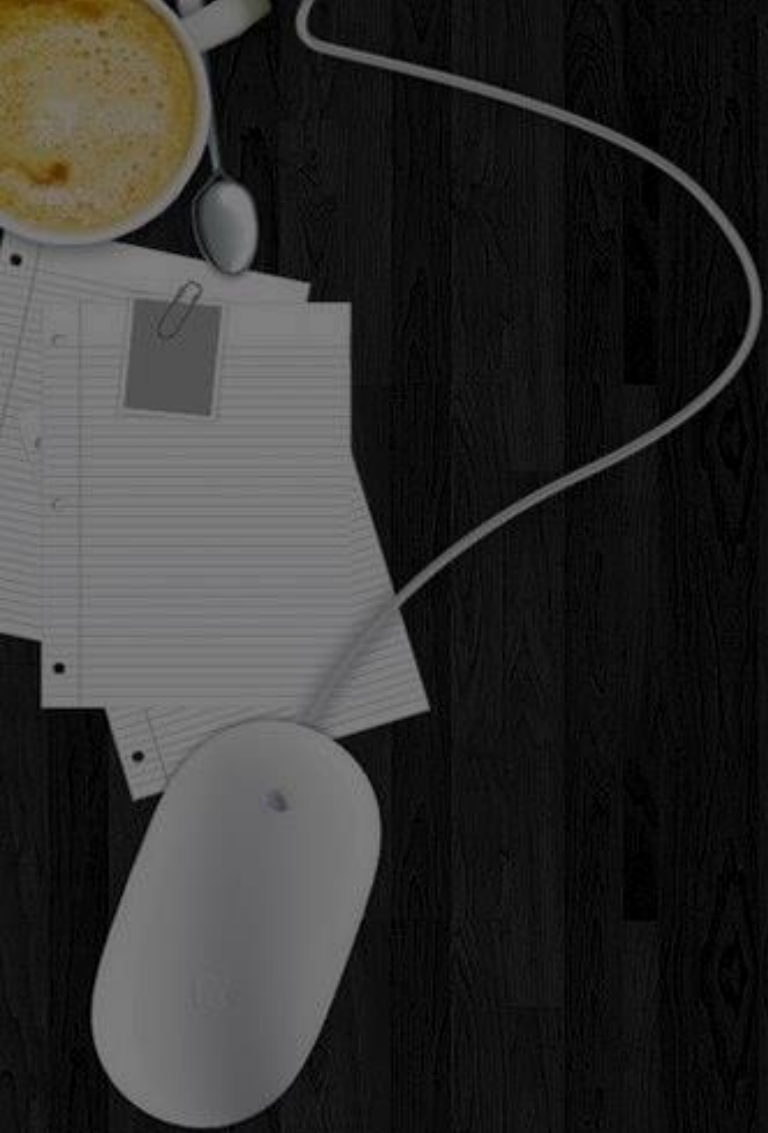 2. SCL ==> GPIO 3
  3. SDA ==> GPIO 2

4. Analog UV Sensor

- It provides Analog data, needs to convert in digital format using MCP3008 ADC.

