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Introduction to Python Programming – Part I

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Why Python?

- Python is a versatile language which is easy to script and easy to read.
- It doesn't support strict rules for syntax.
- Its installation comes with integrated development environment for programming.
- It supports interfacing with wide ranging hardware platforms.
- With open-source nature, it forms a strong backbone to build large applications.

Python IDE

- Python IDE is a free and open source software that is used to write codes, integrate several modules and libraries.
- It is available for installation into PC with Windows, Linux and Mac.
- Examples: Spyder, PyCharm, etc.

Starting with Python

- Simple printing statement at the python interpreter prompt,
`>>> print "Hi, Welcome to python!"`
Output: Hi, Welcome to python!
- To indicate different blocks of code, it follows rigid indentation.

if True:

```
    print "Correct"
```

else:

```
    print "Error"
```



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Data-types in Python

- There are 5 data types in Python:

- ✓ Numbers

- $x, y, z = 10, 10.2, " Python "$

- ✓ String

- $x = 'This is Python'$

- $print x$

- $print x[0]$

- $print x[2:4]$

- $>>This is Python$

- $>>T$

- $>>is$



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Data-types in Python (contd..)

- ✓ List

```
x = [10, 10.2, 'python']
```

- ✓ Tuple

- ✓ Dictionary

```
d = {1:'item','k':2}
```



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Controlling Statements

- if (cond.):
 - statement 1
 - statement 2
- elif (cond.):
 - statement 1
 - statement 2
- else:
 - statement 1
 - statement 2
- while (cond.):
 - statement 1
 - statement 2
- x = [1,2,3,4]
 - for i in x:
 - statement 1
 - statement 2



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Controlling Statements (contd..)

- Break

```
for s in "string":  
    if s == 'n':  
        break  
    print (s)  
print "End"
```

- Continue

```
for s in "string":  
    if s == 'y':  
        continue  
    print (s)  
print "End"
```



Functions in Python

- Defining a function

- ✓ Without return value

```
def funct_name(arg1, arg2, arg3):      # Defining the function  
    statement 1  
    statement 2
```

- ✓ With return value

```
def funct_name(arg1, arg2, arg3):      # Defining the function  
    statement 1  
    statement 2  
    return x                            # Returning the value
```



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Functions in Python

- Calling a function

```
def example (str):  
    print (str + "!")
```

```
example ("Hi")
```

```
# Calling the function
```

Output:: Hi!



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Functions in Python (contd..)

- Example showing function returning multiple values

```
def greater(x, y):  
    if x > y:  
        return x, y  
    else:  
        return y, x
```

```
val = greater(10, 100)  
print(val)
```

Output:: (100,10)



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Functions as Objects

- Functions can also be assigned and reassigned to the variables.
- Example:

```
def add (a,b)  
    return a+b
```

```
print (add(4,6))  
c = add(4,6)  
print c
```

Output:: 10 10

Variable Scope in Python

Global variables:

These are the variables declared out of any function , but can be accessed inside as well as outside the function.

Local variables:

These are the ones that are declared inside a function.

Example showing Global Variable

```
g_var = 10
```

```
def example():
    l_var = 100
    print(g_var)
```

```
example()      # calling the function
```

Output:: 10



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Example showing Variable Scope

```
var = 10
```

```
def example():
    var = 100
    print(var)
```

```
example()          # calling the function
print(var)
```

Output:: 100

10



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Modules in Python

- Any segment of code fulfilling a particular task that can be used commonly by everyone is termed as a module.
- Syntax:

```
import module_name          #At the top of the code
```

```
using module_name.var      #To access functions and values  
                           with 'var' in the module
```



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Modules in Python (contd..)

- Example:

```
import random
```

```
for i in range(1,10):  
    val = random.randint(1,10)  
    print (val)
```

Output:: varies with each execution



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Modules in Python (contd..)

- We can also access only a particular function from a module.
- Example:

```
from math import pi
```

```
print(pi)
```

Output:: 3.14159



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Exception Handling in Python

- An error that is generated during execution of a program, is termed as exception.
- Syntax:

```
try:  
    statements  
except _Exception_:  
    statements  
else:  
    statements
```



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Exception Handling in Python (contd..)

- Example:

```
while True:  
    try:  
        n = input ("Please enter an integer: ")  
        n = int (n)  
        break  
    except ValueError:  
        print "No valid integer!"  
print "It is an integer!"
```



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Example Code: to check number is prime or not

```
x = int (input("Enter a number: "))

def prime (num):
    if num > 1:
        for i in range(2,num):
            if (num % i) == 0:
                print (num,"is not a prime number")
                print (i,"is a factor of",num)
                break
            else:
                print(num,"is a prime number")
        else:
            print(num,"is not a prime number")

prime (x)
```

Thank You!!



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Introduction to Python Programming – Part II

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File Read Write Operations

- Python allows you to read and write files
- No separate module or library required
- Three basic steps
 - Open a file
 - Read/Write
 - Close the file



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File Read Write Operations (contd..)

Opening a File:

- Open() function is used to open a file, returns a file object
`open(file_name, mode)`
- Mode: Four basic modes to open a file
 - r: read mode
 - w: write mode
 - a: append mode
 - r+: both read and write mode



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File Read Write Operations (contd..)

Read from a file:

- `read():` Reads from a file
`file=open('data.txt', 'r')`
`file.read()`

Write to a file:

- `Write():` Writes to a file
`file=open('data.txt', 'w')`
`file.write('writing to the file')`



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File Read Write Operations (contd..)

Closing a file:

- Close(): This is done to ensure that the file is free to use for other resources
`file.close()`

Using WITH to open a file:

- Good practice to handle exception while file read/write operation
- Ensures the file is closed after the operation is completed, even if an exception is encountered

```
with open("data.txt","w") as file:  
    file.write("writing to the text file")  
    file.close()
```

File Read Write Operations code + image

```
with open("PythonProgram.txt","w") as file:
```

```
    file.write("Writing data")
```

```
file.close()
```

```
with open("PythonProgram.txt","r") as file:
```

```
f=file.read()
```

```
print('Reading from the file\n')
```

```
print (f)
```

```
file.close()
```

Reading from the file

Writing data

>>> |



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File Read Write Operations (contd..)

