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NPTEL ONLINE CERTIFICATION COURSES

Implementation of IoT with Raspberry Pi: Part 2

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IOT

Internet Of Things

- Creating an interactive environment
- Network of devices connected together

IOT: Remote Data Logging

- Collect data from the devices in the network
- Send the data to a server/remote machine
- Control the network remotely

IOT: Remote Data Logging

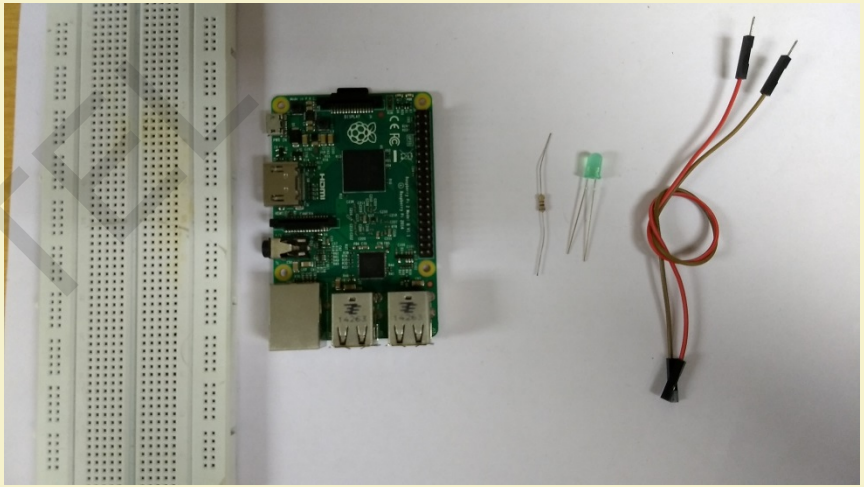
System Overview:

- A network of Temperature and humidity sensor connected with Raspberry Pi
- Read data from the sensor
- Send it to a Server
- Save the data in the server

IOT: Remote Data Logging (contd..)

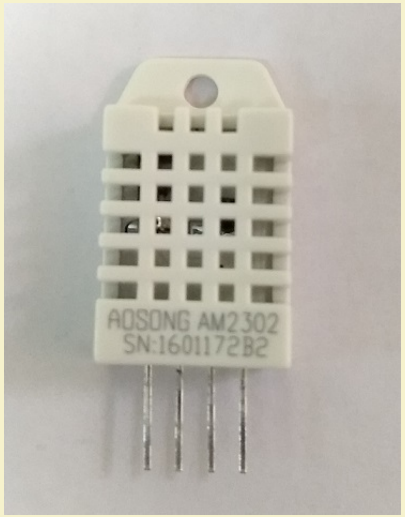
Requirements

- DHT Sensor
- 4.7K ohm resistor
- Jumper wires
- Raspberry Pi



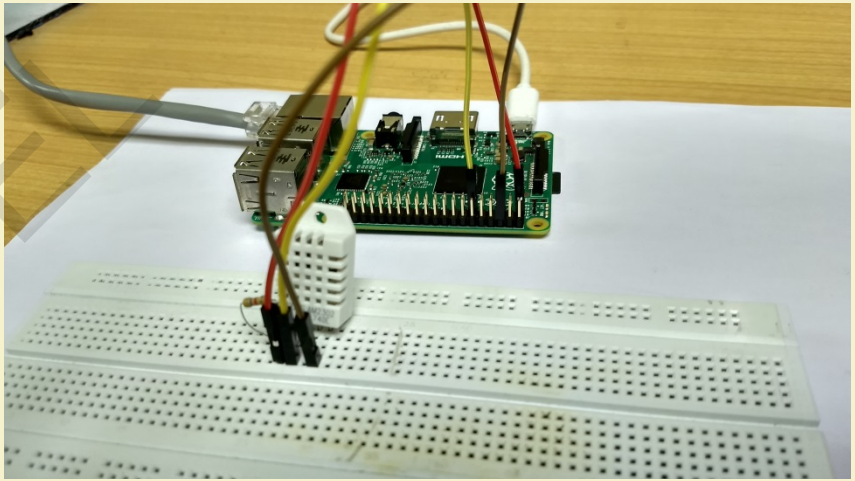
DHT Sensor

- Digital Humidity and Temperature Sensor (DHT)
- PIN 1, 2, 3, 4 (from left to right)
  - PIN 1- 3.3V-5V Power supply
  - PIN 2- Data
  - PIN 3- Null
  - PIN 4- Ground