- Based on Galium Nitride UV photodiode

- Can detect 240-370 nm range of light

Graphical Circuit Representation

UV Sensor

DHT22
TEMP/HUM SENSOR

TEMP/PRESS/ALT Sensor
BMP180

Ext Temperature Sensor
DS18B20

3.3V

GPIO 16

GPIO 3

GPIO 2

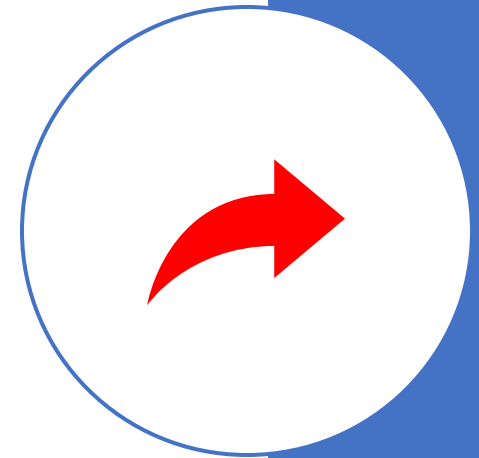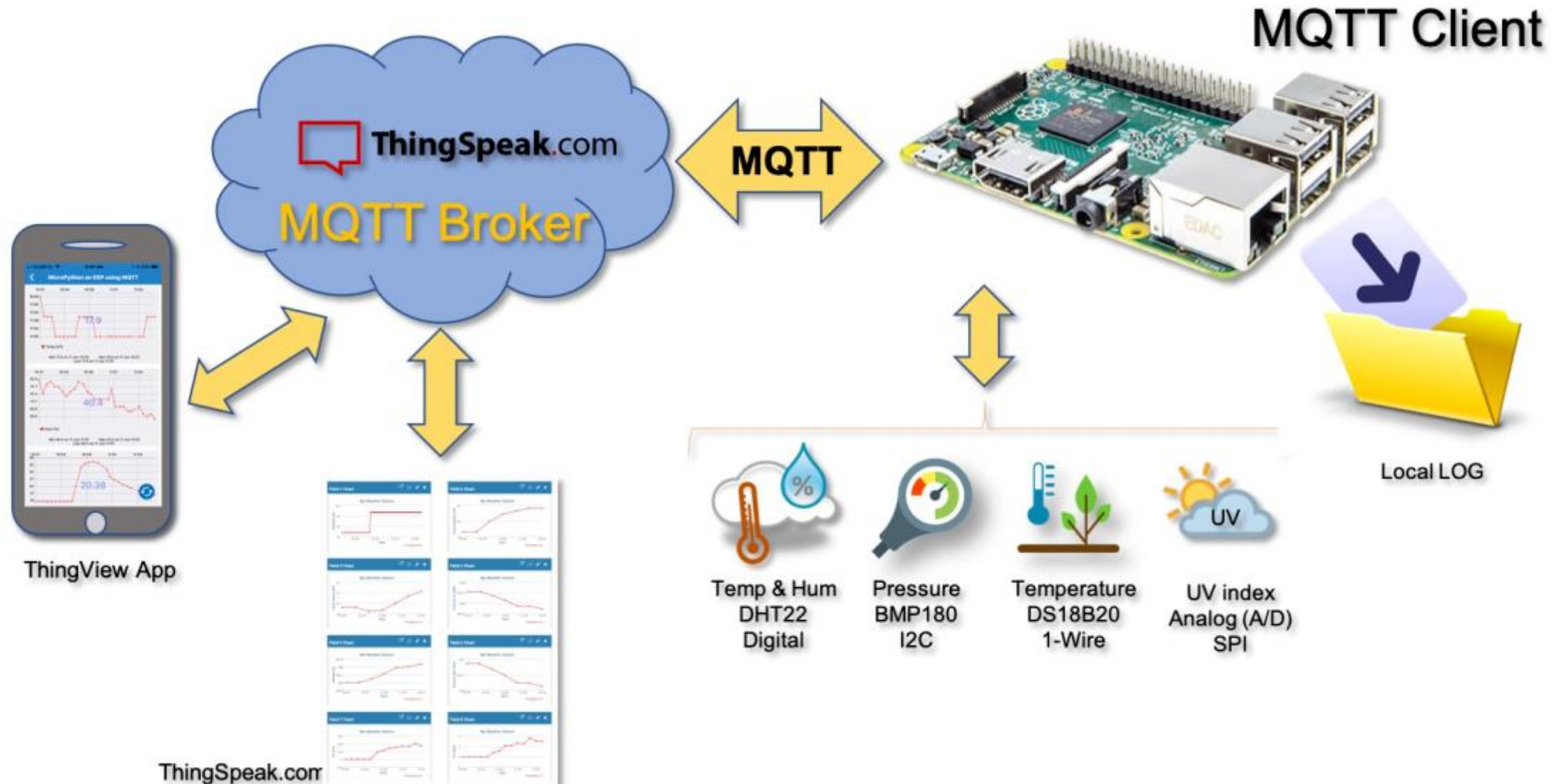GPIO 4

R5
4.7kΩ

R6
4.7kΩ

Working

Overview

We will get data from several different sensors, sending them to an IoT service, and to a mobile App , where we can log and play with data and explore several different ways of connecting sensors to Raspberry Pi. In short, the data collected from the sensors shown in the previous slide will be captured , saved locally on a CSV file and send to an IoT service , via MQTT protocol, as you can see in the next slide:

Flow Chart Explaining Working of the Project

MQTT Client

ThingSpeak.com

MQTT Broker

MQTT

ThingView App

ThingSpeak.com

Local LOG

Temp & Hum
DHT22
Digital

Pressure
BMP180
I2C

Temperature
DS18B20
1-Wire

UV index
Analog (A/D)
SPI

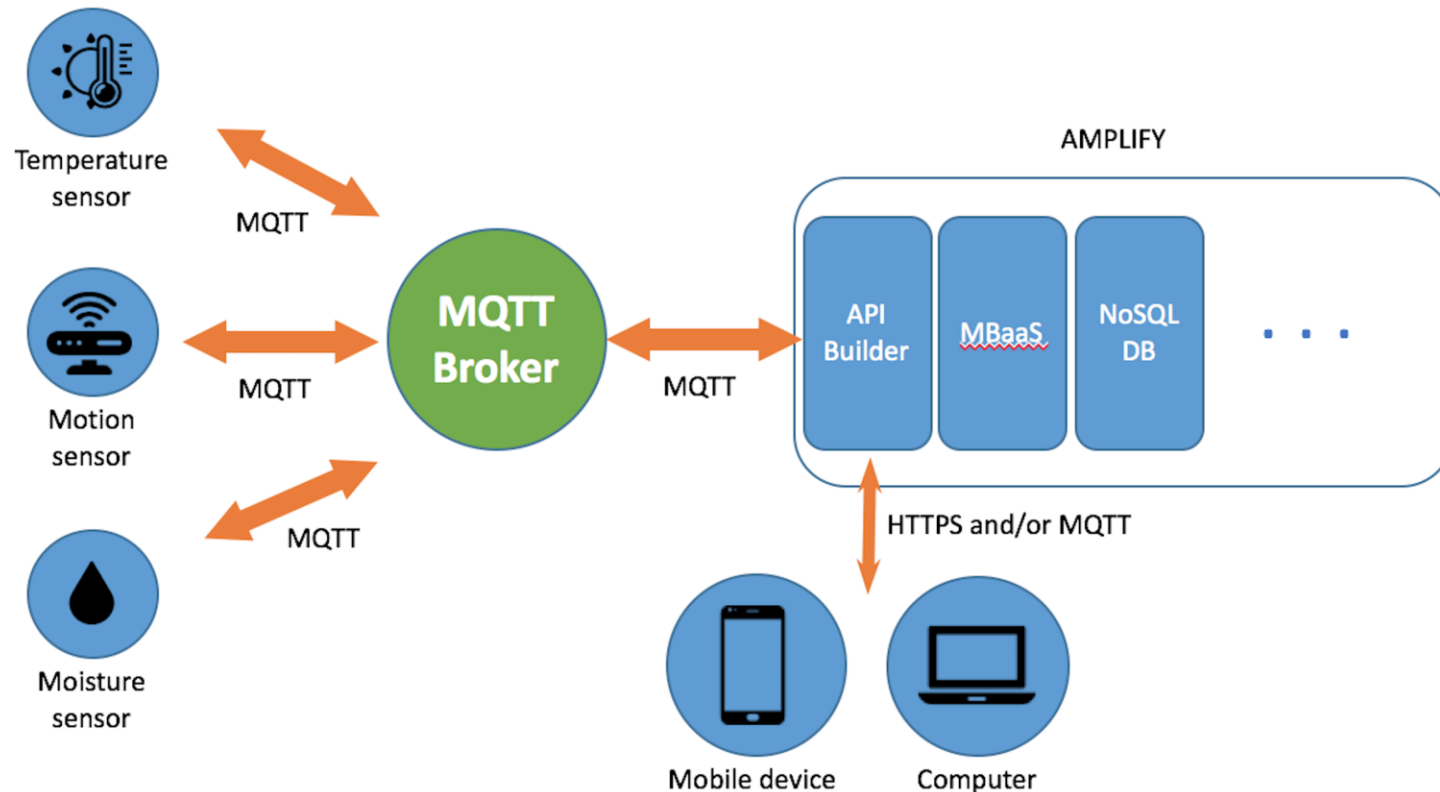UV

Development Environment: Jupyter Notebook

We will use Jupyter Notebook which uses ipython, to interact with Raspberry Pi GPIOs, directly reading sensors and sending data to the internet.