Comma Separated Values Files

- CSV module supported for CSV files

Read:

```
with open(file, "r") as csv_file:  
    reader = csv.reader(csv_file)  
    print("Reading from the CSV File\n")  
    for row in reader:  
        print(" ".join(row))  
    csv_file.close()
```

Write:

```
data = ["1,2,3,4,5,6,7,8,9".split(",")]  
file = "output.csv"  
with open(file, "w") as csv_file:  
    writer = csv.writer(csv_file, delimiter=',')  
    print("Writing CSV")  
    for line in data:  
        writer.writerow(line)  
    csv_file.close()
```



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File Read Write Operations (contd..)

```
import csv

#writing a csv file
data = ["1,2,3,4,5,6,7,8,9".split(",")]
file = "output.csv"
with open(file, "w") as csv_file:
    writer = csv.writer(csv_file, delimiter=',')
    print("Writing CSV")
    for line in data:
        writer.writerow(line)
csv_file.close()

#reading from a csv file|
with open(file, "r") as csv_file:
    reader = csv.reader(csv_file)
    print("Reading from the CSV File\n")
    for row in reader:
        print(" ".join(row))
csv_file.close()
```

Writing CSV
Reading from the CSV File

1 2 3 4 5 6 7 8 9

>>>



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Image Read/Write Operations

- Python supports PIL library for image related operations
- Install PIL through PIP

```
sudo pip install pillow
```

PIL is supported till python version 2.7. Pillow supports the 3x version of python.



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Image Read/Write Operations

Reading Image in Python:

- PIL: Python Image Library is used to work with image files

```
from PIL import Image
```

- Open an image file

```
image=Image.open(image_name)
```

- Display the image

```
image.show()
```



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Image Read/Write Operations (contd..)

Resize(): Resizes the image to the specified size

```
image.resize(255,255)
```

Rotate(): Rotates the image to the specified degrees, counter clockwise

```
image.rotate(90)
```

Format: Gives the format of the image

Size: Gives a tuple with 2 values as width and height of the image, in pixels

Mode: Gives the band of the image, 'L' for grey scale, 'RGB' for true colour image

```
print(image.format, image.size, image.mode)
```

Image Read/Write Operations (contd..)

Convert image to different mode:

- Any image can be converted from one mode to ‘L’ or ‘RGB’ mode

`conv_image=image.convert('L')`

- Conversion between modes other than ‘L’ and ‘RGB’ needs conversion into any of these 2 intermediate mode

Output

Converting a sample image to Grey Scale

```
from PIL import Image  
  
im = Image.open('/home/saswati/VRP_Linux/Images/i3.jpg')  
im.show()  
grey_image=im.convert('L')  
grey_image.show()  
grey_image.save('GreyScaleImage.jpg')
```

Output



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Networking in Python

- Python provides network services for client server model.
- Socket support in the operating system allows to implement clients and servers for both connection-oriented and connectionless protocols.
- Python has libraries that provide higher-level access to specific application-level network protocols.

Networking in Python (contd..)

- Syntax for creating a socket:

```
s = socket.socket (socket_family, socket_type, protocol=0)
```

socket_family – AF_UNIX or AF_INET

socket_type – SOCK_STREAM or SOCK_DGRAM

protocol – default ‘0’.

Example - simple server

- The socket waits until a client connects to the port, and then returns a connection object that represents the connection to that client.

```
import socket  
import sys
```

```
# Create a TCP/IP socket  
sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)  
  
# Bind the socket to the port  
server_address = ('10.14.88.82', 2017)  
print >>sys.stderr, 'starting up on %s port %s' % server_address  
sock.bind(server_address)
```

Example - simple server (contd..)

```
# Listen for incoming connections
```

```
sock.listen(1)
```

```
connection, client_address = sock.accept()
```

```
#Receive command
```

```
data = connection.recv(1024)
```

```
print(data)
```

```
sock.close()
```



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Example - simple client

```
import socket  
import sys
```

```
# Create a TCP/IP socket  
client_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
```

```
#Connect to Listener socket  
client_socket.connect(("10.14.88.82", 2017))  
print>>sys.stderr,'Connection Established'
```

```
#Send command  
client_socket.send('Message to the server')  
print('Data sent successfully')
```

Code Snapshot

```
import socket
import sys

# Create a TCP/IP socket
sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)

# Bind the socket to the port
server_address = ('10.14.88.82', 2017)
print >>sys.stderr, 'starting up on %s port %s' % server_address
sock.bind(server_address)

# Listen for incoming connections
sock.listen(1)

connection, client_address = sock.accept()

#Receive command
data = connection.recv(1024)
print(data)
sock.close()
|
```

```
import socket
import sys

# Create a TCP/IP socket
client_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)

#Connect to Listener socket
client_socket.connect(("10.14.88.82", 2017))
print>>sys.stderr,'Connection Established'

#Send command
client_socket.send('Message to the server')
print('Data sent successfully')
```

Output

```
starting up on 10.14.88.82 port 2017
```

```
Message to the server
```

```
saswati@saswati-BK361AA-ACJ-CQ3236IX:~/Desktop$
```

```
Connection Established
```

```
Data sent successfully
```

```
saswati@saswati-BK361AA-ACJ-CQ3236IX:~/Desktop$
```



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Thank You!!



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Introduction to Raspberry Pi – Part I

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What is Raspberry Pi?

- Computer in your palm.
- Single-board computer.
- Low cost.
- Easy to access.