Sensor- Raspberry Pi Interface

- Connect pin 1 of DHT sensor to the 3.3V pin of Raspberry Pi
- Connect pin 2 of DHT sensor to any input pins of Raspberry Pi, here we have used pin 11
- Connect pin 4 of DHT sensor to the ground pin of the Raspberry Pi



Read Data from the Sensor

Adafruit provides a library to work with the DHT22 sensor

Install the library in Raspberry Pi

Use the function Adafruit_DHT.read_retry() to read data from the sensor

Source: ADAFRUIT DHTXX SENSORS, Lady Ada, 2012-07-29

Program: DHT22 interfaced with Raspberry Pi

Code

```
GNU nano 2.2.6                File: IOTSR.py

import RPi.GPIO as GPIO
from time import sleep

import Adafruit_DHT

GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)

sensor = Adafruit_DHT.AM2302  # create an instance of the sensor type

print ('Getting data from the sensor')

#humidity and temperature are 2 variables that store the values received from the sensor
humidity, temperature = Adafruit_DHT.read_retry(sensor,17)

print ('Temp={0:0.1f}*C humidity={1:0.1f}%'.format(temperature, humidity))
```

Output

```
pi@raspberrypi:~ $ python IOTSR.py
Getting data from the sensor
Temp=26.1*C humidity=65.9%
pi@raspberrypi:~ $
```

Sending Data to a Server

Sending data to Server using network protocols

- Create a server and client
- Establish connection between the server and the client
- Send data from the client to the server

Sending Data to a Server (contd..)

Socket Programming:

- Creates a two-way communication between two nodes in a network
- The nodes are termed as Server and Client
- Server performs the task/service requested by the client

Sending Data to a Server (contd..)

Creating a socket:

s = socket.socket (SocketFamily, SocketType, Protocol=0)

- ✓ SocketFamily can be AF_UNIX or AF_INET
- ✓ SocketType can be SOCK_STREAM or SOCK_DGRAM
- ✓ Protocol is set default to 0

Source: PYTHON NETWORK PROGRAMMING, TutorialsPoint

Sending Data to a Server (contd..)

Server:

```
s = socket.socket()             # creating a socket object
host = socket.gethostname()             # local machine name/address
port = 12321                    # port number for the server
s.bind((host, port))            # bind to the port
s.listen(5)                     # waiting for the client to connect
while True:
        c, addr = s.accept()                # accept the connection request from the client
        print ‘Connected to', addr
        c.send(‘Connection Successful')
c.close()                                   #close the socket
```

Source: PYTHON NETWORK PROGRAMMING, TutorialsPoint

Sending Data to a Server (contd..)

Client:

```
s = socket.socket()                  # creating a socket object
host = socket.gethostname()          # getting local machine name
port = 12345                         # assigning a port
s.connect((host, port))
print s.recv(1024)
s.close
```


Source: PYTHON NETWORK PROGRAMMING, TutorialsPoint

Sending Data to a Server (contd..)

Client Code: Obtain readings from the sensor

```
def sensordata():
    GPIO.setmode(GPIO.BOARD)
    GPIO.setwarnings(False)
    sensor = Adafruit_DHT.AM2302
    humidity, temperature = Adafruit_DHT.read_retry(sensor,17)
    return(humidity, temperature)
```

This function returns the values from the DHT sensor

Sending Data to a Server (contd..)

Client Code: Connecting to the server and sending the data

```
sock = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)                    #create UDP socket
server_address = ('10.14.3.194', 10001)
try:
   while (1):
            h,t = sensordata()
            message = str(h)+','+str(t)
            #Send data
            print >>sys.stderr, 'sending "%s"' % message

            sent = sock.sendto(message, server_address)
finally:
   print >>sys.stderr, 'closing socket'
   sock.close()
```

Sending Data to a Server (contd..)

