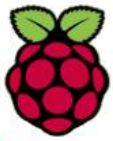
CrowPi



CrowPi Lessons with Python 2.7

- Lesson 1 - Using the Buzzer for alert sound or notification.
- Lesson 2 - Get input from button to control the Buzzer.
- Lesson 3 - How Relay works and how to control it.
- Lesson 4 - Send vibration signal to the vibration sensor.
- Lesson 5 - Detect sound using the sound sensor.
- Lesson 6 - Detect low or bright light using the Light sensor.
- Lesson 7 - Detect room temperature and humidity using the DHT11 sensor.
- Lesson 8 - Detect motion using the motion sensor.
- Lesson 9 - Getting distance information using the Ultrasonic sensor.
- Lesson 10 - Controlling the LCD Display.
- Lesson 11 - Read / Write RFID card using the RFID module.
- Lesson 12 - Using the step motor and making step movements.
- Lesson 13 - Controlling servos motors using the servo interfaces.
- Lesson 14 - Controlling the 8x8 Matrix LED.
- Lesson 15 - Controlling the 7 Segment Display.
- Lesson 16 - Detecting touch using the Touch Sensor.
- Lesson 17 - Detecting tilt using the Tilt Sensor.
- Lesson 18 - Using and controlling the Button Matrix.
- Lesson 19 - Using and controlling the IR sensor
- Lesson 20 - Making your own circuit board using the Bread Board
- Lesson 21 - Using the CrowPi Camera

Note: we also have Scratch lessons, Please download it by yourself
Website:https://www.elecrow.com/download/crowpi/Scratch-Lessons.pdf

Introduction

Thank you for backing CrowPi on kickstarter and supporting our continues work on making everyone's making easier.

In the following file you'll find 20 lessons to get your hands on over the CrowPi.

The lessons are variant from complete beginner to more advanced, no matter what's your level of understanding we can promise you'll enjoy it.

During the lessons, the examples requires to download a file and execute it on the CrowPi, for that reason we've made 2 brief explanations on basic python and linux usage.

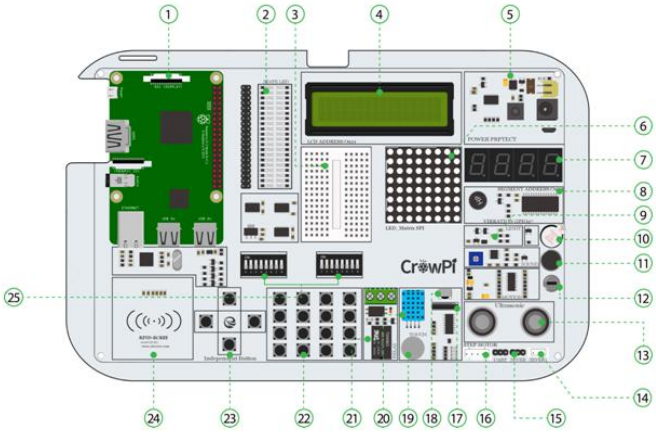
Both short tutorials explain how to download scripts from GitHub (code sharing platform where we keep our codes and scripts) and also executing the python scripts to be able to run the samples with ease.

The lessons begin with explaining briefly about the Raspberry Pi and it's GPIO methods, afterwards during the tutorials we'll use GPIO.IN and GPIO.OUT to control our sensors.

Some sensors are controllable by ports called SPi, we'll also explain how to use those in order to execute our scripts.

This tutorials are just the beginning.

We are looking forward to see what you will make with our CrowPi.



Sensors & modules list

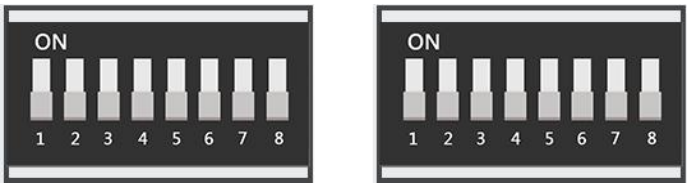
The sensors below are listed same as the numbers on the CrowPi board:

* 1 - Raspberry Pi -
* 2 - GPIO LED Indicator -
* 3 - Breadboard - Used to make custom circuits using outside modules which the CrowPi doesn't include in
* 4 - LCD Module - Used to show multi line information and text
* 5 - Power Circuit -
* 6 - Matrix LED - Used to show text and other sort of data
* 7 - Segment LED - Used to show numbers and data
* 8 - Vibration module - Used to make a strong vibration over the CrowPi board
* 9 - Light sensor - Used to detect and measure the strength of the light in the room
* 10 - Buzzer - Used to make a really loud buzzing alarm!
* 11 - Sound Sensor - Used to detect loud noise in the room
* 12 - Motion sensor - Used to detect motion in the room and around the CrowPi
* 13 - Ultrasonic sensor - Used to measure distance between the sensor and an object on top of it!
* 14,15 - Servos interface - 2 interfaces to connect servos and be able to rotate them to any direction you want!
* 16 - Step motor - Used to control robots and machines in the industry, learn how to make step movements using this module!
* 17 - Tilt Sensor - Used to detect a tilt over the CrowPi; whenever you tilt it to the right or to the left, you'll know!
* 18 - IR Sensor - Used to send and receive IR signals also able to copy them and transmit them back!
* 19 - Touch Sensor - Works like a button but instead of clicking detects a touch!
* 20 - DH11 Sensor - Used to check and measure the humidity and the temperature in the room!

* 21 - Relay - Used to open and close electronic circuits to controls electronics such as LED's!
* 22 - Matrix Buttons - Can be used as keypad or multiple options buttons!
* 23 - Independent buttons - Can be used to play games or control a robot!
* 24 - RFID Module - Used to Read and Write data over RFID/NFC cards!
* 25 - Switches - Used to switch between the sensors and modules as the Raspberry Pi doesn't contain enough GPIO pins

Switching between the modules

Understanding how to switch between the CrowPi sensors



The CrowPi board contains 2 "switches" each switch contains 8 pins, total of 16 pins.

The switches enables us to change between usage of sensors and modules, the Raspberry Pi supports only limited number of GPIO pins but using those switches we can extend our capability into much more.

Using those switches is pretty easy and will be required in some of the lessons above.

The following sensors requires using switches and changing them accordantly:

* **Button array (the whole left switch is dedicated for the button array & independent button)**
* **Independent button (the whole left switch is dedicated for the button array & independent button)**
* **Vibration sensor (the right switch, first pin)**
* **Tilt sensor (the right switch, second pin)**
* **Step motor (the right switch, pins number: 3,4,5,6)**
* **Servos (the right switch, number 7,8)**

When you need to use one of those sensors, you'll need to switch up using the switch according to the right number, after the class or in case you don't use that sensor it's good practice to turn off the switch as some other sensors use those GPIO pins as well.

In case you won't turn off unused pins and keep the switch on, that might cause conflict between sensors and the CrowPi might not work the way it should be.

If you encounter any issue in the tutorials - make sure that the switch is turn on or off accordingly.

Basic Python and Linux usage

Cloning the git repository

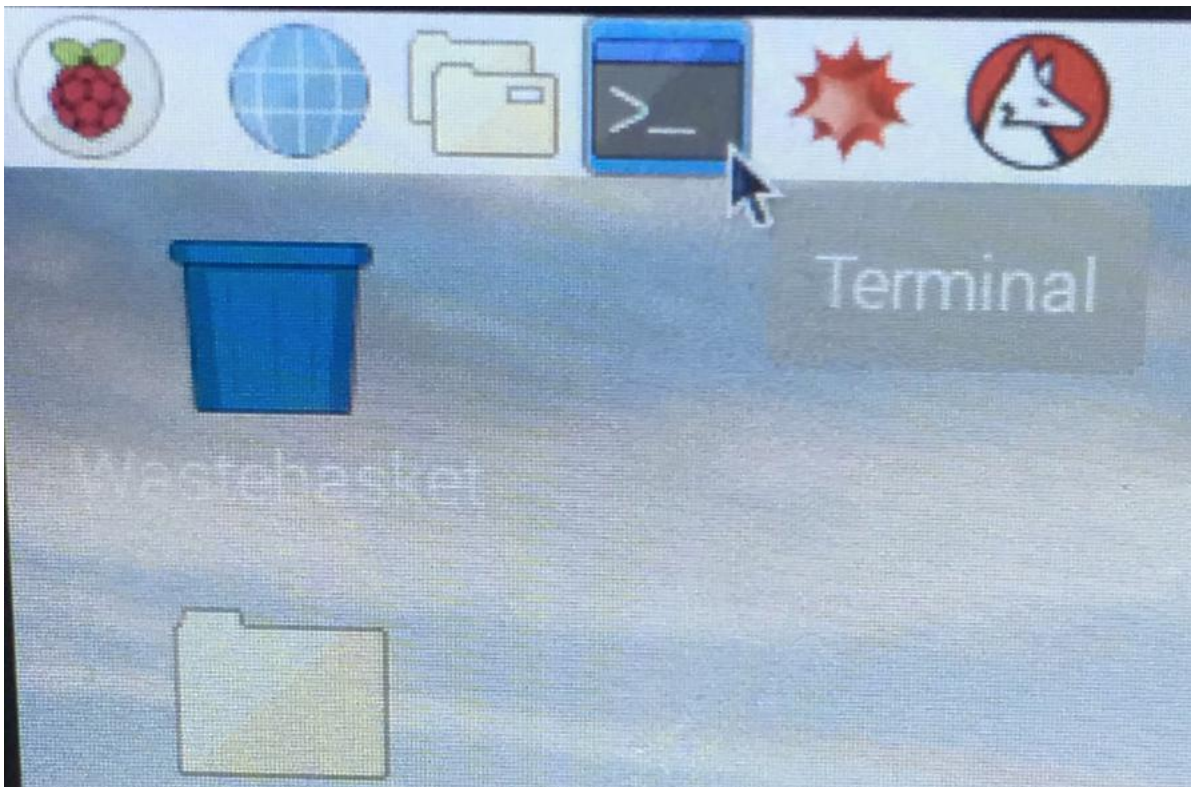
This step is optional but makes it easier to execute script without the need to download each one separately.

All the scripts already exist on the desktop inside "CrowPi" Folder, incase you want to update the folder for any future changes, you can follow the following steps.

This incredibly useful way called "git cloning".

In simple explanation: we will clone the GitHub directory where all the example scripts are located into our desktop environment so we won't need to download every single script every time, how we gonna do that? Using the git clone command:

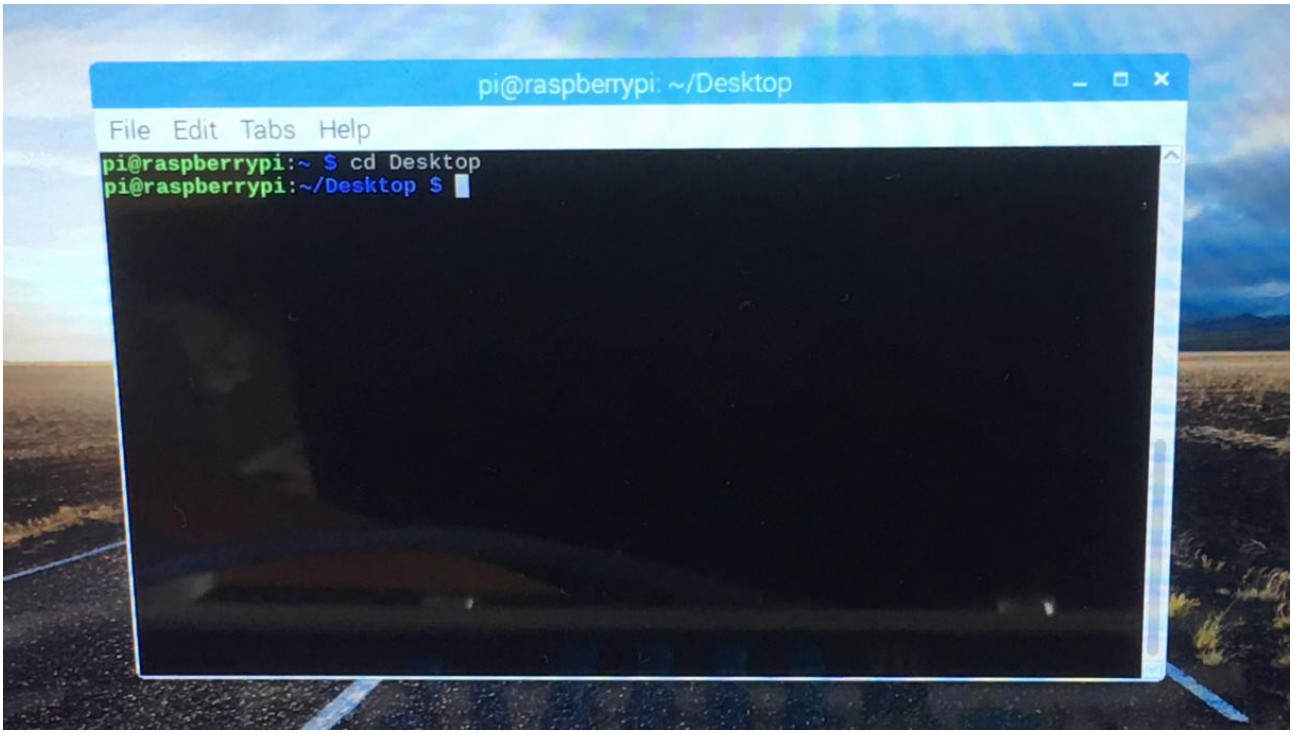
1. Open "terminal". It looks like a black screen and we will use it to execute most of our python scripts and to download extensions and scripts from GitHub



2. After opening terminal successfully we'll need to clone the scripts directory into our desktop. To do so you need to type in the terminal:

```
cd Desktop
```

3. press "Enter" on your keyboard. Now you should be in your desktop folder which is your desktop that you see.