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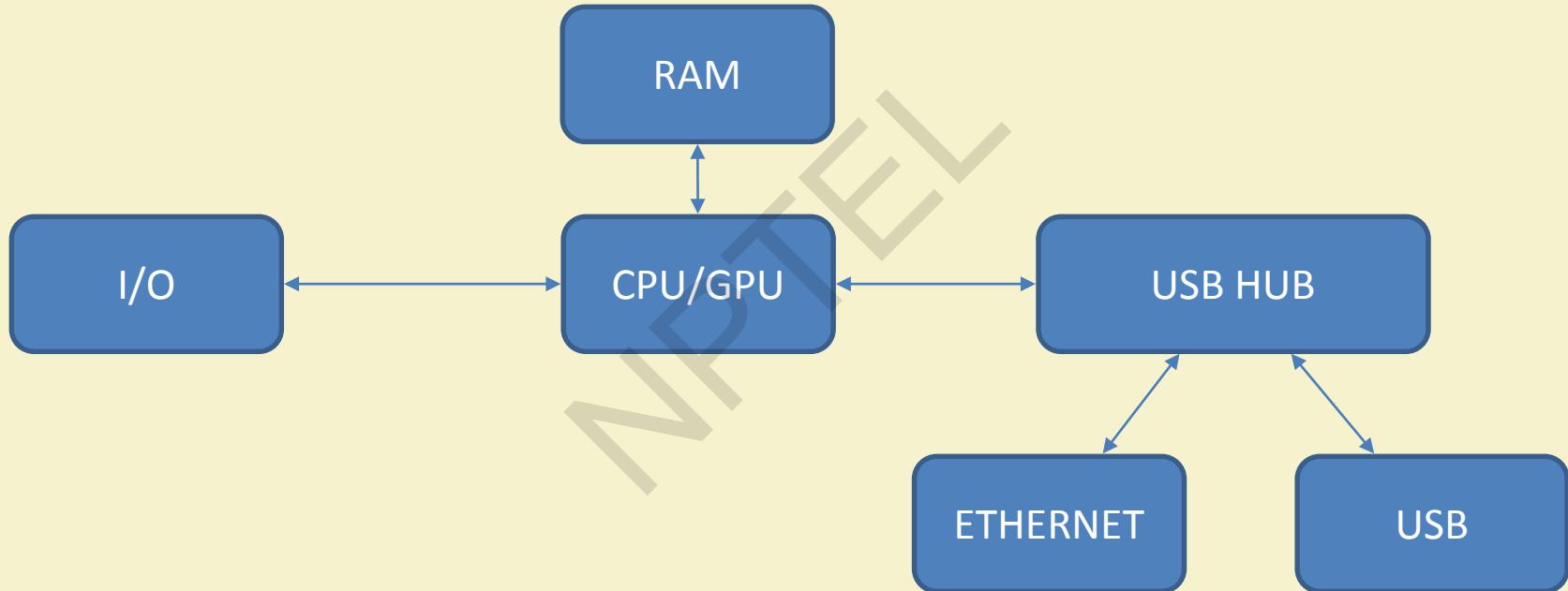
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Specifications

Key features	Raspberry pi 3 model B	Raspberry pi 2 model B	Raspberry Pi zero
RAM	1GB SDRAM	1GB SDRAM	512 MB SDRAM
CPU	Quad cortex A53@1.2GHz	Quad cortex A53@900MHz	ARM 11@ 1GHz
GPU	400 MHz video core IV	250 MHz video core IV	250 MHz video core IV
Ethernet	10/100	10/100	None
Wireless	802.11/Bluetooth 4.0	None	None
Video output	HDMI/Composite	HDMI/Composite	HDMI/Composite
GPIO	40	40	40

Basic Architecture



Raspberry Pi



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Start up raspberry pi



Raspberry Pi GPIO

- Act as both digital output and digital input.
- **Output:** turn a GPIO pin high or low.
- **Input:** detect a GPIO pin high or low.

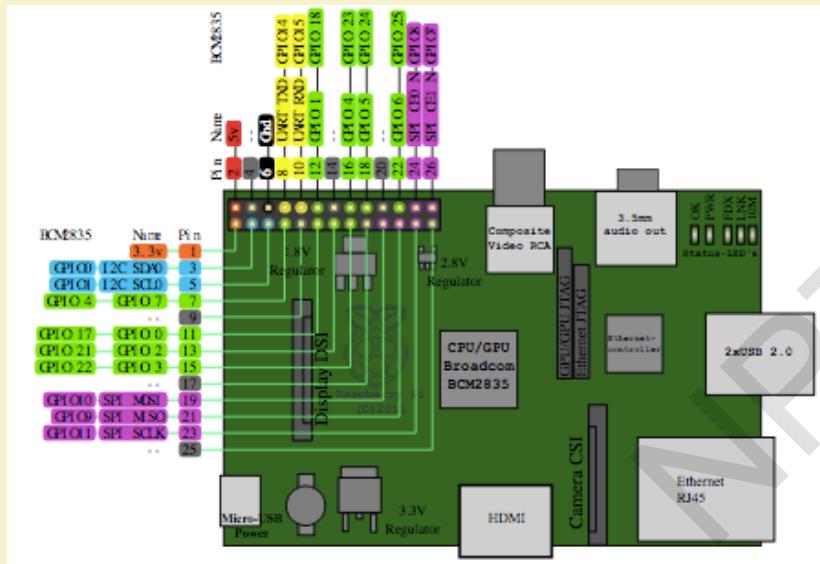


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Raspberry Pi pin configuration



Source: Raspberry Pi PCB Pin Overview, Wikimedia Commons (Online)

Source: [Raspberry Pi GPIO](#), Wikimedia Commons (Online)



Basic Set up for Raspberry Pi

- HDMI cable.
- Monitor.
- Key board.
- Mouse.
- 5volt power adapter for raspberry pi.
- LAN cable .
- Min- 2GB micro sd card



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Basic Set up for Raspberry Pi



Operating System

Official Supported OS :

- Raspbian
- NOOBS

Some of the third party OS :

- UBUNTU mate
- Snappy Ubuntu core
- Windows 10 core
- Pinet
- Risc OS

Source: [Downloads](#), Raspberry Pi Foundation

Raspberry Pi Setup

Download Raspbian:

- Download latest Raspbian image from raspberry pi official site:
<https://www.raspberrypi.org/downloads/>
- Unzip the file and end up with an .img file.