Server Code: Receive data from client and save it

```
sock = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)

server_address = ('10.14.3.194', 10001)
sock.bind(server_address)
while True:
   data, address = sock.recvfrom(4096)
   with open("Datalog.txt","a") as f:
      mess=str(data)
      f.write(mess)
      print mess
   f.close()
```

```
# Create a UDP socket

# Bind the socket to the port
```

Result

- The client takes reading from the sensor and sends it to the server
- The server receives the data from the client and saves it in a text file DataLog.txt

```
68.9000015259,23.5
68.9000015259,23.5
68.9000015259,23.5
68.9000015259,23.5
68.9000015259,23.3999996185
68.9000015259,23.3999996185
68.9000015259,23.5
68.9000015259,23.5
68.8000030518,23.3999996185
68.9000015259,23.5
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Thank You!!

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Implementation of IoT with Raspberry Pi: Part 3

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- Collect data from the devices in the network
- Send the data to a server/remote machine
- Processing the data
- Respond to the network

IOT: Remote Data Logging

System Overview:

- A network of Temperature and humidity sensor connected with Raspberry Pi
- Read data from the sensor
- Send it to a Server
- Save the data in the server
- **Data Splitting**
- **Plot the data**

IOT: Remote Data Logging (contd..)

Requirements

- DHT Sensor
- 4.7K ohm resistor
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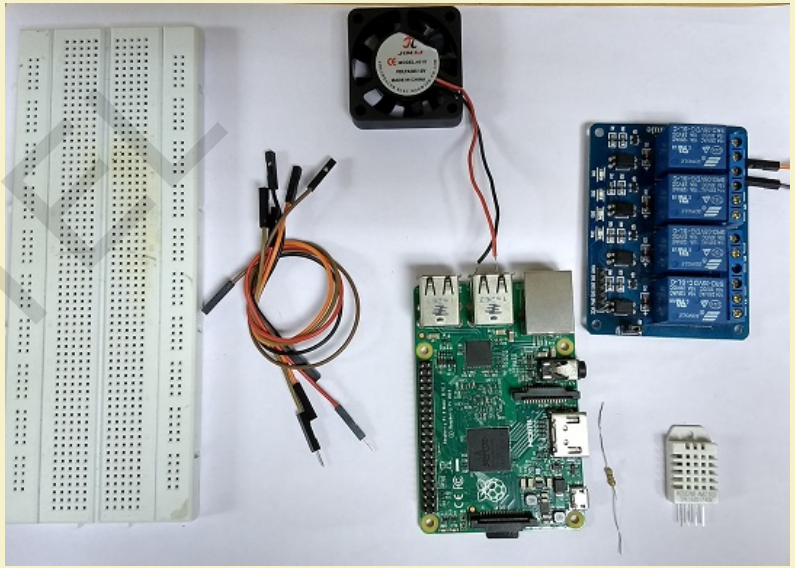

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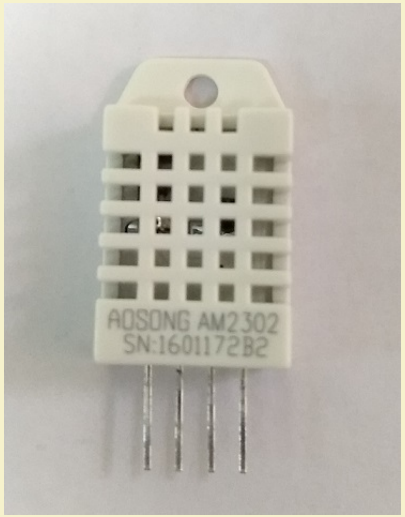

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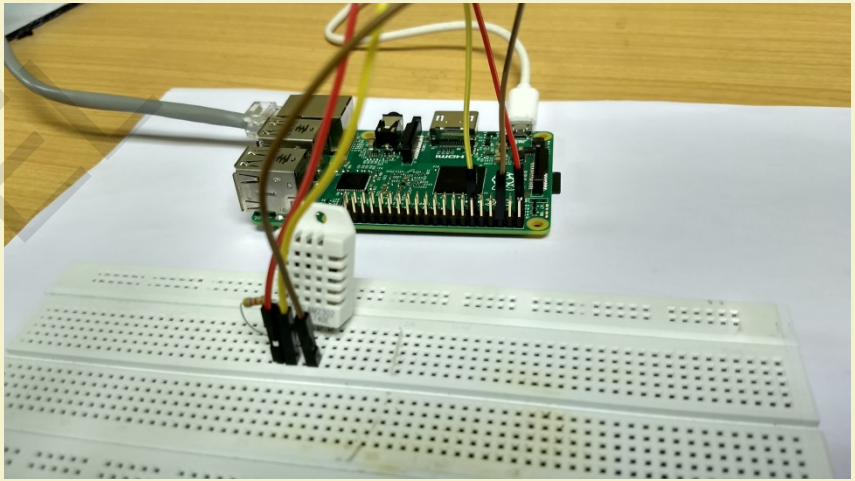

Read Data from the Sensor

Use the Adafruit library for DHT22 sensor to read the sensor data