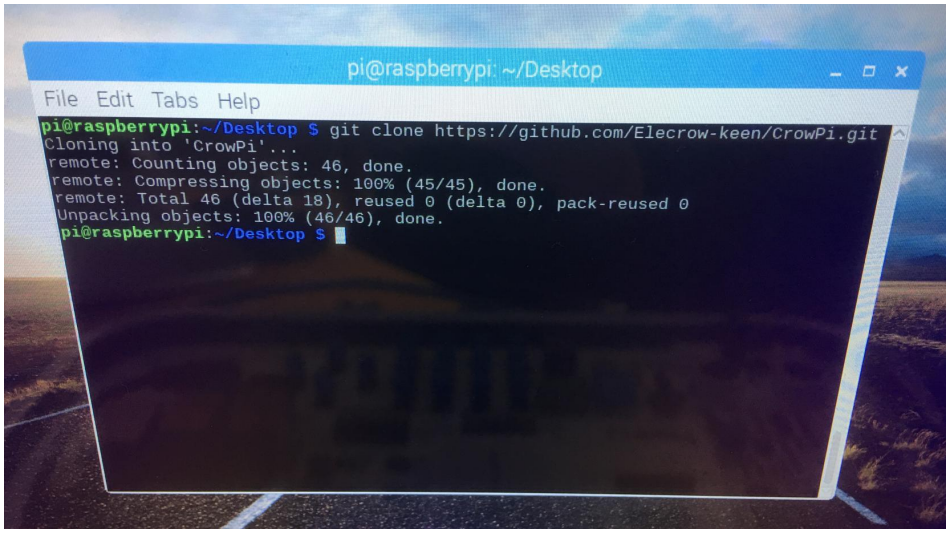


4. Inside the terminal type the following command:

```
git clone https://github.com/Elecrow-keen/CrowPi.git
```

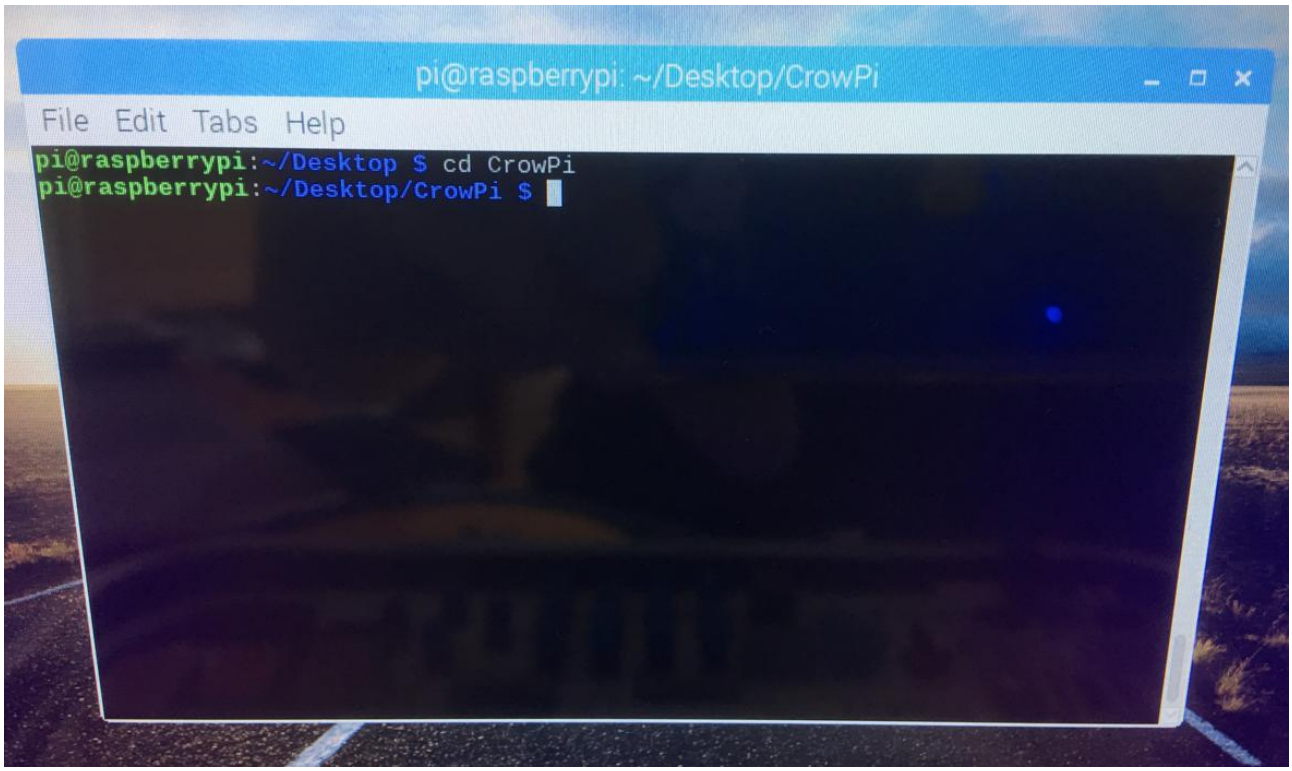
5. press ENTER and wait till the cloning process complete.

6. After



cloning the git repository, it should show up on our desktop as “CrowPi” folder, let’s go into that folder by “cd” command so we could use the scripts that are inside

```
1   cd CrowPi
```



Now, during the tutorials all you need to do is execute the script, learn how to execute the scripts in the next page!

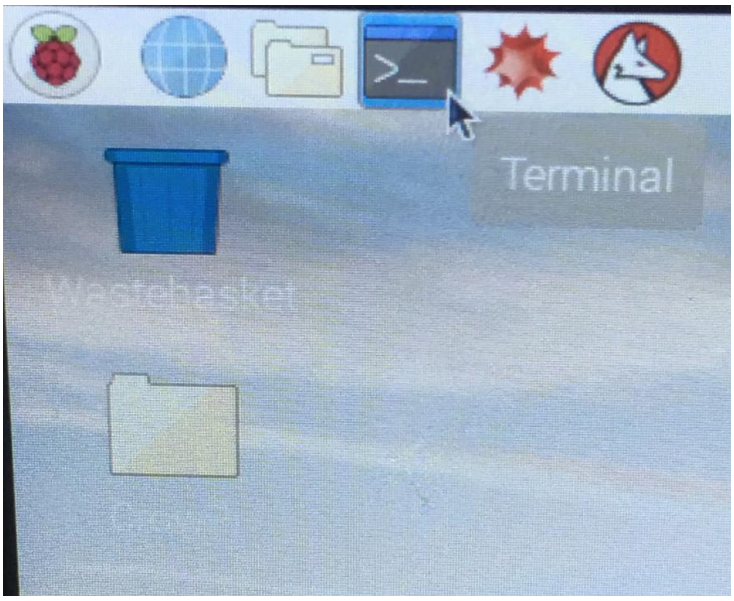
*** Note: every time you will turn off your CrowPi you’ll need to repeat the steps of going into the folder using the “CD” command BUT you don’t need to repeat the step of cloning or downloading the scripts from GitHub as they are already there on your desktop environment!**

Basic Python and Linux usage

Executing Python scripts

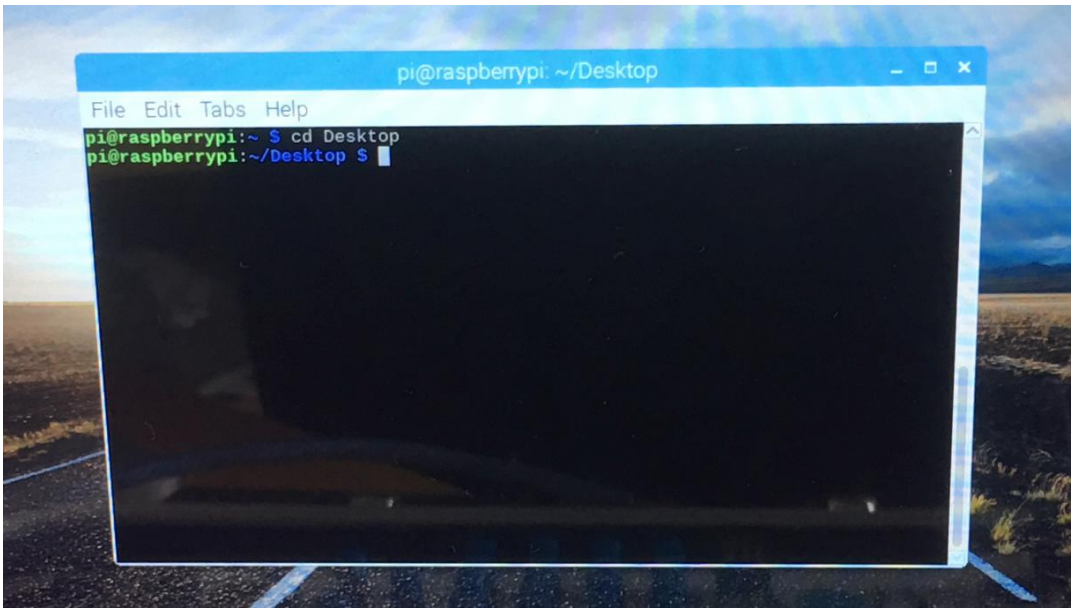
After we've successfully downloaded our script from GitHub, we might want to execute it now. In order to execute the script, we'll need to run "python" command inside the terminal. Follow the following steps in order to get the script running through the terminal:

1) Open "terminal". It looks like a black screen and we will use it to execute most of our python scripts and to download extensions and scripts from GitHub



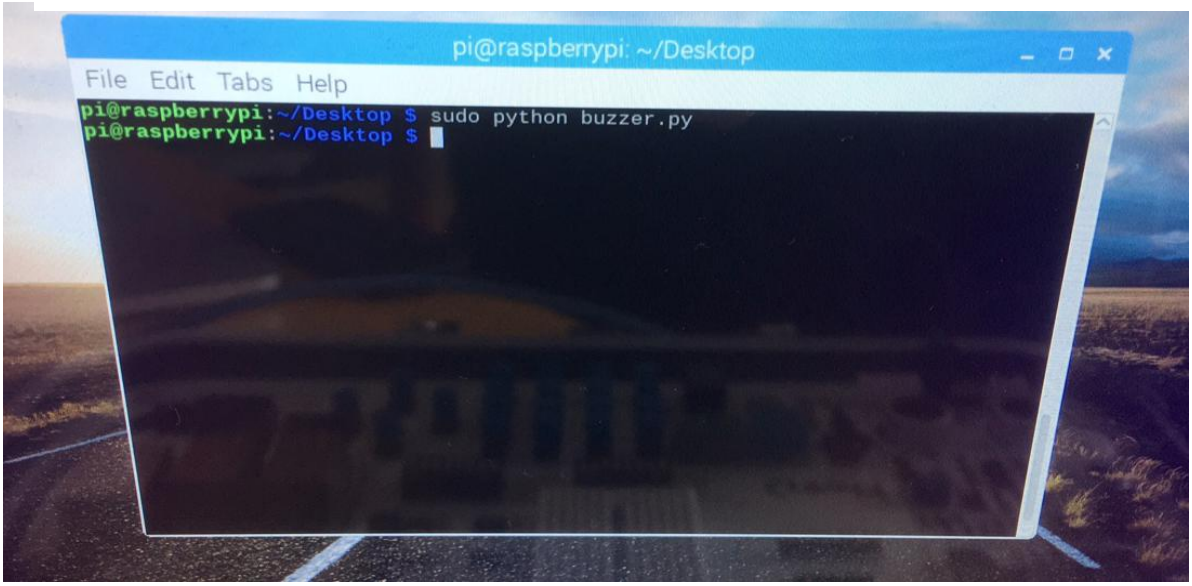
2) Change folder into the desktop folder using "cd Desktop" as command inside the terminal

```
1   cd Desktop
```



3) Write the command “sudo python <script name>” in order to execute the python script, for example “sudo python buzzer.py”

```
1   sudo python buzzer.py
```