PROJECT SOURCE CODE

MQTT Protocol:

- It stands for Message Queuing Telemetry Transport

- It is a publish-subscribe-based messaging protocol used in the internet of Things.

- It works on top of the TCP/IP protocol, and

- It is designed for connections with remote locations where a "small code footprint" is required or the network bandwidth is limited.

Importance and Applications

IOT and dawn of CLOUD

• With the advent of various cloud services today with flexible infrastructure and scalability, IOT is never so widely used and accepted. Nowadays, IBM Cloud, Azure and all the other cloud service providers provide inbuilt de-facto support for IOT platform as now it coexists with us. With the aid of this project, many ideas can be exercised in a practical way, as:

• As data is stored as a dataset, so it can be used in time series forecast models to study various weather prediction algorithms and revise them based on real world data, instead of a biased one.

• A long term use of the project can aid in determining important patterns in weather for a particular location which can then be used to aggregate and arrange many weather dependent activities such as agricultural, scientific study and so on.

• Various data from the project, can be specifically used in many other forms. Such as data from UV sensor can be used in a particular study to determine sunrays' effect at a particular location.

Use cases

- Following use cases visualize more possible and wider uses of Weather data in real life scenarios with the invent of cloud and in the age of AI. Let's dive in........

Towards Smart Future

- There is a user who wants that his AC should be temperature dependent and he doesn't have to worry about that.

- Now he can connect his AC to cloud services and can devise a particular T (temperature), which would determine the state of AC.

- And now he can take real time data from this weather station to compare with T, and render the curated state as he wanted.

- This flow is quite well articulated today in many scenarios, and is the building block of Smart future. In this similar way, many devices can be made flexible which are dependent on weather conditions and thus will pave way to a smarter offices and smart homes. And then these will together make a smarter ecosystem and in turn smart cities (a prospect posed by Indian Government). So in this way, this whole device is a lot useful.

Fighting Skin Cancer

- As per the Skin Cancer Foundation, UV rays are the one of the major risk factors for the skin cancer (or melanoma). And, apart from this , there are other ton of skin diseases that arises from UV rays.

- A particular medical association or a corporate company, can by using various decentralized sources of weather data select particular regions with high exposure of UV rays, which will also lead to above mentioned diseases and circumstances, namely scan cancer. So this analysis will then help one to approach those regions with proper medical support and instruments and also official guidelines of present risks in the region. One could also study for the cause of increased radiation and can gain important insights there just due to a mere UV ray sensor working somewhere.

AI and Weather data

- Well, today wherever you see, there is an instance of a learnt machine. And thus the age of AI is here folks. But how weather data plays an important role in this domain. Well, there's one everyone knows, weather forecasting. But interestingly, there are many others...

- Weather data can be used for making agricultural decisions and can many farmers' lives as their suicides skyrocketed in India in recent times. Due to global warming, new weather patterns are emerging and people relying on old patterns are suffering huge losses and AI can eradicate this. This paper [here](#) also explains this dialect in much detail with some groundwork.

- Weather data can be interestingly also used for solving crimes or for simulating certain happenings in past or for many other unexpected scenarios. It is a difficult and is an advanced implementation of AI methodologies as explained [here](#) in detail.

Limitations

Even with many wider use cases and advantages, there are certain limitations to this project, as depicted below:

- For successful working of the project and manipulation of data, we need cloud and so if the network is too bad or cloud servers are compromised, then we're stuck.

- There are many other parameters which are deciding factors in weather simulation and forecasting, but it's not feasible to record them through this project.

- While using the data for prediction and forecasting uses, there is lot of noise in the data, and for unbiased analysis, we need too much computational power due to more complex algorithms.

- This hardware needs exposure to environment to get real data, but at the same time it is prone to natural risks and calamities, and so deploying it in real time is a practical challenge.

And at last, we're still quite far from understanding everything about nature, and so these all are a mere quantitative study and it's all probabilistic at its core. So, affirming something for sure was never an option for mankind, and thus it's a limitation we can't overcome yet.

Thank You !!

We will be happy to answer any queries.

Signing Off...