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Raspberry Pi OS Setup

Write Raspbian in SD card :

- Install “Win32 Disk Imager” software in windows machine .
- Run Win32 Disk Imager
- Plug SD card into your PC
- Select the “Device”
- Browse the “Image File”(Raspbian image)
- Write



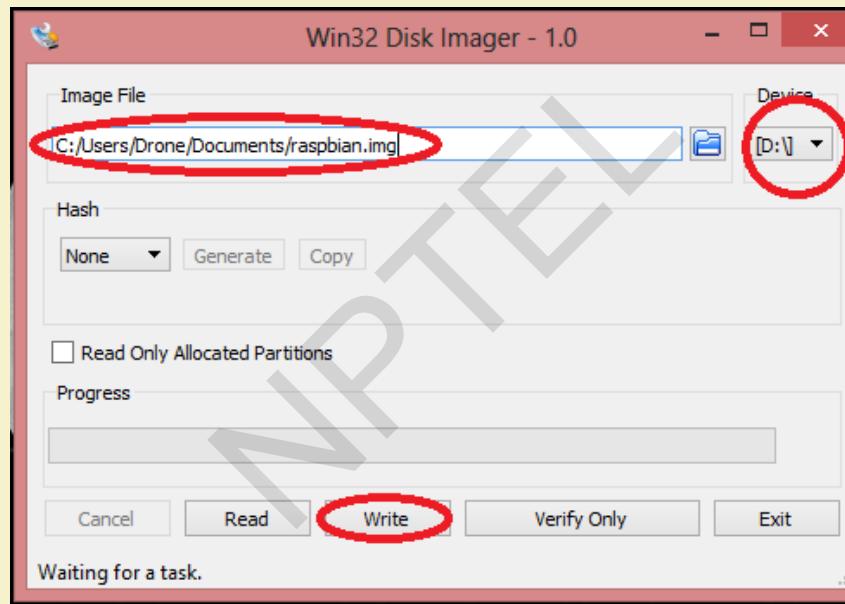
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Raspberry Pi OS Setup



Basic Initial Configuration

Enable SSH

Step1 : Open command prompt and type **sudo raspi-config** and press enter.

Step2: Navigate to SSH in the Advance option.

Step3: Enable SSH



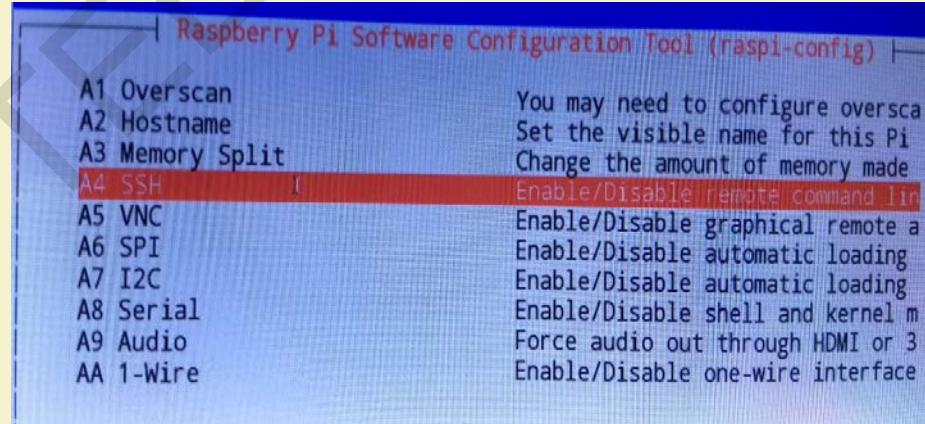
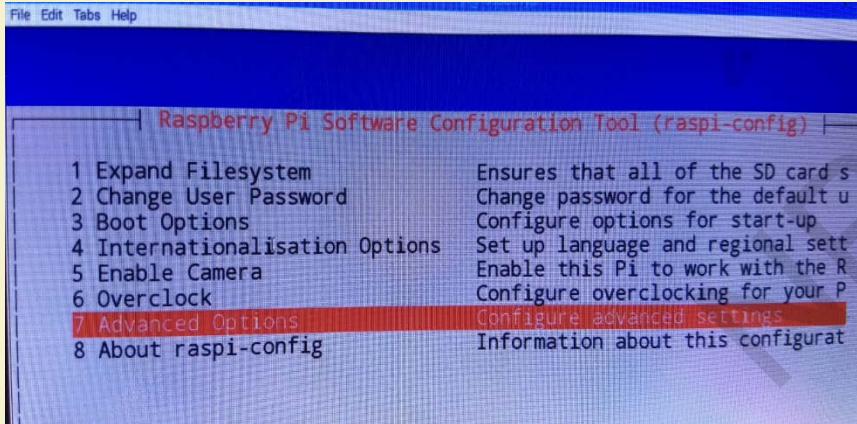
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Basic Initial Configuration



Basic Initial Configuration contd.

Expand file system :

Step 1: Open command prompt and type **sudo raspi-config** and press enter.

Step 2: Navigate to Expand Filesystem

Step 3: Press enter to expand it.



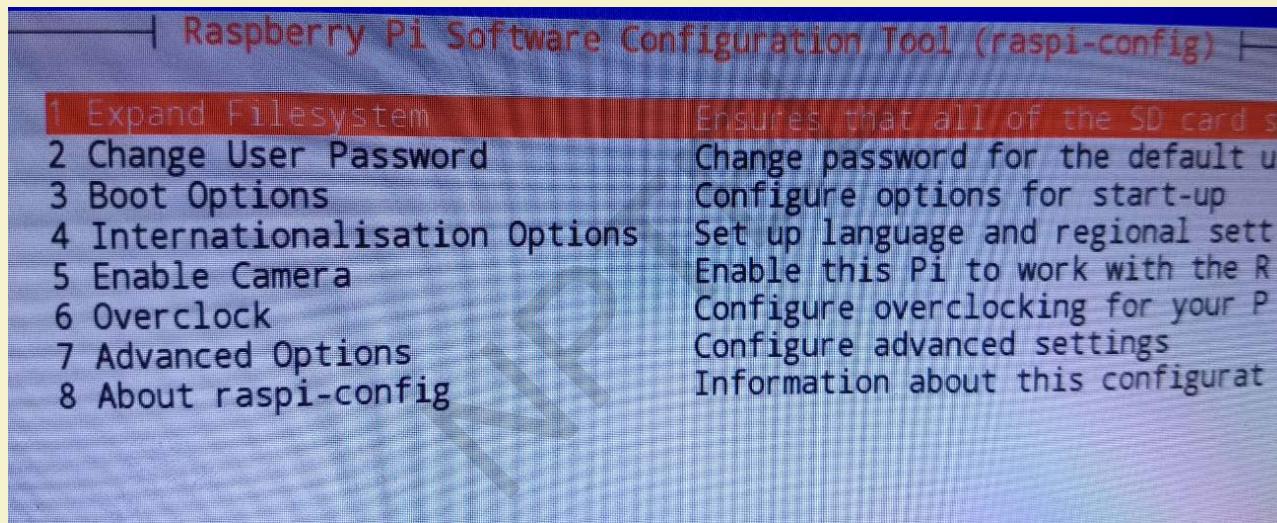
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Basic Initial Configuration contd.