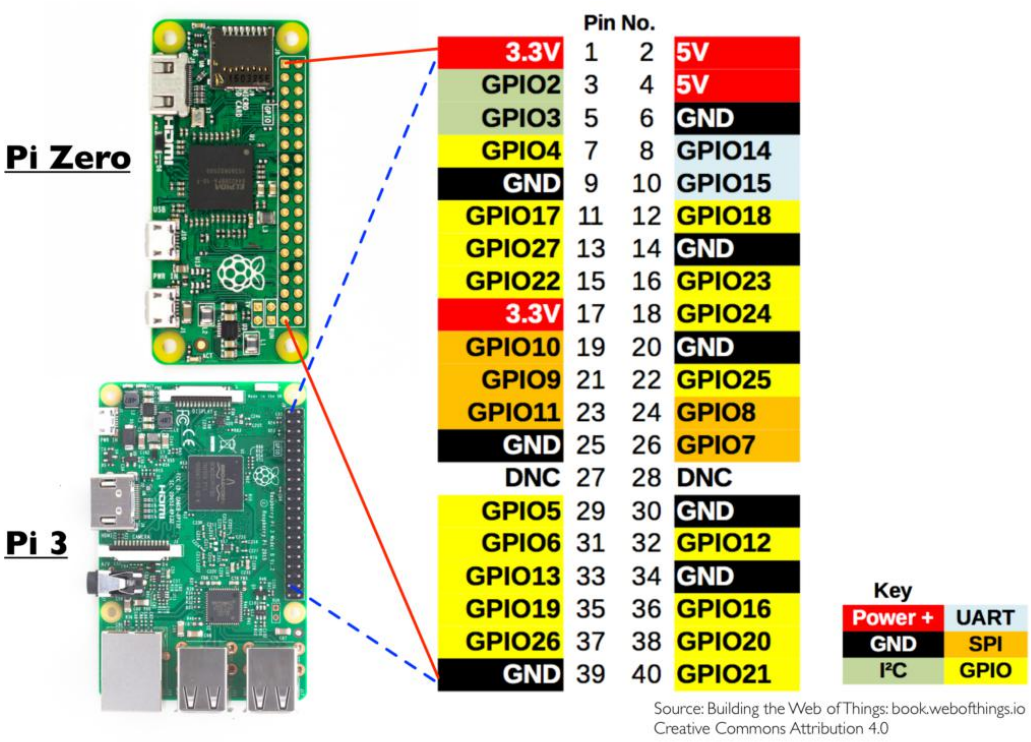


The sudo command gives us root permissions (admin permissions) which required by the GPIO library, afterwards we write “python” to tell the system that we want to execute command using the python library. At the end, we write the script name as we downloaded it to the desktop, and that’s it! You’ve successfully executed the python script.

Now when you know how to download scripts and execute them, we are ready to start the tutorials!

GPIO Usage introduction

Basics of GPIO and how to use GPIO Input/Output



In this lesson we'll go through understanding what is GPIO, how it works and how to control it.

What will you learn

At the end of this lesson you'll be able to:

* Understand what is GPIO and how it works

* Know the difference between the BCM and BOARD GPIO

* Understand and be able to control both GPIO input and GPIO output

What will you need

* CrowPi Board after initial installation

Requires switching modules using the switch

* No

What is GPIO

"General-purpose input/output (GPIO) is a generic pin on an integrated circuit or computer board whose behavior—including whether it is an input or output pin—is controllable by the user at run time." ~ Wikipedia

In simple language:

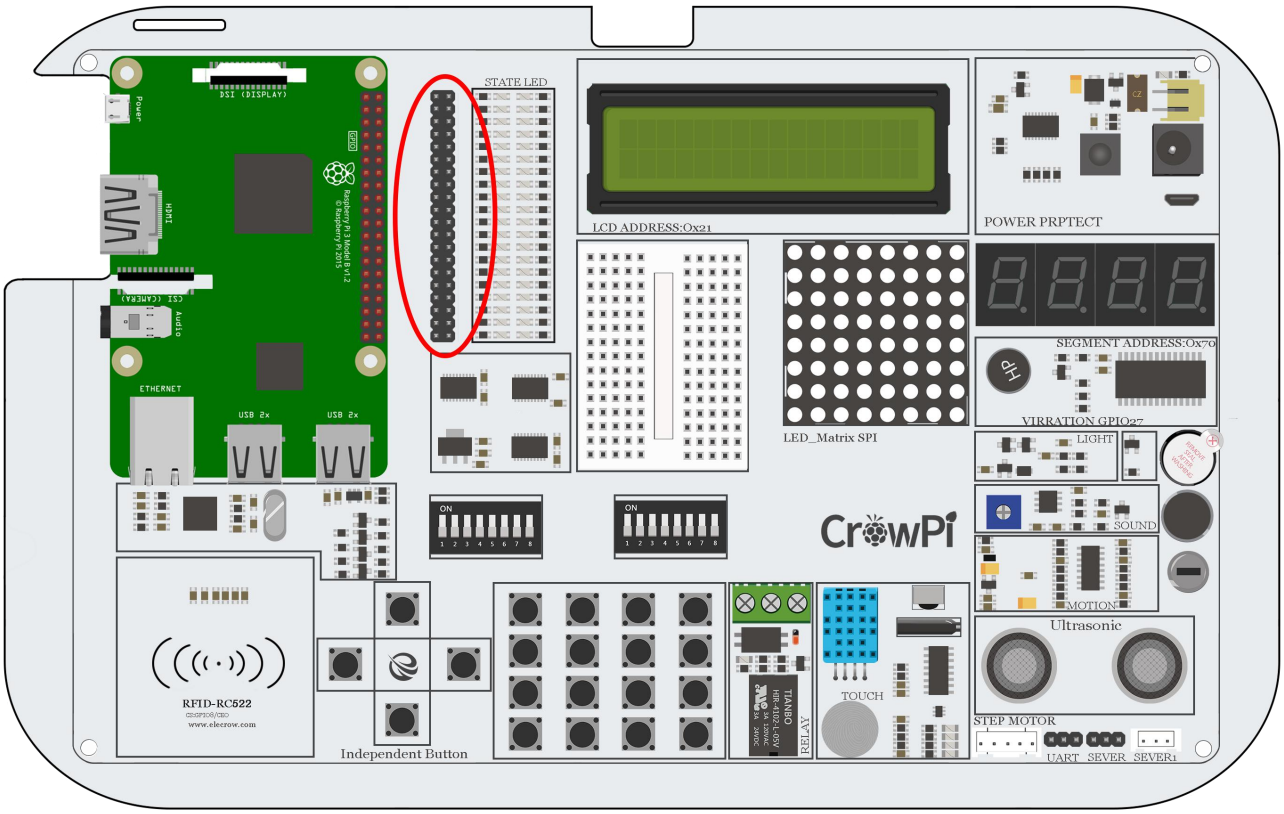
GPIO pin have no specific dedicated purpose, it can either be configured as input pins or output pins and has general purpose depends on what you want to accomplish.

Example for input pin: a button would be considered input, because you click on it.

Example for output pin: a buzzer would be considered output, because you send it signal to buzz.

The location of the GPIO pins

The GPIO pins located on the right side of the Raspberry Pi board if you're looking from the CrowPi perspective



GPIO Schemes

There are 2 possible Raspberry Pi GPIO Scheme: GPIO.BOARD and GPIO.BCM

The GPIO.BOARD option specifies that you are referring to the pins by the number of the pin the the plug - i.e the numbers printed on the board (inside the circles on the diagram below)

The GPIO.BCM option means that you are referring to the pins by the "Broadcom SOC channel" number, these are the numbers after "GPIO" in the green rectangles around the outside of the below diagrams:

Unfortunately the **BCM** numbers changed between versions of the Pi1 Model B, So it will be better and safer way to use the **BOARD** numbers as they don't change.

How to use the GPIO pins

In our examples we use Python language to control the GPIO pins.
In python, we have a strong magical library called "RPi.GPIO",
which is a library that helps us to control the pins programmatically using Python.

Check the below example and the comments inside the code for better understanding how it works in the physical world

the first step will be to import the library by the command “RPi.GPIO as GPIO” afterwards comes the “time” library by “import time”.

Then we setup the GPIO mode to GPIO.BOARD
(not BCM as we discussed before)

We declare the input pin as pin number **11** for our example and output pin as pin **12**.

(the input is touch sensor and the output is buzzer)

We send output to the output pin wait **1** second and then turning it off.

Then to confirm the input, we go through a loop till the GPIO.input received input signal, we print “Input Given” to make sure the click was confirmed,
clean the GPIO using GPIO.cleanup() and quit the script.

In order to understand and grow your knowledge about GPIO purpose and usage we highly recommend reading the official documentation about the RFID GPIO modules.

Follow this link to read more about the official Raspberry Pi GPIO Documentation:

https://pythonhosted.org/RPIO/

Lesson 1

Using the buzzer as an alert notification

After the previous class, we understood how to use the GPIO pin both as output and input. To test it up we will go with real-life example and apply our knowledge from the previous class into one of the modules over the board.

The Module we will use is the “buzzer”. The buzzer, as the name states, buzz.

We will use GPIO output to send signal to the buzzer and close the circuit to make a loud buzzing noise then we will send another signal to turn it off and close the circuit.

What will you learn

At the end of this lesson you'll be able to:

* Be able to control the buzzer module using GPIO output

What will you need

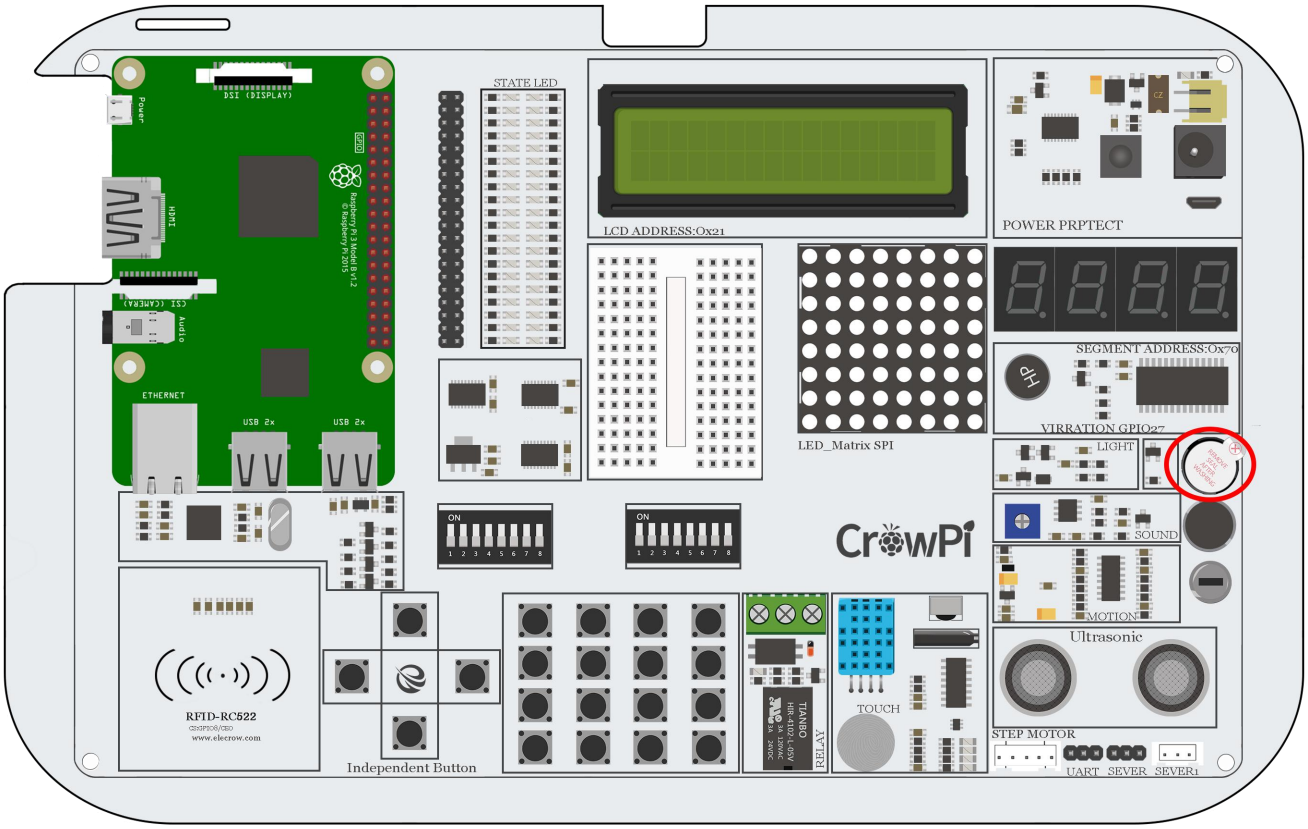
* CrowPi Board after initial installation

Requires switching modules using the switch

* No

Location of the buzzer on the CrowPi

The Buzzer is located on the right side of the CrowPi board, it's easy to be detected by the loud noise it makes when activated



On the first time you'll use your Raspberry Pi, the Buzzer sensor might be sealed with protection sticker.

Make sure to unseal the sticker by simply tearing it off and expose the buzzer itself.

Activating the Buzzer

Just as at the previous example, we've prepared special script with detailed comments that will explain how the whole buzzing process works and how we are able to control the buzzer using GPIO output.