```
 GNU nano 2.2.6                File: IOTSR.py

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from time import sleep

import Adafruit_DHT

GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)

sensor = Adafruit_DHT.AM2302  # create an instance of the sensor type

print ('Getting data from the sensor')

#humidity and temperature are 2 variables that store the values received from the sensor
humidity, temperature = Adafruit_DHT.read_retry(sensor,17)

print ('Temp={0:0.1f}*C humidity={1:0.1f}%'.format(temperature, humidity))
```

```
pi@raspberrypi:~ $ python IOTSR.py
Getting data from the sensor
Temp=26.1*C humidity=65.9%
pi@raspberrypi:~ $
```

Sending Data to a Server

- Sending data to server using socket programming
  - Create a client and server
  - Establish connection between the two
  - Send data from the client to the server
  - Save the data in a file

Data Processing

Data from the client needs to be processed before it can be used further

- Data splitting/filtering
- Data plotting

Data Processing

Data splitting/filtering:

- Data from the client is saved in a text file
- The values are separated by a comma(‘ , ’)

message = str(h)+','+str(t)

- Split() function can be used to split a string into multiple strings depending on the type of separator/delimiter specified.

Example:

Data= ‘sunday,monday,tuesday’ #Data is a string with 3 words separated by a comma

Data.split(“,”) # split the data whenever a “,” is found

[‘sunday’,’monday’,’tuesday’] # Gives 3 different strings as output

Source: HOW TO USE SPLIT IN PYTHON, PythonForBeginners, Sep 26, 2012

Data Processing

Plotting the data:

- MATPLOTLIB is a python library used to plot in 2D
  - Plot(x,y): plots the values x and y
  - xlabel('X Axis'): Labels the x-axis
  - ylabel('Y Axis'): Labels the y-axis
  - title("Simple Plot"): Adds title to the plot

Source: MATPLOTLIB, John Hunter, Darren Dale, Eric Firing, Michael Droettboom and the Matplotlib development team, 2012 - 2016

Data Processing (contd..)

Plotting the data:

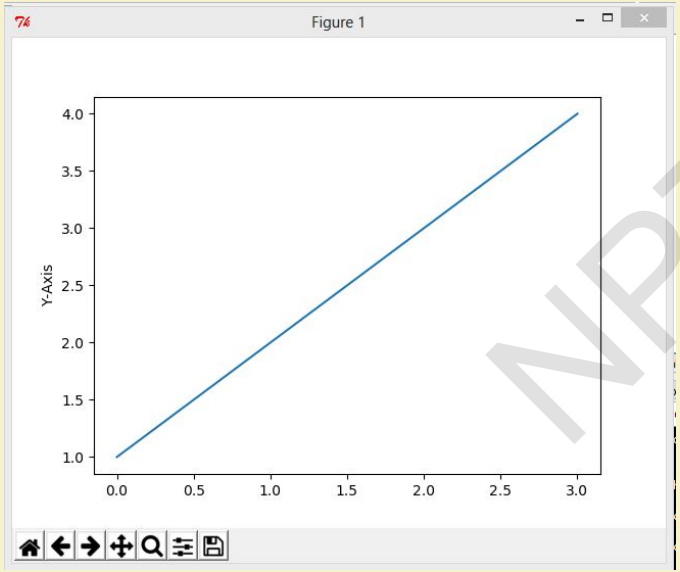
```
import matplotlib.pyplot as myplot
myplot.plot([1,2,3,4])
myplot.ylabel('Y-Axis')
myplot.show()
```

By default the values are taken for y-axis, values for x-axis are generated automatically starting from 0

Source: MATPLOTLIB, John Hunter, Darren Dale, Eric Firing, Michael Droettboom and the Matplotlib development team, 2012 - 2016

Data Processing (contd..)

Basic Plot:




```
import matplotlib.pyplot as myplot
myplot.plot([1,2,3,4])
myplot.ylabel("Y-Axis")
myplot.show()
```

Data Proceessing (contd..)

Some other common functions used in plotting:

- figure(): Creates a new figure
- grid(): Enable or disable axis grids in the plot
- ion(): turns on the interactive mode
- subplot(): Adds subplot in a figure
- Close(): Close the current figure window
- Scatter(): make a scatter plot of the given points

Source: MATPLOTLIB, John Hunter, Darren Dale, Eric Firing, Michael Droettboom and the Matplotlib development team, 2012 - 2016

Sending Data to a Server (contd..)

Client:

```
def sensordata():
    GPIO.setmode(GPIO.BOARD)
    GPIO.setwarnings(False)
    sensor = Adafruit_DHT.AM2302
    humidity, temperature =
Adafruit_DHT.read_retry(sensor,17)
    return(humidity, temperature)
```

```
sock = socket.socket(socket.AF_INET,
socket.SOCK_DGRAM)          #create UDP socket
server_address = ('10.14.3.194', 10001)
try:
  while (1):
      h,t = sensordata()
      message = str(h)+','+str(t)          #Send data
      print >>sys.stderr, 'sending "%s"' % message
      sent = sock.sendto(message, server_address)
finally:
  print >>sys.stderr, 'closing socket'
  sock.close()
```

Sending Data to a Server (contd..)

Server:

```
def coverage_plot(data,i):
    hum=data.split(",")[0]
    tem=data.split(",")[1]
    print 'temp='+(str(tem))+'iter='+str(i)
    plt.ion()
    fig=plt.figure(num=1,figsize=(6,6))
    plt.title(' IoT Temperature and Humidity Monitor')
    ax = fig.add_subplot(121)
    ax.plot(tem,i, c='r', marker=r'$\Theta$')
    plt.xlabel('Temp ($^0 C$)')
```

```
    ax.grid()
    ax = fig.add_subplot(122)
    ax.plot(hum,i, c='b', marker=r'$\Phi$')
    plt.xlabel('Humidity ($\%$)')
    ax.grid()
    fig.show()
    fig.canvas.draw()

sock = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)

# Bind the socket to the port
server_address = ('10.14.3.194', 10001)
sock.bind(server_address)
```

Sending Data to a Server (contd..)

Server:

```
i=0
while True:
    data, address = sock.recvfrom(4096)
    with open("DataLog.txt","a") as f:
        mess=str(data)
        f.write(mess)
        coverage_plot(mess,i)
        print mess
        i+=1
    f.close()
```

Output

- The Reading from the sensor is sent to the Server and saved in a text file.
- Two different plots for temperature and humidity data

```
pi@raspberrypi:~ $ python client.py
sending "69.0,23.6000003815"
sending "69.0,23.3999996185"
sending "69.0,23.3999996185"
sending "69.0,23.3999996185"
sending "69.0,23.3999996185"
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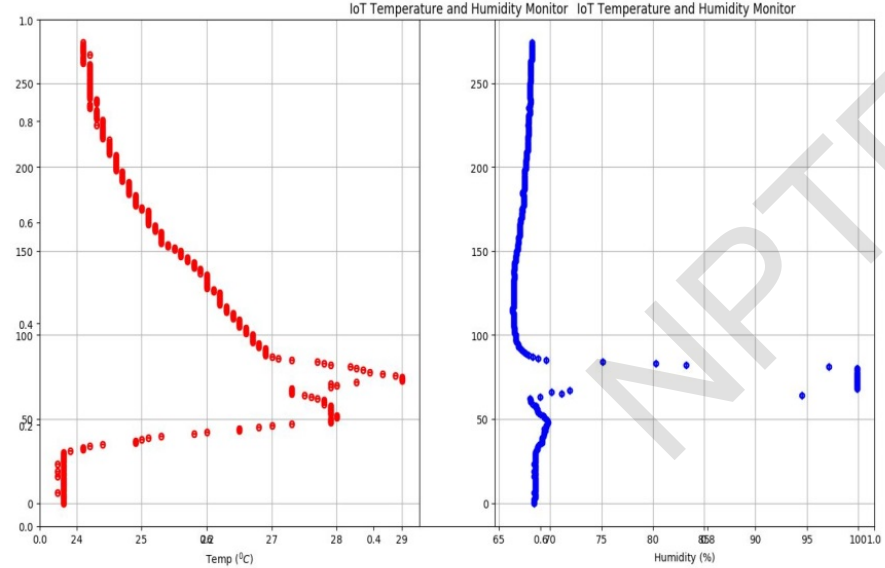
```

Output




```
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Thank You!!