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Programming

Default installed :

- Python
- C
- C++
- Java
- Scratch
- Ruby

Note : Any language that will compile for ARMv6 can be used with raspberry pi.

Source: [Programming languages for Raspberry Pi](#), eProseed, Lonneke Dikmans, August 07, 2015

Popular Applications

- Media streamer
- Home automation
- Controlling BOT
- VPN
- Light weight web server for IOT
- Tablet computer

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Thank You!!

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Introduction to Raspberry Pi – Part II

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Topics Covered

- Using GPIO pins
- Taking pictures using PiCam

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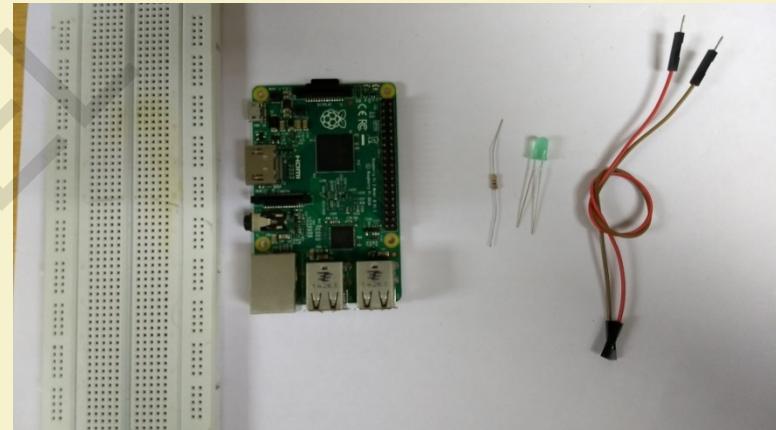


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Blinking LED

- Requirement:
- Raspberry pi
- LED
- 100 ohm resistor
- Bread board
- Jumper cables



Blinking LED (contd..)

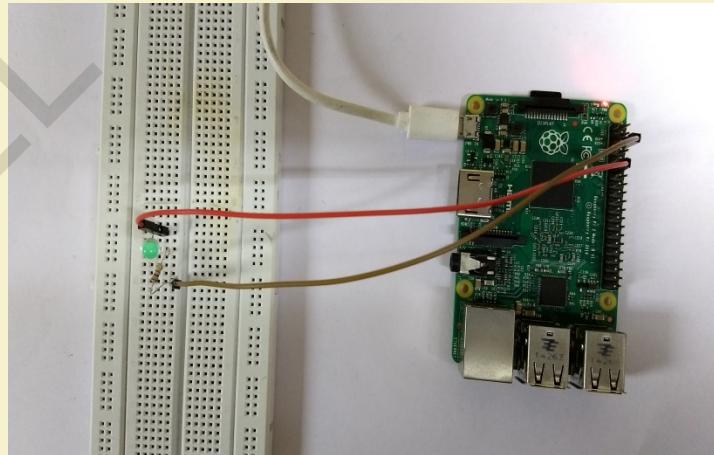
Installing GPIO library:

- Open terminal
- Enter the command “sudo apt-get install python-dev” to install python development
- Enter the command “sudo apt-get install python-rpi.gpio” to install GPIO library.

Blinking LED (contd..)

Connection:

- Connect the negative terminal of the LED to the ground pin of Pi
- Connect the positive terminal of the LED to the output pin of Pi



Blinking LED (contd..)

Basic python coding:

- Open terminal enter the command
`sudo nano filename.py`
- This will open the nano editor where you can write your code
- Ctrl+O : Writes the code to the file
- Ctrl+X : Exits the editor

Blinking LED (contd..)

Code:

```
import RPi.GPIO as GPIO      #GPIO library
import time
GPIO.setmode(GPIO.BOARD)    # Set the type of board for pin numbering
GPIO.setup(11, GPIO.OUT)     # Set GPIO pin 11as output pin
for i in range (0,5):
    GPIO.output(11,True)    # Turn on GPIO pin 11
    time.sleep(1)
    GPIO.output(11,False)
    time.sleep(2)
    GPIO.output(11,True)
GPIO.cleanup()
```

Blinking LED (contd..)

GNU nano 2.2.6

File: BLINK_LED.py

```
import RPi.GPIO as GPIO ## GPIO library
import time
GPIO.setmode(GPIO.BCM) ## Set the type of board for pin numbering
GPIO.setup(11, GPIO.OUT) ## Set GPIO pin 11 as output pin
for i in range (0,5):
    GPIO.output(11,True) ## Turn on GPIO pin 11
    time.sleep(1)
    GPIO.output(11,False)
    time.sleep(2)
    GPIO.output(11,True)
GPIO.cleanup()
```



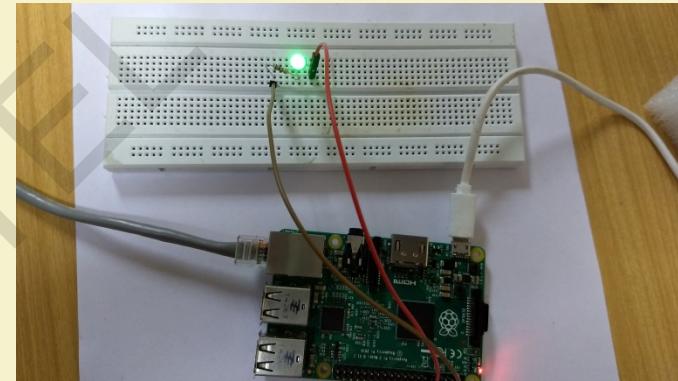
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Blinking LED (contd..)