At first we import RPi.GPIO library and the time library for sleeping. Then we configure the buzzer at pin 12, we setting up the mode of GPIO to GPIO BOARD and setting up the pin as OUTPUT pin.

We will output buzzing signal for 0.5 seconds and then turn it off to prevent loud noise.

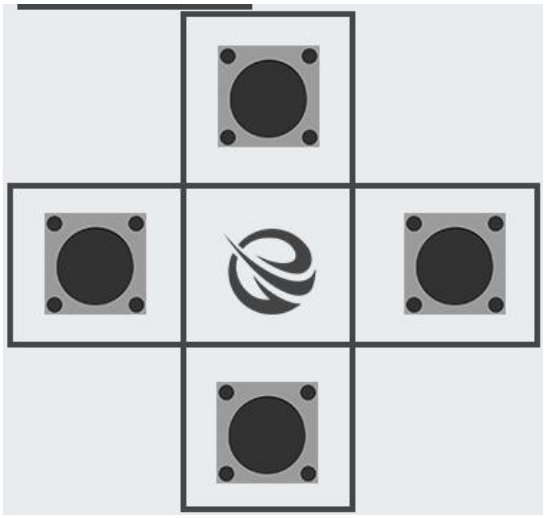
```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# http://elecrow.com/

import RPi.GPIO as GPIO
import time

buzzer_pin = 12

GPIO.setmode(GPIO.BOARD)
GPIO.setup(buzzer_pin, GPIO.OUT)

# Make buzzer sound
GPIO.output(buzzer_pin, GPIO.HIGH)
time.sleep(0.5)
# Stop buzzer sound
GPIO.output(buzzer_pin, GPIO.LOW)

GPIO.cleanup()
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python buzzer.py
```

Lesson 2

Get input from button to control the Buzzer.



After successfully demonstrating how to turn on and off the buzzer now it's time to get things a bit more exciting. In this lesson we'll combine a button with the buzzer so the buzzer will turn on only by pressing the button.

This time we'll use 2 GPIO setups.

One will be the GPIO.INPUT which will take in charge of the button as an input way to get the "press" another one will be the GPIO.OUTPUT which will send signal to the buzzer to make some noise.

What will you learn

At the end of this lesson you'll be able to:

* Be able to activate the buzzer by pressing a button

What will you need

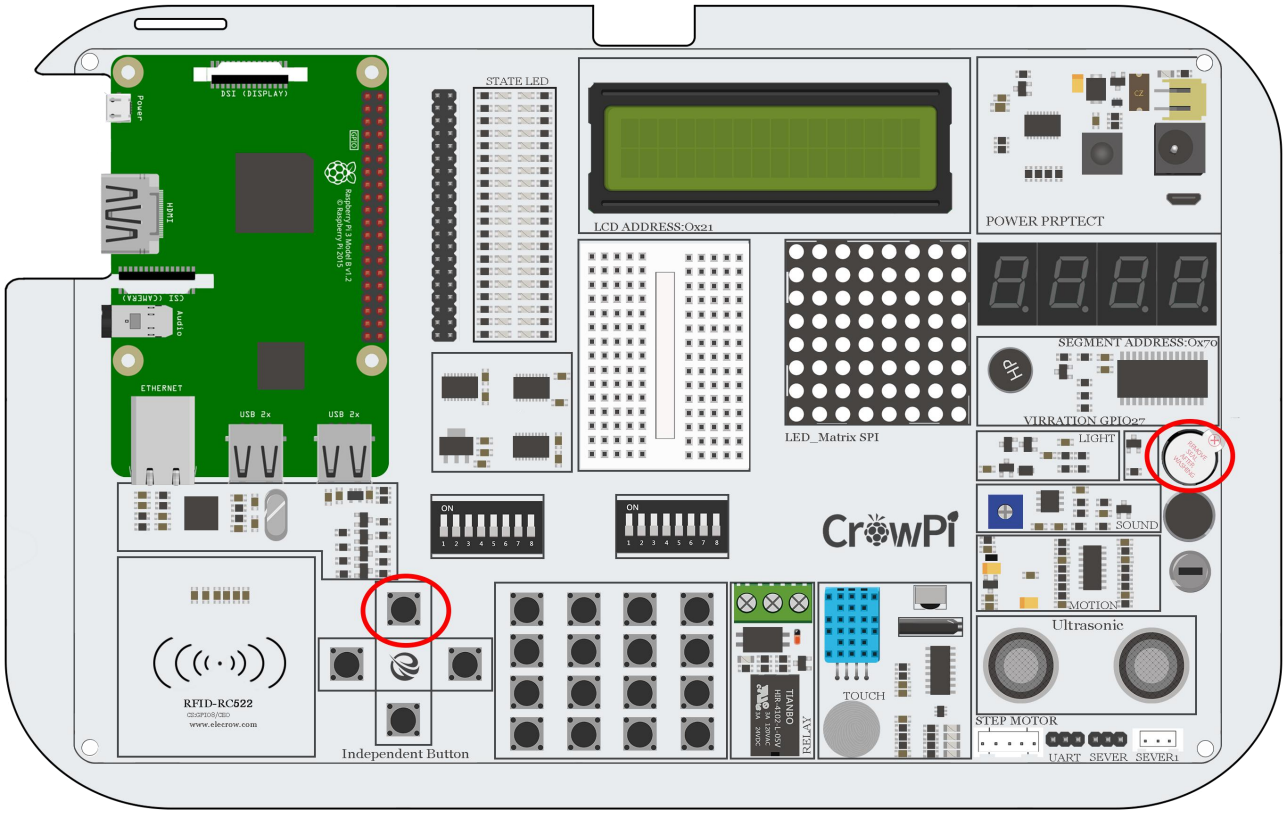
* CrowPi Board after initial installation

Requires switching modules using the switch

* **Yes**, the left switch - turn ALL the pins ON by turning them UP (refer to page number 5 if you forgot how to switch the sensors)

Activation button location

For our example we'll use the top button of the 4 buttons on the down left side next to the NFC module to activate the buzzer by pressing it



Technically, we can choose any of the 4 buttons on the independent buttons, for convenience we'll use the the top one of the 4 independent buttons.

In order to change the button we would like to use, we need to set different GPIO pin that is suitable for those buttons.

The 4 buttons GPIO pins numbers are:

GPIO37 - Up

GPIO27 - down

GPIO35 - Right

GPIO22 - Left

Try changing to any other of those GPIO numbers and see how it works!

Activating the Buzzer by pressing a button

For this part of our tutorial we'll need to use 2 GPIO settings, one is input and one is output.

The GPIO input will be used to determine whenever a button been clicked or not and the GPIO output will be used to to active the buzzer as soon as the button is pressed.

As you can see in the image below - we setup 2 pins one is buzzer_pin and one is button_pin, the action will take forever until CTRL+C is pressed,

If you'll click the up button on the CrowPi board, the buzzer will make sound! Stop pressing it and the buzzer sound will stop.

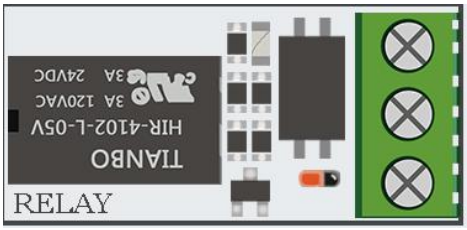
```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# http://elecrow.com/

import RPi.GPIO as GPIO
import time

# configure both button and buzzer pins
button_pin = 37
buzzer_pin = 12

# set board mode to GPIO.BOARD
GPIO.setmode(GPIO.BOARD)

# setup button pin asBu input and buzzer pin as output
GPIO.setup(button_pin, GPIO.IN, pull_up_down=GPIO.PUD_UP)
GPIO.setup(buzzer_pin, GPIO.OUT)

try:
    while True:
        # check if button pressed
        if(GPIO.input(button_pin)):
            # set buzzer on
            GPIO.output(buzzer_pin, GPIO.HIGH)
        else:
            # it's not pressed, set button off
            GPIO.output(buzzer_pin, GPIO.LOW)
except KeyboardInterrupt:
    GPIO.cleanup()
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python button_buzzer.py
```

Lesson 3

How Relay works and how to control it.



After we've completely finished with the buzzing part, it's time to move on.

On lesson 4 we are going learn about how to use Relay, what's the function of the Relay and how to control it.

A *relay* is an electrically operated switch. Many *relays* use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state *relays*. *Relays* are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

In our example we will show how to send a GPIO signal to open the relay and enable a custom circuit and how to send another signal to close the relay, and close the circuit.

What will you learn

At the end of this lesson you'll be able to:

* How to control the relay - open and close it using GPIO signal

What will you need

* CrowPi Board after initial installation

Requires switching modules using the switch

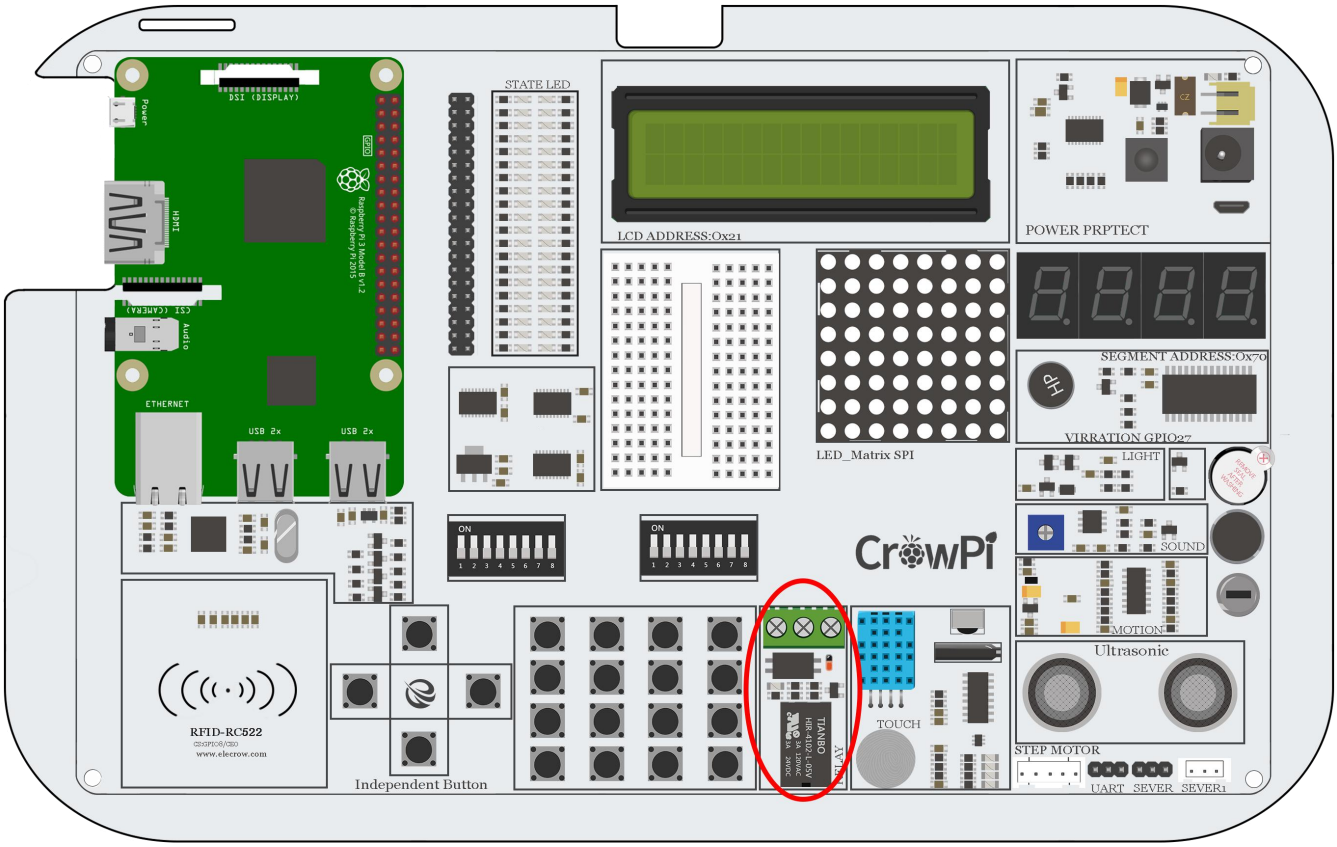
* No

Relay location on the CrowPi

The relay located in the middle bottom part of the board right after the button matrix, it can be easy detected as a black object with 3 inserts pins which we'll use 2 of them (positive and negative)

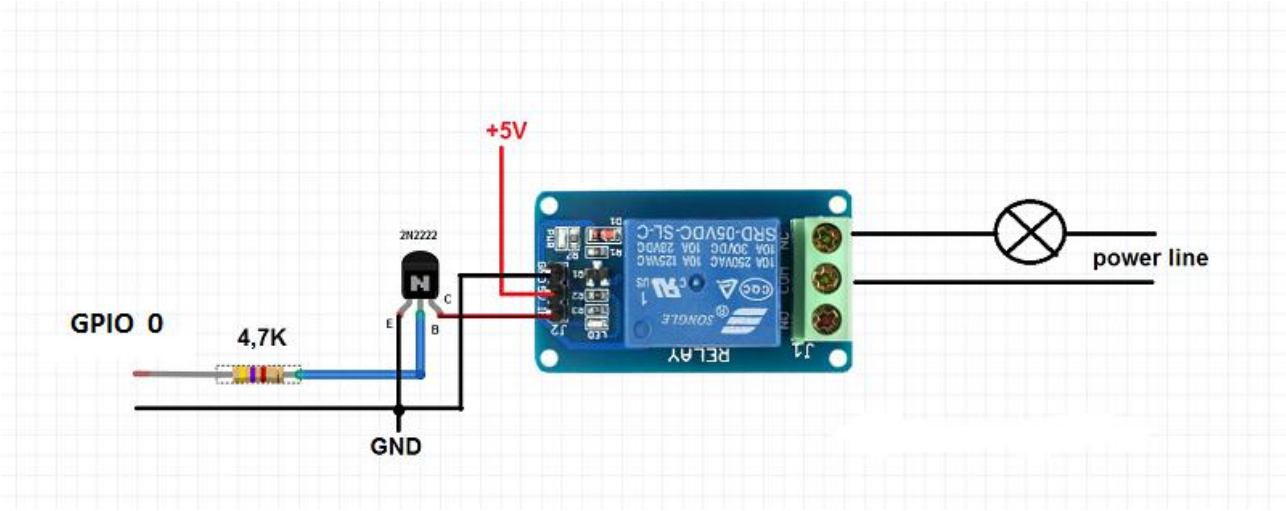
The Positive one will be the one marked with NC, the negative one will be the one marked as NO and the last one is COM which we won't use in our use case.

The positive one located on the right side of the relay, the negative one is in the middle.



Controlling the Relay

Before we'll dive into our code it's important to understand how relay works and what's the purpose of it. Let's look at the diagram below:



If we'll look on the right side of the diagram we can see there are 2 black lines, the top one is negative line and the bottom one is positive line, by connecting positive and negative lines into the relay we are able to create a custom electronic circuit to control for example LED.

By opening the relay we are allowing the circuit to "flow" and by completing it, it should turn on the LED. By closing the relay we block our circuit and by doing so our LED wouldn't turn on.

It's VERY important to DO NOT try to connect HIGH VOLTAGE equipment into the relay such as table lamp, coffee machine and others …

This might cause electric shock and serious injury. Only follow the instructions in this guide for your own safety.

During the next lessons we'll learn how to create your custom circuit using the Bread Board where you could use the knowledge you gained from this page.

Now when we understand what is relay and how it works, after making sure that we followed **the safety guidelines and we didn't connect any high voltage device to it** , let's see the code:

```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# http://elecrow.com/

import RPi.GPIO as GPIO
import time

# define relay pin
relay_pin = 40

# set GPIO mode as GPIO.BOARD
GPIO.setmode(GPIO.BOARD)
# setup relay pin as OUTPUT
GPIO.setup(relay_pin, GPIO.OUT)

# Open Relay
GPIO.output(relay_pin, GPIO.LOW)
# Wait half a second
time.sleep(0.5)
# Close Relay
GPIO.output(relay_pin, GPIO.HIGH)
GPIO.cleanup()
```

If you'll look closely you might notice something a bit unusual in the code above.

The opening relay function is GPIO.LOW and the closing is GPIO.HIGH which doesn't make sense right?

On our previous examples we used GPIO.HIGH to open things and GPIO.LOW to close them.

The relay is a very special module.

In our CrowPi board we are using a resistor to protect your safety, this resistor switch the directions of the relay so over the relay ONLY GPIO.HIGH means to close to relay and GPIO.LOW means to open it.

Execute the following commands and try it by yourself:

```
1  cd /home/pi/Desktop/CrowPi/
2  sudo python relay.py
```

Lesson 4

Send vibration using the vibration sensor

Have you always been wondering how does your phone vibrate when someone is calling you or when you get an SMS message?

Well, we included the exact same module into our CrowPi and now we are going to learn how to use it - the vibration module.

Vibration sensor - whose internal structure is like a metal ball that is fixed in a special spring as pole, around it is the other pole. When the vibration gets to an extent, the two poles are connected so as to judge the shock occurs, which makes the vibration sensation.

What will you learn

At the end of this lesson you'll be able to:

* How to control the vibration sensor and send vibration signal

What will you need

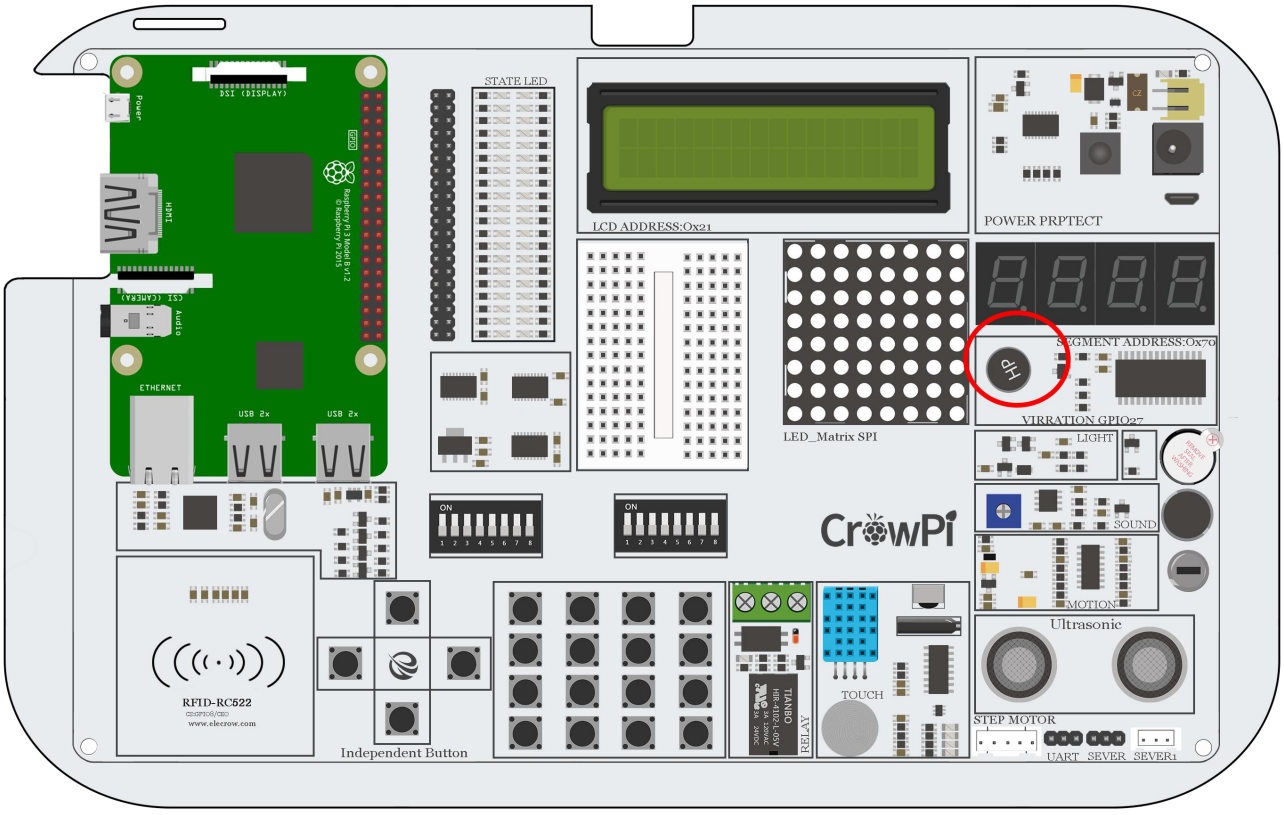
* CrowPi Board after initial installation

Requires switching modules using the switch

* **Yes**, The Right Switch, Pin number 1 - Make sure it's on by switching it UP (refer to page number 5 if you forgot how to switch the sensors)

Vibration location on the CrowPi

The vibration sensor located on the right side of the matrix LED and under the segment LED, sometimes when it's on it's difficult to detect where the vibration comes from as it feels like the whole CrowPi board is shaking and moving !



Activating the vibration sensor

The vibration sensor uses an GPIO.OUTPUT signal just as the buzzer and other modules we showed before. By sending an output signal the vibration sensor will vibrate, by stopping the signal with GPIO.LOW the vibration will stop.

This can be programmed through intervals of different **time.sleep()** which can make the vibration module to vibrate in different tempo … have a try yourself and see what tempo you can make!

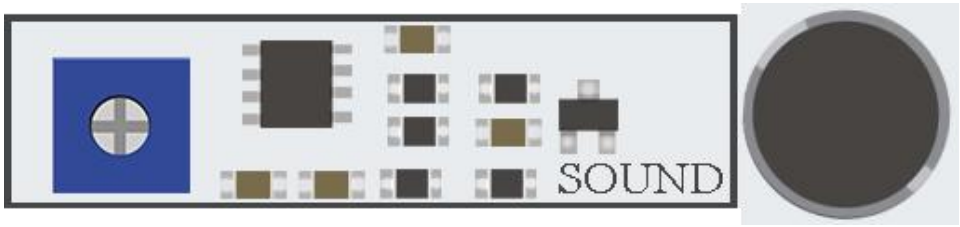
```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# http://elecrow.com/

import RPi.GPIO as GPIO
import time

# define vibration pin
vibration_pin = 13

# Set board mode to GPIO.BOARD
GPIO.setmode(GPIO.BOARD)

# Setup vibration pin to OUTPUT
GPIO.setup(vibration_pin, GPIO.OUT)

# turn on vibration
GPIO.output(vibration_pin, GPIO.HIGH)
# wait half a second
time.sleep(0.5)
# turn off vibration
GPIO.output(vibration_pin, GPIO.LOW)
# cleaup GPIO
GPIO.cleanup()
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python vibration.py
```

Lesson 5

Detect sound using the sound sensor.



Sound is very interesting thing, we can figure out what sound is too noisy and which one is too low … but can the Raspberry Pi do that as well?

In this lesson we'll learn how to get input through the sound sensor, detect loud sound and react accordantly this is a great way to build your own alarm system that detects loud noise or maybe turn on the LED by clapping!

What will you learn

At the end of this lesson you'll be able to:

* You will learn how to detect sound using the sound sensor module

What will you need

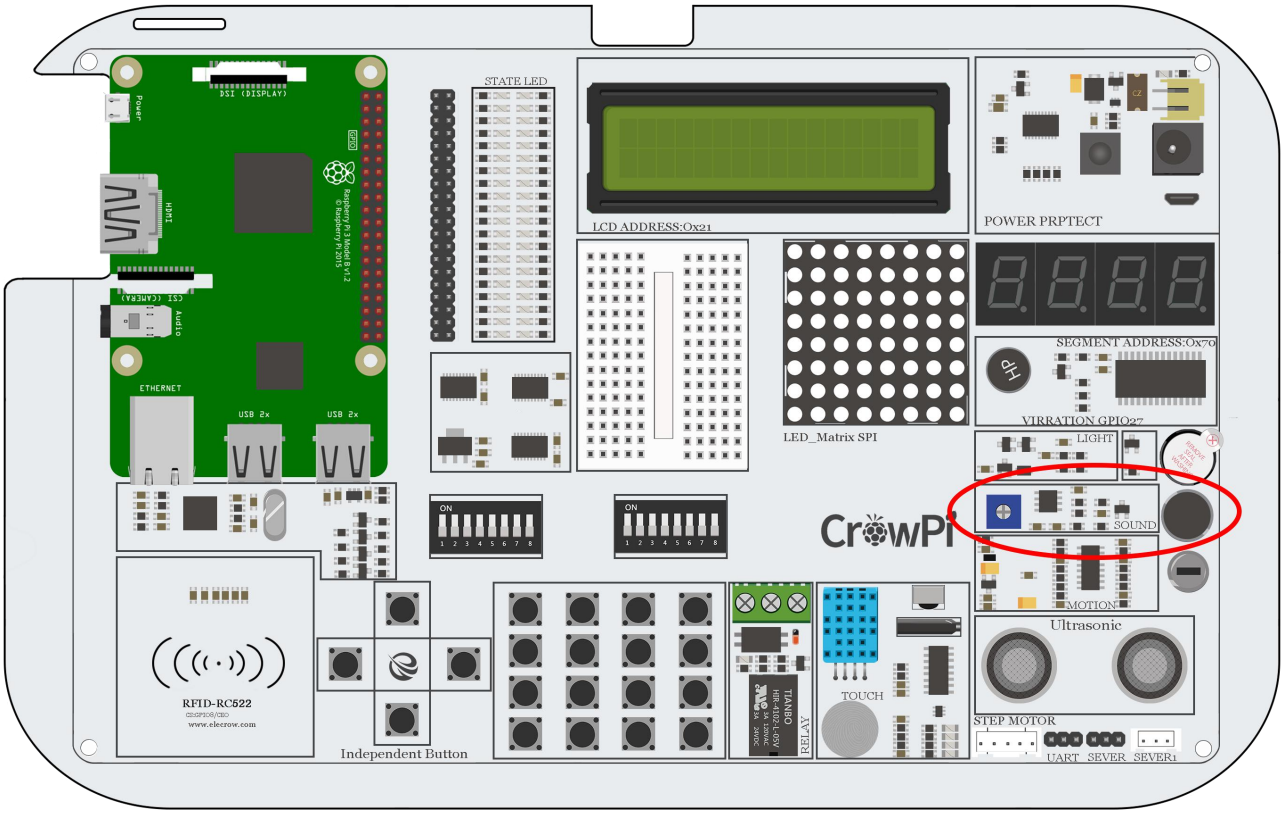
* CrowPi Board after initial installation

Requires switching modules using the switch

* No

Sound sensor location on the CrowPi

The sound sensor can be seen by the blue configuration square and the sensor itself is right under the buzzer, the sound sensor constructed out of 2 parts one which is the the blue square to configure and regulate the sensitivity and the sensor itself which detect input of loud noise.