The LED blinks in a loop with delay of 1 and 2 seconds.



Capture Image using Raspberry Pi



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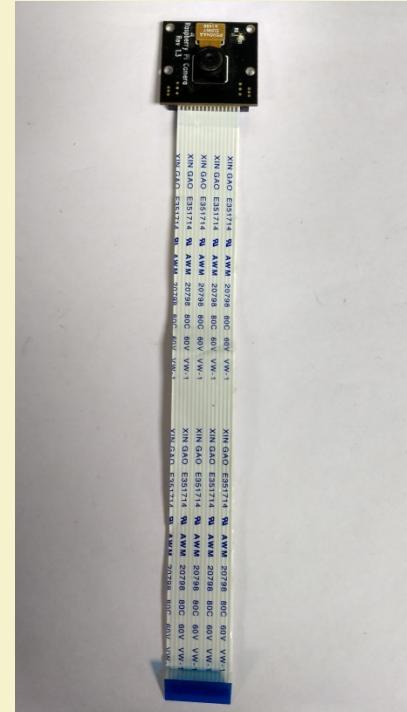
Requirement

- Raspberry Pi
- Raspberry Pi Camera



Raspberry Pi Camera

- Raspberry Pi specific camera module
- Dedicated CSI slot in Pi for connection
- The cable slot is placed between Ethernet port and HDMI port



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Connection

Boot the Pi once the camera is connected to Pi



Configuring Pi for Camera

- In the terminal run the command “sudo raspi-config” and press enter.
- Navigate to “Interfacing Options” option and press enter.
- Navigate to “Camera” option.
- Enable the camera.
- Reboot Raspberry pi.

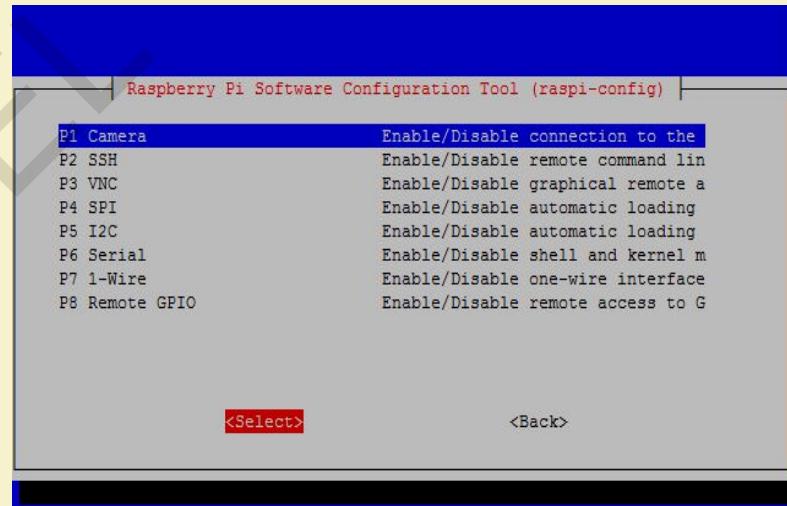
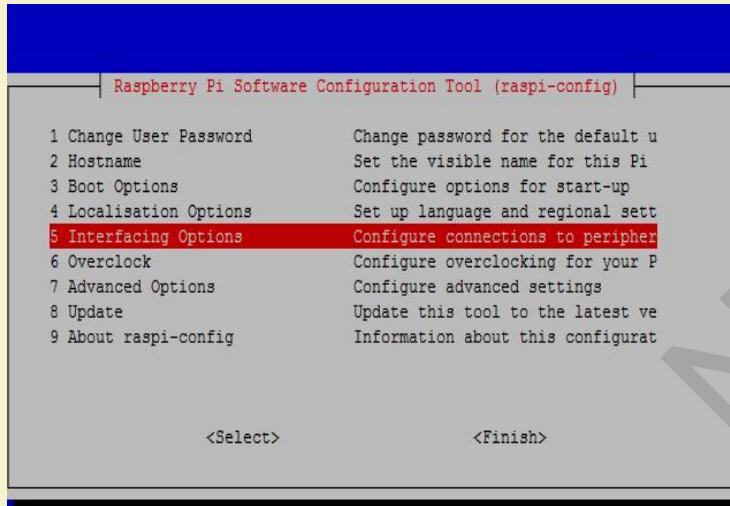


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Configuring Pi for Camera (contd..)



Capture Image

- Open terminal and enter the command-

```
raspistill -o image.jpg
```

- This will store the image as 'image.jpg'



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Capture Image (contd..)

PiCam can also be processed using Python camera module `python-picamera`

```
sudo apt-get install python-picamera
```

Python Code:

```
Import picamera  
camera = picamera.PiCamera()  
camera.capture('image.jpg')
```

Source: [PYTHON PICAMERA](#), Raspberry Pi Foundation

Capture Image (contd..)

```
pi@raspberrypi:~ $ raspistill -o image.jpg  
pi@raspberrypi:~ $
```



Thank You!!