Configuring the sensitivity

Our sensor contains a small controller that allows us manually to control the sensitivity of the noise for either too soft or too loud.

In order to make our script work we first must learn how to control that sensitivity option … take a look at the picture above:

We'll need to spin the little blue square that is rounded with red oval (in the picture) for either left or right in order to control it's sensitivity.

Spinning the sensitivity controller can be done by simply using any Phillips screw driver.

The best way to know what sensitivity level is suitable for you is by running the script and clapping your hands once in a while or shout so you can see if there is an INPUT reaction from the sensor which means he detects the loud noise.

In case the sensor doesn't detect the loud noise it means the sensitivity is too low and he won't react to it.

Increasing the sensitivity by spinning the blue square will solve this issue immediately .

Getting input from the sound sensor

After we learned how to control the sensor sensitivity it's time to test it in real Time and see how it works, take a look at the following code:

```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# http://elecrow.com/

import RPi.GPIO as GPIO
import time

# define sound pin
sound_pin = 18
# set GPIO mode to GPIO.BOARD
GPIO.setmode(GPIO.BOARD)
# setup pin as INPUT
GPIO.setup(sound_pin, GPIO.IN, pull_up_down=GPIO.PUD_UP)

try:
    while True:
        # check if sound detected or not
        if(GPIO.input(sound_pin)):
            print('Sound Detected')
except KeyboardInterrupt:
    # CTRL+C detected, cleaning and quitting the script
    GPIO.cleanup()
```

We first define our pin which is GPIO 18, then we set a while loop to keep this script running forever, we check if we got input from the sound sensor which indicates loud noise been detected and then we'll print "Sound Detected"

Incase of CTRL+C we'll interrupt the script and clean our GPIO pins.

Execute the following commands and try it by yourself:

```
1  cd /home/pi/Desktop/CrowPi/
2  sudo python sound.py
```

Lesson 6

Detect low or bright light using the Light sensor.

Light sensor is one of our favourites. It's extremely useful in many projects and situations for example in case you'd like to control something by detecting if there is bright light around light sensor is a great module for that exact case.

By using the light sensor we'll be able to detect how bright is the module surface, as each case is different we'll need to play around to figure out which configuration suitable for us the most.

What will you learn

At the end of this lesson you'll be able to:

* You will learn how to detect low light and bright light using the light sensor

What will you need

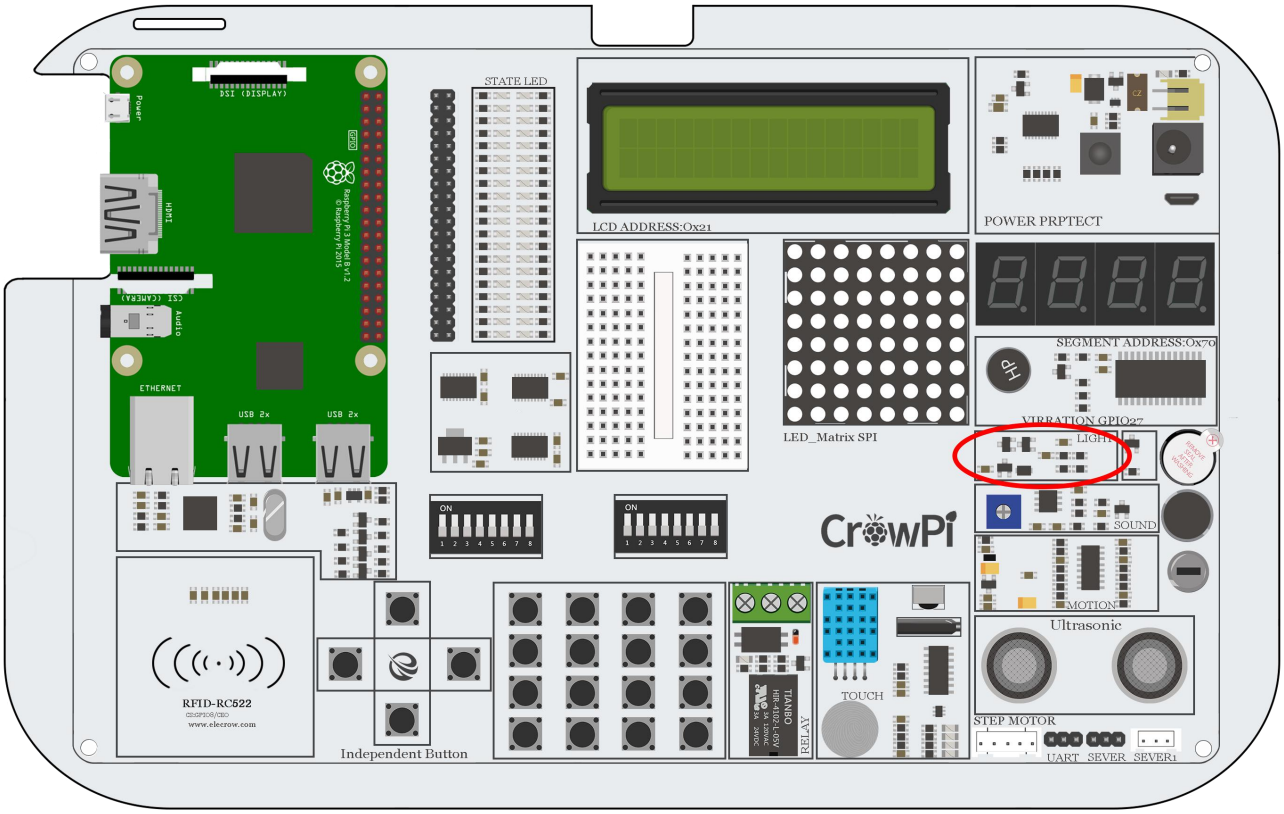
* CrowPi Board after initial installation

Requires switching modules using the switch

* No

Light sensor location on the CrowPi

The light sensor is almost invisible as it contains a very small parts which takes charge of detecting the light, the light sensor located on the left side of the buzzer, if you'll cover that part with your hand you could realise the output of the light sensor will be close to 0 as there is no light coming in …



Working with the light sensor

After we learned how to control the sensor sensitivity it's time to test it in real time and see how it works, the light sensor is a bit different from other sensors as it works using I2C and not using the normal GPIO way we did before.

The script is longer than other scripts and more difficult to explain.

In short: we set binary data to control the light sensor like turning it on, off, getting high input and low input afterwards we use this functions to "talk" with the light sensor and get the output we want regarding the light sensitivity around.

Then we simply use the function we've made "sensor = LightSensor()" to get the light and then we use "sensor.readLight()" to convert the binary data into readable brightness numbers (the higher, the brighter)

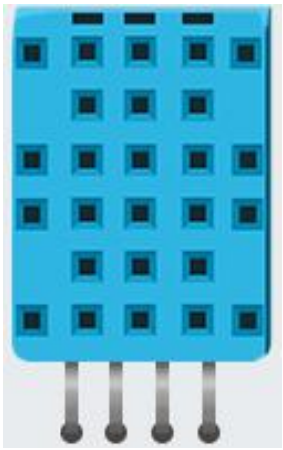
```
46      def convertToNumber(self, data):
47
48          # Simple function to convert 2 bytes of data
49          # into a decimal number
50          return ((data[1] + (256 * data[0])) / 1.2)
51
52      def readLight(self):
53
54          data = bus.read_i2c_block_data(self.DEVICE,self.ONE_TIME_HIGH_RES_MODE_1)
55          return self.convertToNumber(data)
56
57  def main():
58
59      sensor = LightSensor()
60      try:
61          while True:
62              print "Light Level : " + str(sensor.readLight()) + " lx"
63              time.sleep(0.5)
64      except KeyboardInterrupt:
65          pass
66
67  if __name__ == "__main__":
68      main()
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python light_sensor.py
```

Lesson 7

Detect room temperature and humidity



The DH11 is a very interesting and unique sensor as its not only combines one functionality but two! It contains both humidity sensor and temperature sensor which are pretty accurate which are great for any weather station project, or if you'd like to check the temperature and humidity in the room and make a smart home project! Can also be used to check the garden humidity and temperature to know if your flowers In danger or they are cool.

What will you learn

At the end of this lesson you'll be able to:

* What you will learn how to control and get the humidity and the temperature from the DH11 sensor

What will you need

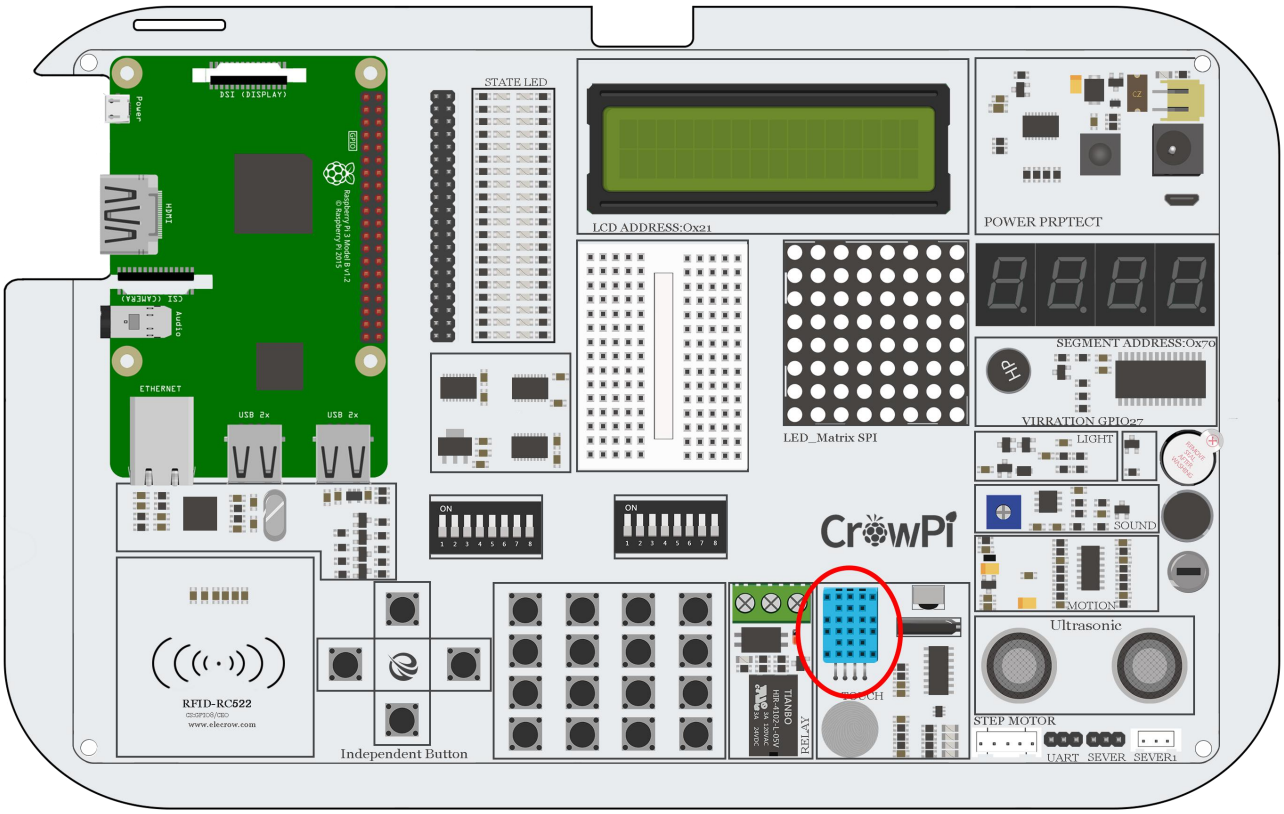
* CrowPi Board after initial installation

Requires switching modules using the switch

* No

DH11 sensor location on the CrowPi

The DH11 is very easy to detect, a small blue sensor with many little holes inside. it’s located right on top of the touch sensor and on the right side of the relay. The sensor doesn’t light up any LED or make any sound when it works but you will know it does by the great output you’ll get!



Working with the DH11 sensor

Working with DH11 is very easy using the Adafruit_DHT library. The library will return to use Temperature and Humidity as values which doesn't require any complicated math calculations and functions!

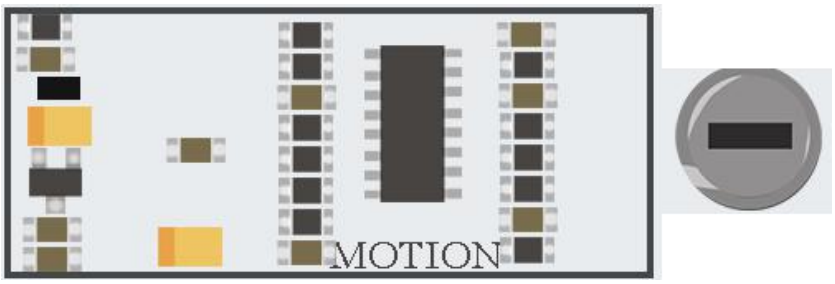
```
23  import sys
24  import Adafruit_DHT
25
26  # set type of the sensor
27  sensor = 11
28  # set pin number
29  pin = 4
30
31  # Try to grab a sensor reading.  Use the read_retry method which will retry up
32  # to 15 times to get a sensor reading (waiting 2 seconds between each retry).
33  humidity, temperature = Adafruit_DHT.read_retry(sensor, pin)
34
35  # Un-comment the line below to convert the temperature to Fahrenheit.
36  # temperature = temperature * 9/5.0 + 32
37
38  # Note that sometimes you won't get a reading and
39  # the results will be null (because Linux can't
40  # guarantee the timing of calls to read the sensor).
41  # If this happens try again!
42  if humidity is not None and temperature is not None:
43      print('Temp={0:0.1f}*  Humidity={1:0.1f}%'.format(temperature, humidity))
44  else:
45      print('Failed to get reading. Try again!')
46  sys.exit(1)
```

Execute the following commands and try it by yourself:

```
1  cd /home/pi/Desktop/CrowPi/
2  sudo python dh11.py
```

Lesson 8

Detect motion using the motion sensor.



The motion sensor is one of the most useful and often used sensors out there. As you've seen in our kick-starter video, we used the motion sensor to detect a thief coming in and trying to steal our CrowPi … by detecting a motion using infra-red light, we were able turn on buzzer alarm and make the thief run away!

What will you learn

At the end of this lesson you'll be able to:

* Get output out of the motion sensor and detecting movement around the CrowPi

What will you need

* CrowPi Board after initial installation

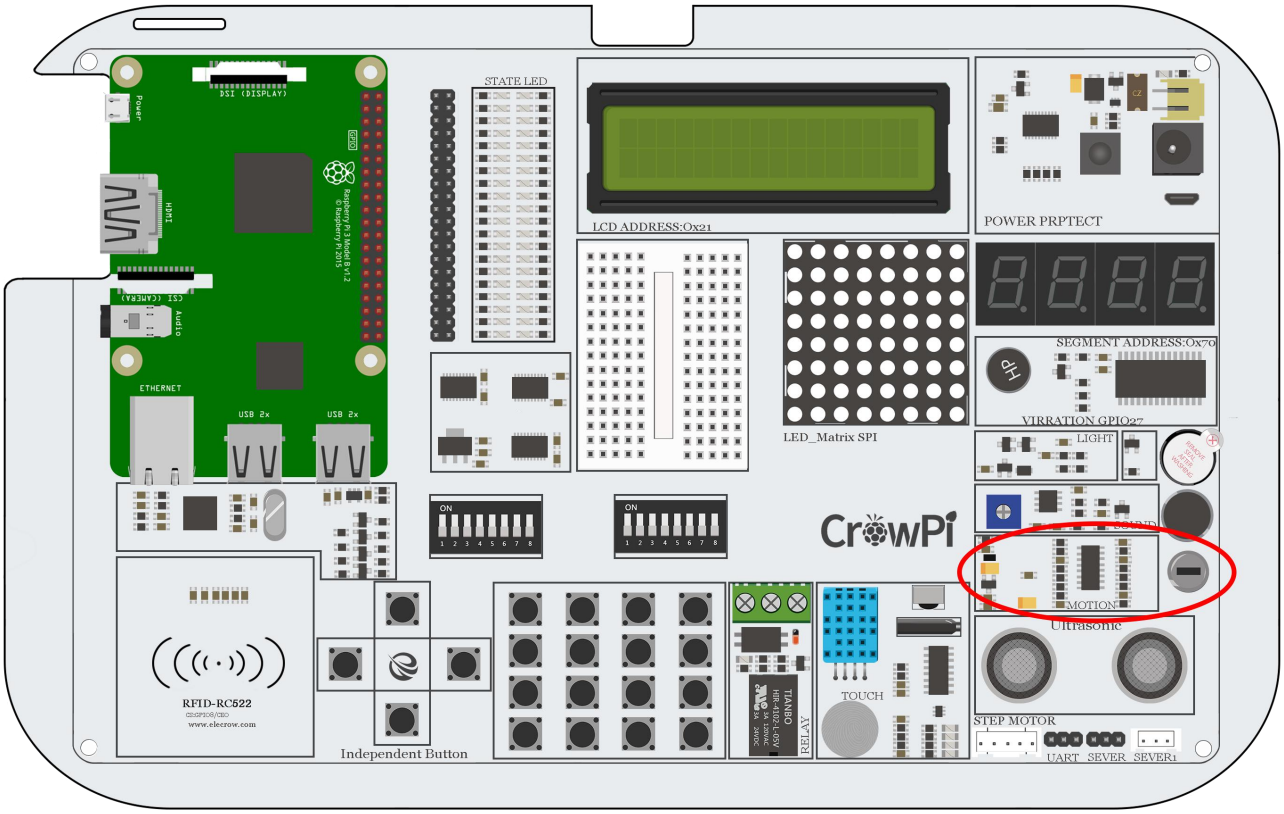
Requires switching modules using the switch

* No

Motion sensor location on the CrowPi

The motion sensor is located right under the sound sensor and contains a small white transparent cup to cover it, the little protector cup helps the sensor detect more surrounding movement by breaking the red infra-light around.

The motion sensor doesn't make any sound or light as well but it's very easy to see if it works by moving your hand on top of the CrowPi and see if it can detect movement!

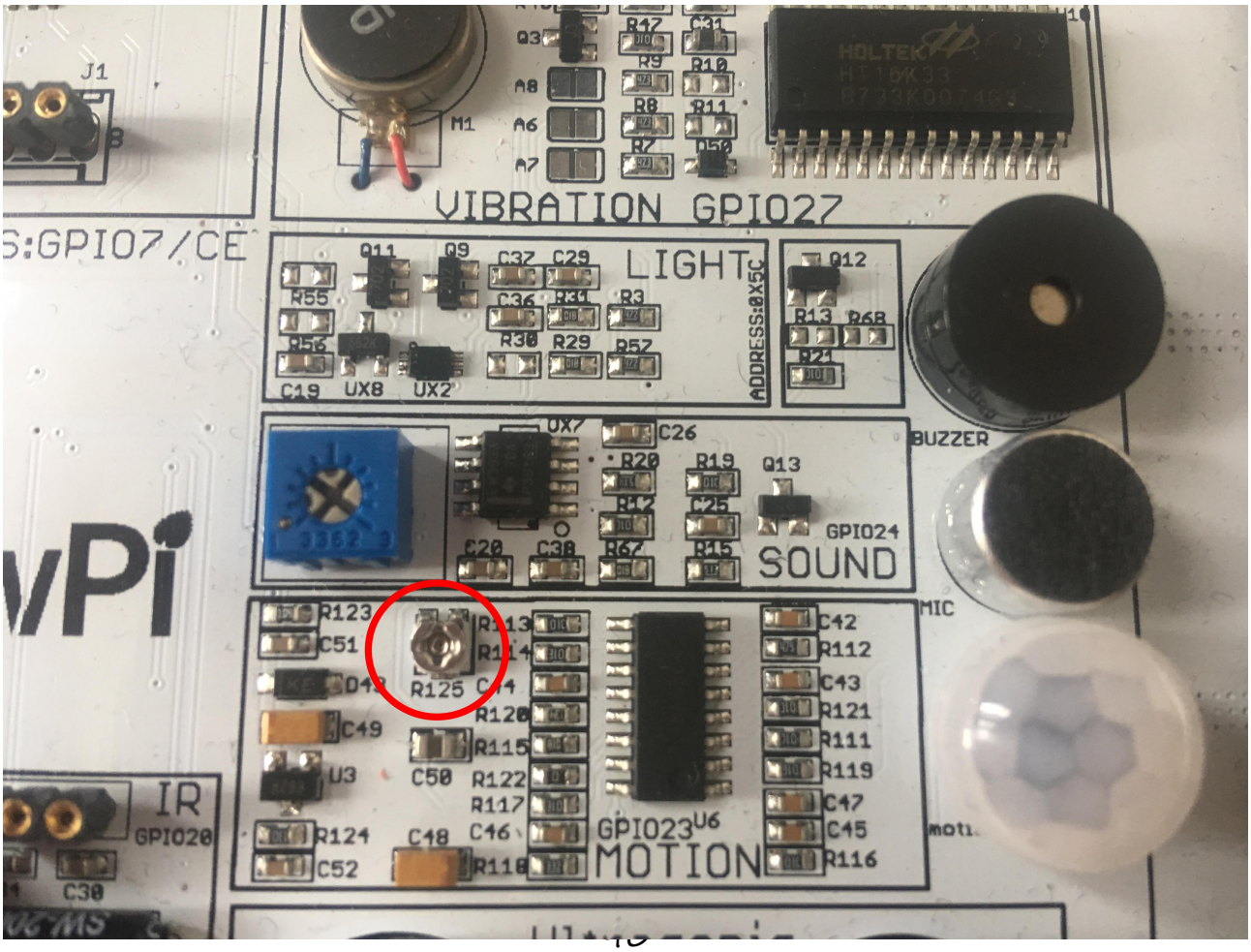


Configuring the sensitivity

The motion sensor includes a tiny screw right under the sound sensor potentiometer (the blue thing to configure the sound sensitivity)

We'll use that tiny potentiometer in order to adjust the sensitivity of the motion sensor.

By adjusting the sensitivity of the motion sensor we'll be able to let the motion sensor know in what distance we would like to detect a motion (far distance or close distance) and that would allow us to have better control over our application.



By using a standard Philips drivers, rotate the screw to the right or to the left when running the motion example script in order to find the suitable distance of the motion sensor.

Working with the motion sensor

The motion sensor is controlled by the GPIO pins, if movement is detected the motion sensor will send input signal which will alert something is moving around after couple of seconds he will turn the input off and wait till the next movement to be happen …

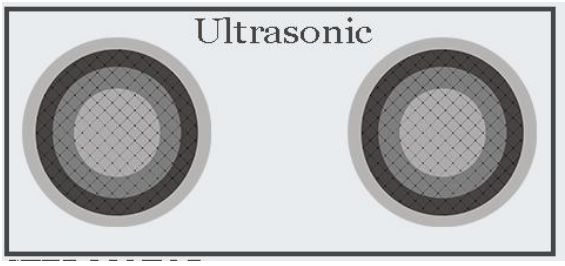
```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# http://elecrow.com/

import RPi.GPIO as GPIO
import time

# define motion pin
motion_pin = 16

# set GPIO as GPIO.BOARD
GPIO.setmode(GPIO.BOARD)
# set pin mode as INPUT
GPIO.setup(motion_pin, GPIO.IN)

try:
    while True:
       if(GPIO.input(motion_pin) == 0):
             print "Nothing moves ..."
       elif(GPIO.input(motion_pin) == 1):
             print "Motion detected!"
       time.sleep(0.1)
except KeyboardInterrupt:
    GPIO.cleanup()
```

Execute the following commands and try it by yourself:

```
1   cd /home/pi/Desktop/CrowPi/
2   sudo python motion.py
```

Lesson 9

Getting distance information using the Ultrasonic sensor.