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Implementation of IoT with Raspberry Pi: Part 1

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IOT

Internet Of Things

- Creating an interactive environment
- Network of devices connected together



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Sensor

- Electronic element
- Converts physical quantity into electrical signals
- Can be analog or digital



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Actuator

- Mechanical/Electro-mechanical device
- Converts energy into motion
- Mainly used to provide controlled motion to other components



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System Overview

- Sensor and actuator interfaced with Raspberry Pi
- Read data from the sensor
- Control the actuator according to the reading from the sensor
- Connect the actuator to a device



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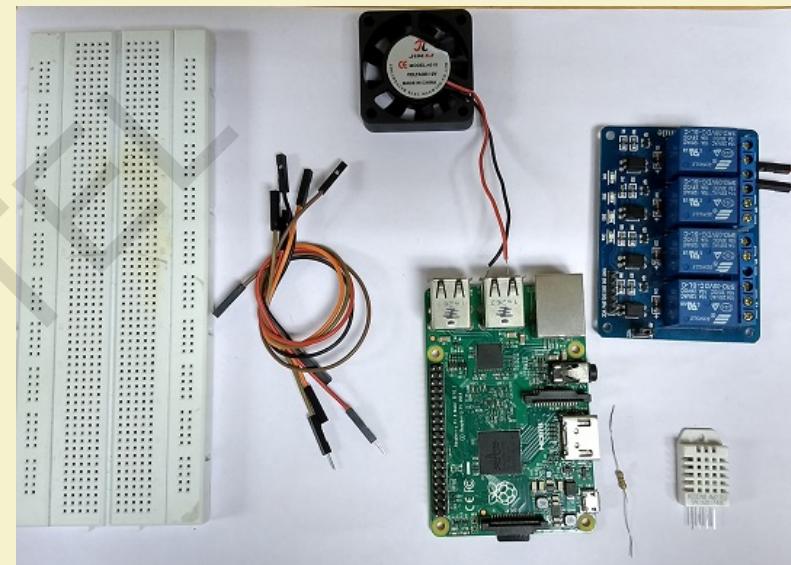


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System Overview (contd..)

Requirements

- DHT Sensor
- 4.7K ohm resistor
- Relay
- Jumper wires
- Raspberry Pi
- Mini fan



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



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Relay

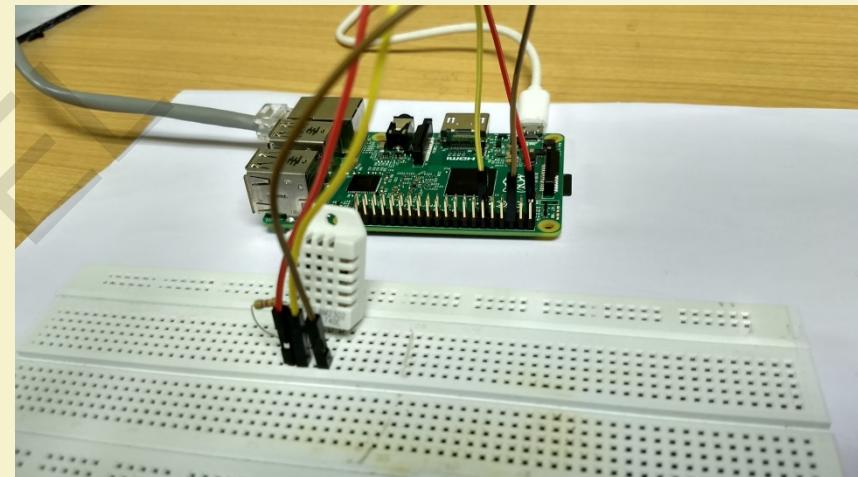
- Mechanical/electromechanical switch
- 3 output terminals (left to right)
 - NO (normal open):
 - Common
 - NC (normal close)



Temperature Dependent Auto Cooling System

Sensor interface with Raspberry Pi

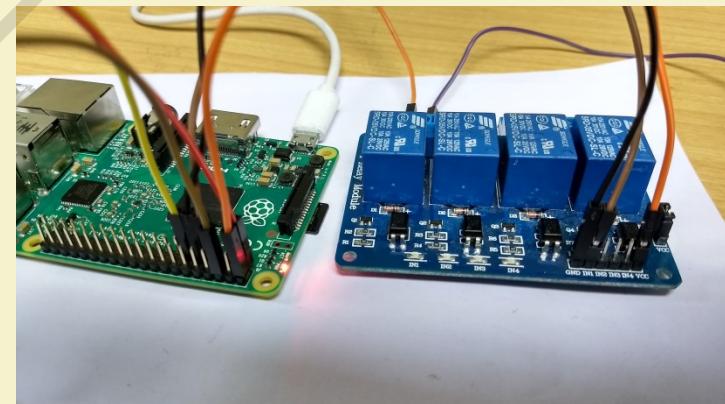
- Connect pin 1 of DHT sensor to the 3.3V pin of Raspberry Pi
- Connect pin 2 of DHT sensor to any input pins of Raspberry Pi, here we have used pin 11
- Connect pin 4 of DHT sensor to the ground pin of the Raspberry Pi



Temperature Dependent Auto Cooling System (contd..)

Relay interface with Raspberry Pi

- Connect the VCC pin of relay to the 5V supply pin of Raspberry Pi
- Connect the GND (ground) pin of relay to the ground pin of Raspberry Pi
- Connect the input/signal pin of Relay to the assigned output pin of Raspberry Pi
(Here we have used pin 7)



Temperature Dependent Auto Cooling System (contd..)

Adafruit provides a library to work with the DHT22 sensor

- Install the library in your Pi-
 - Get the clone from GIT

```
git clone https://github.com/adafruit/Adafruit_Python_DHT.g...
```
 - Go to folder Adafruit_Python_DHT

```
cd Adafruit_Python_DHT
```
 - Install the library

```
sudo python setup.py install
```

Source: [ADAFRUIT DHTXX SENSORS](#), Lady Ada, 2012-07-29

Program: DHT22 with Pi

```
import RPi.GPIO as GPIO
from time import sleep
import Adafruit_DHT
# importing the Adafruit library

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))
```

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:~ $
```

Connection: Relay

- Connect the relay pins with the Raspberry Pi as mentioned in previous slides
- Set the GPIO pin connected with the relay's input pin as output in the sketch
GPIO.setup(13,GPIO.OUT)
- Set the relay pin high when the temperature is greater than 30
if temperature > 30:
 GPIO.output(13,0) # Relay is active low
 print('Relay is on')
 sleep(5)
 GPIO.output(13,1) # Relay is turned off after delay of 5 seconds

Connection: Relay (contd..)

```
GNU nano 2.2.6          File: IOTSR.py

import RPi.GPIO as GPIO
from time import sleep

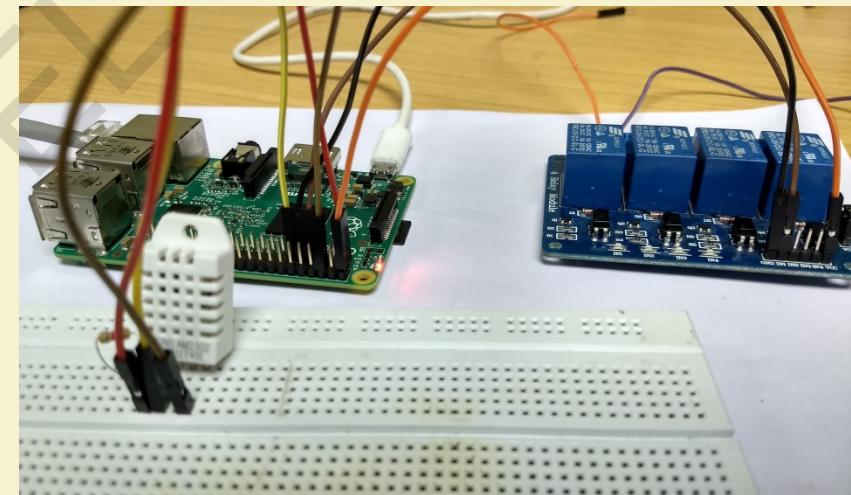
import Adafruit_DHT

GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)
GPIO.setup(7,GPIO.OUT)

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))
if temperature > 20:
    GPIO.output(7,0) # Relay is active low
    print('Relay is on')
    sleep(5)
    GPIO.output(7,1) # Relay is turned off after delay of 5 seconds
```



Connection: Fan

- Connect the Li-po battery in series with the fan
 - NO terminal of the relay -> positive terminal of the Fan.
 - Common terminal of the relay -> Positive terminal of the battery
 - Negative terminal of the battery -> Negative terminal of the fan.
- Run the existing code. The fan should operate when the surrounding temperature is greater than the threshold value in the sketch

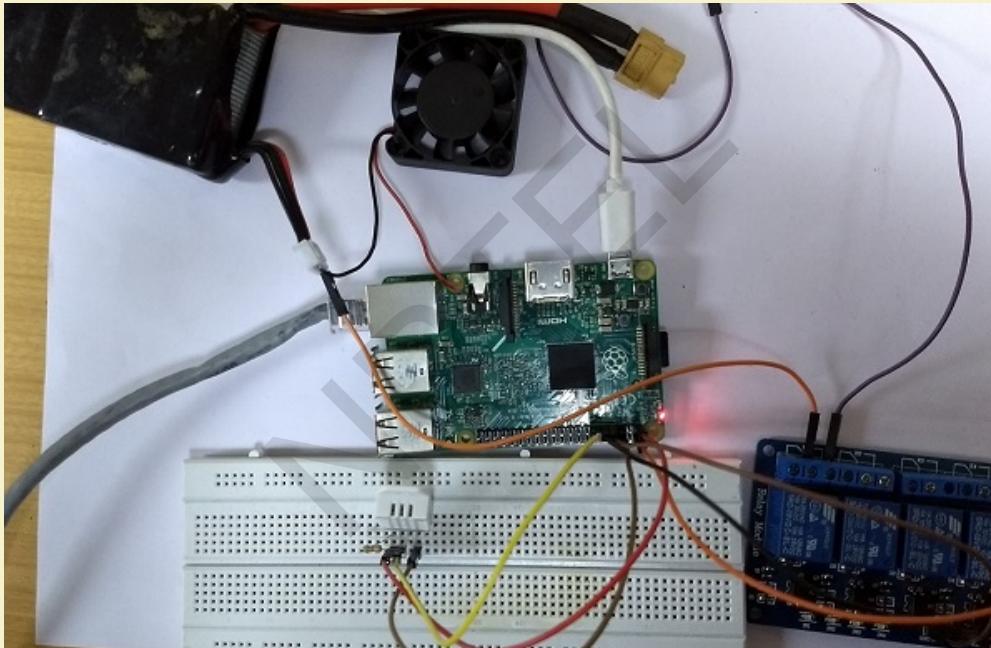


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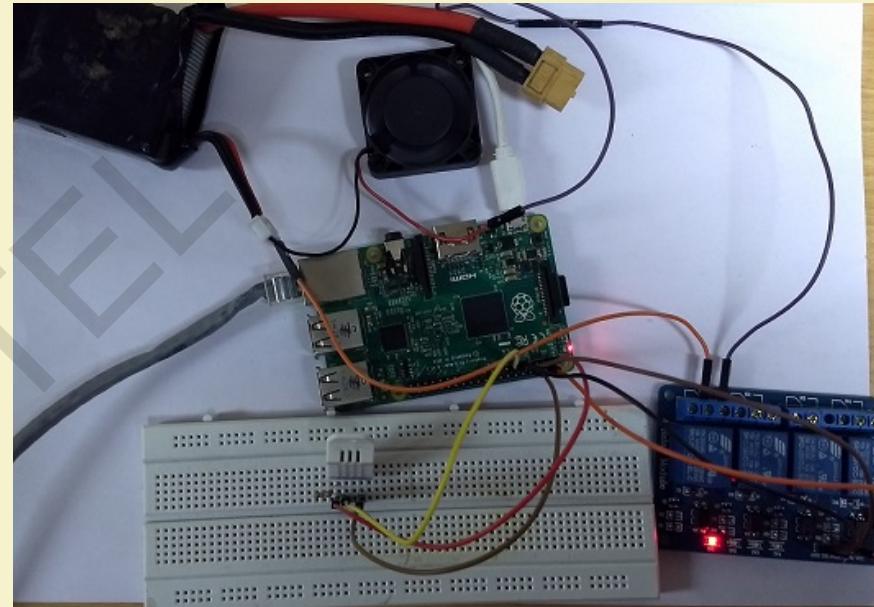
Connection: Fan (contd..)



Result

The fan is switched on whenever the temperature is above the threshold value set in the code.

Notice the relay indicator turned on.



Thank You!!



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