Distance is a very useful thing in our daily life .. we use it to measure walls before we buy new furniture and cars using it to make sure they won't stuck and crash anyone behind! Cars by the way .. use the same ultrasonic sensor we will use in our demonstration! In this tutorial we will use how to use an ultrasonic sensor to measure the distance and output it on the CrowPi screen

What will you learn

At the end of this lesson you'll be able to:

* Control the Ultrasonic sensor and get distance as output

What will you need

* CrowPi Board after initial installation

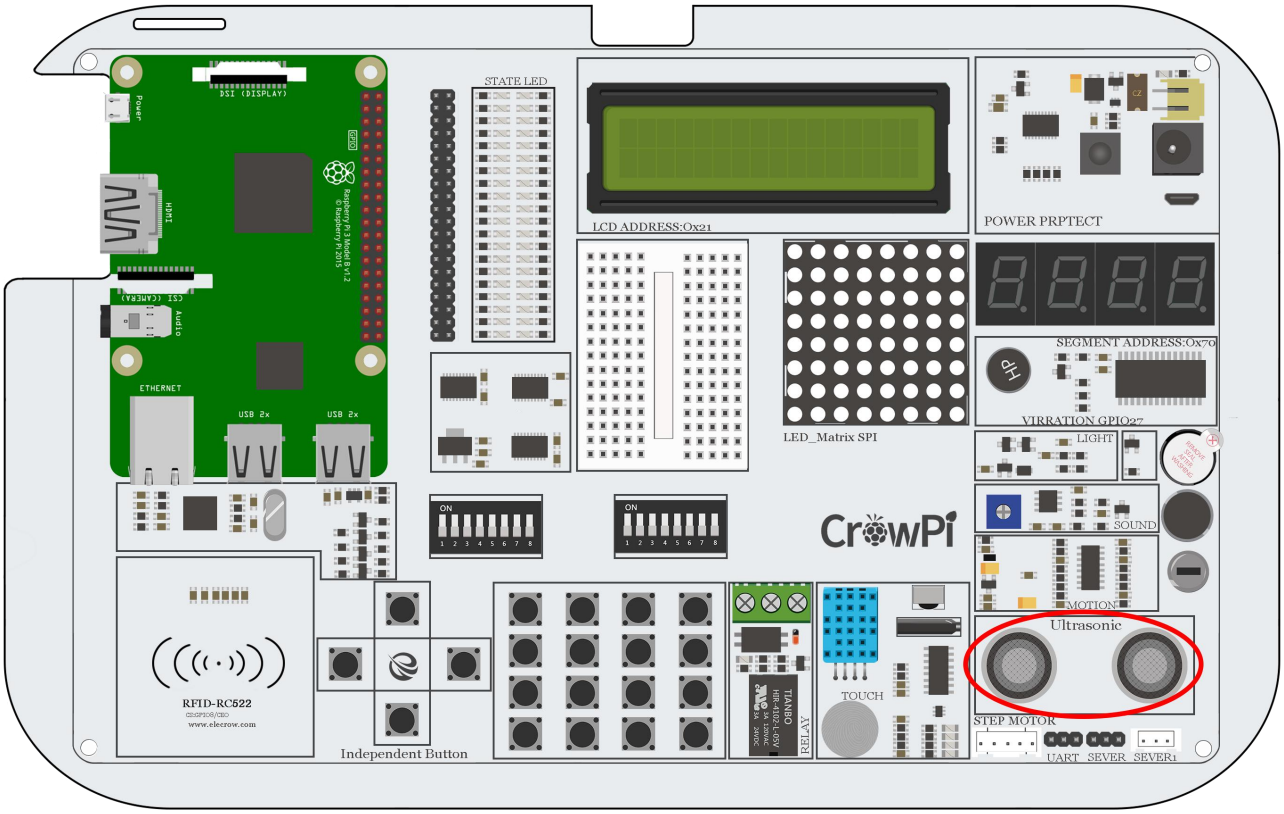
Requires switching modules using the switch

* No

Ultrasonic sensor location on the CrowPi

The ultrasonic sensor is located on the bottom right of the CrowPi board right on top of the servo and UART pins, it's easy to be recognised by 2 giant circles which looks like robotic eyes!

We will use our hands to move them up and down on top of the distance sensor in order to measure the distance between our hands to the CrowPi!



Working with the ultrasonic distance sensor

The distance sensor works using GPIO INPUT but it's a bit different from what we used to do in our previous lessons.

The distance needs some interval to be able to detect the distance in accurate way, it uses pulses of HIGH and LOW in order to do so, after we know the duration of the pulse we'll be able to use Math and Science to calculate the distance between the distance sensor and the object that standing in front of it.

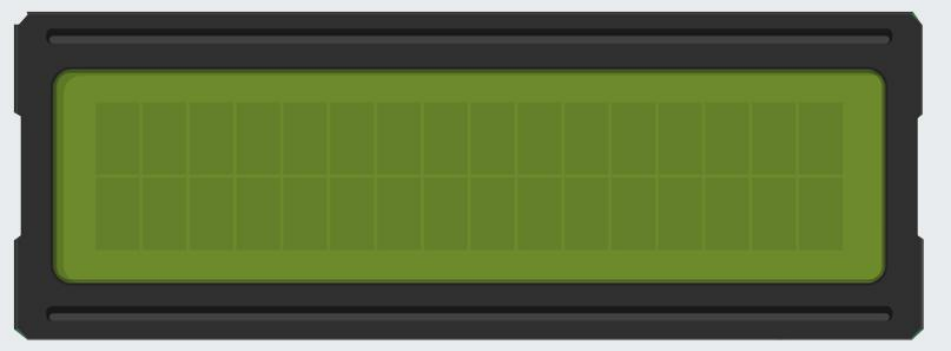
```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# Author : www.modmypi.com
# Link: https://www.modmypi.com/blog/hc-sr04-ultrasonic-range-sensor-on-the-raspberry-pi

import RPi.GPIO as GPIO
import time

GPIO.setmode(GPIO.BOARD)

TRIG = 36
ECHO = 32

print "Distance Measurement In Progress"

GPIO.setup(TRIG,GPIO.OUT)
GPIO.setup(ECHO,GPIO.IN)

GPIO.output(TRIG, False)
print "Waiting For Sensor To Settle"
time.sleep(2)

GPIO.output(TRIG, True)
time.sleep(0.00001)
GPIO.output(TRIG, False)

while GPIO.input(ECHO)==0:
  pulse_start = time.time()

while GPIO.input(ECHO)==1:
  pulse_end = time.time()

pulse_duration = pulse_end - pulse_start

distance = pulse_duration * 17150

distance = round(distance, 2)

print "Distance:",distance,"cm"

GPIO.cleanup()
```

Execute the following commands and try it by yourself:

```
1  cd /home/pi/Desktop/CrowPi/
2  sudo python distance.py
```

Lesson 10

Controlling the LCD Display



LCD (and matrix display) is probably the funniest and most exciting part when building projects using the CrowPi, using the LCD display you could show data that you collect using your CrowPi sensors and also update it in real time depends on the change that the modules goes through!

For example: yesterday it was really hot but today it's really cold - let the CrowPi LCD change itself automatically with the latest and most updated info so you will not accidentally wear the wrong clothes for school / work!

What will you learn

At the end of this lesson you'll be able to:

* What you will learn how to control the LCD display and write data into it

What will you need

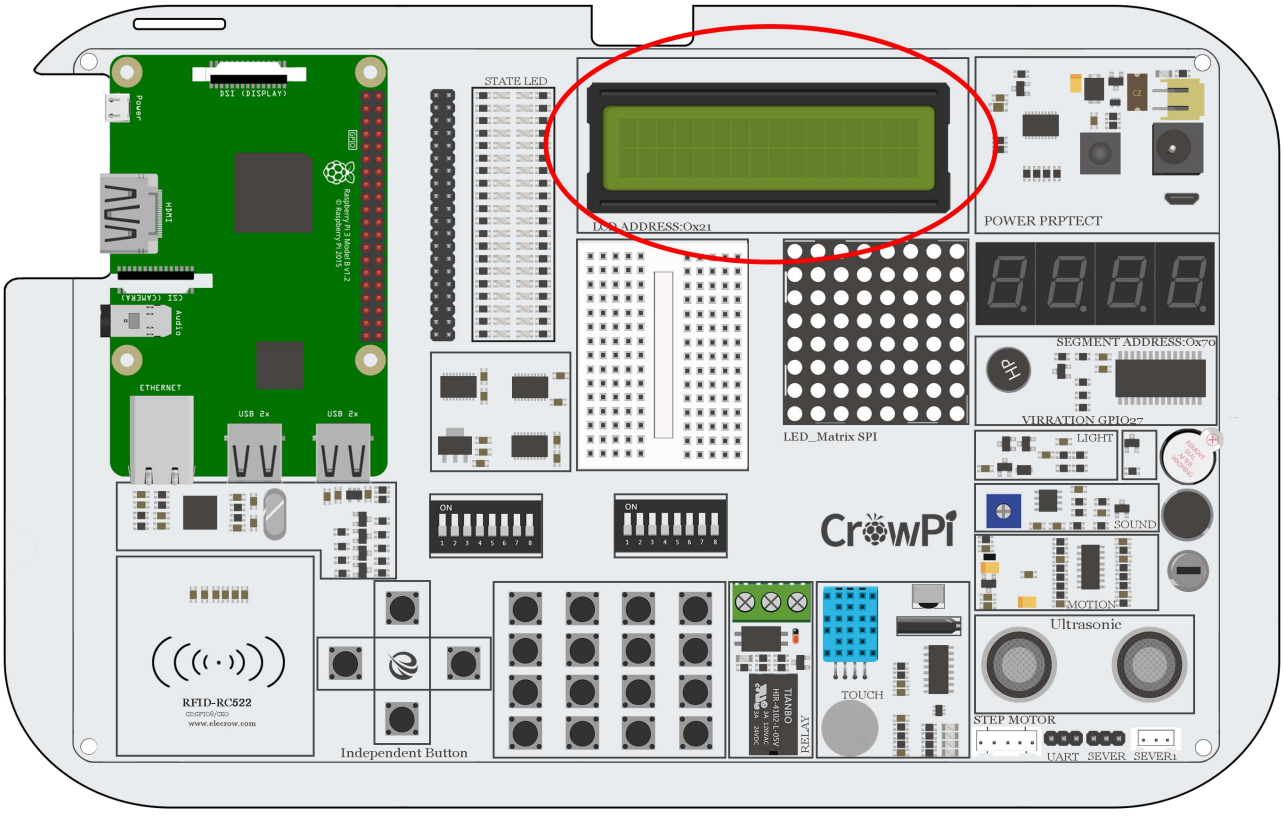
* CrowPi Board after initial installation

Requires switching modules using the switch

* No

LCD Screen location on the CrowPi

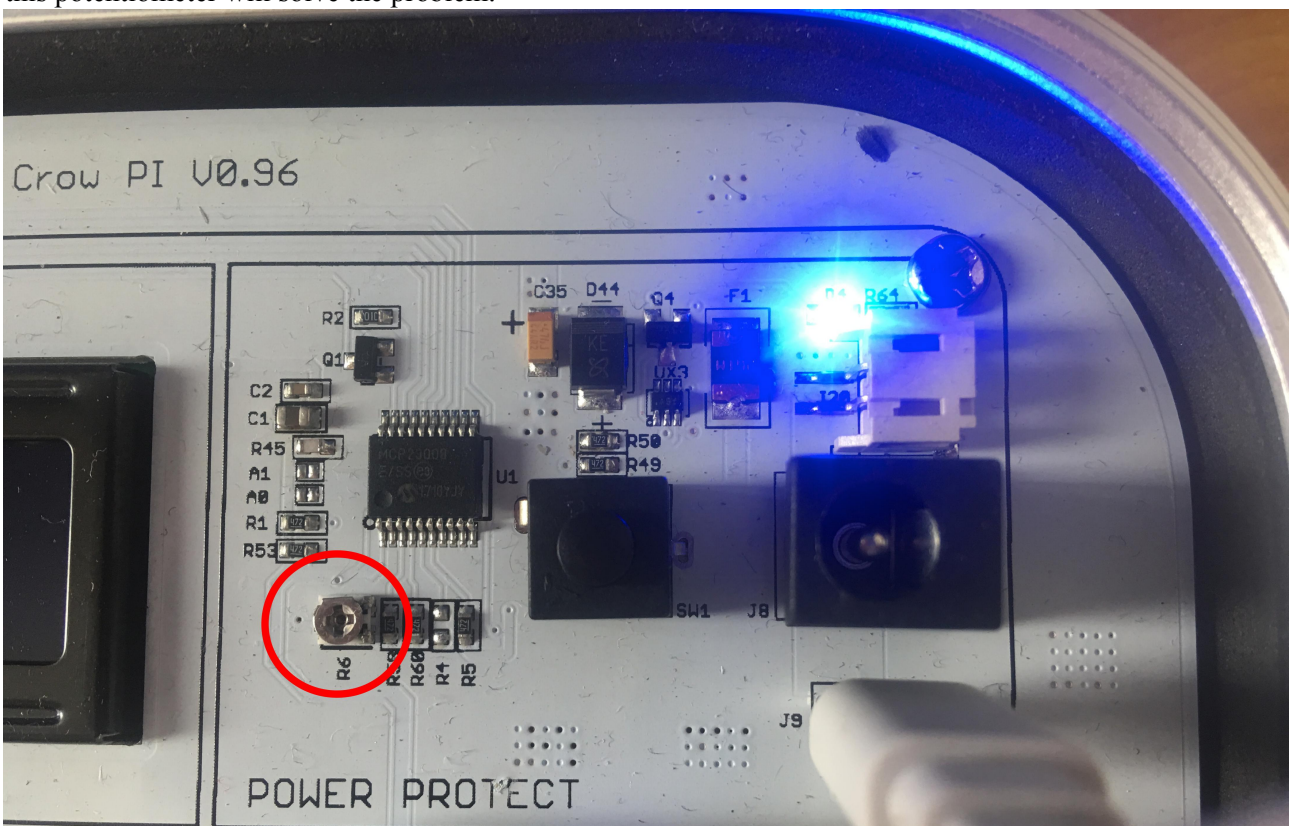
The LCD screen takes the biggest part of the CrowPi board so we are sure you noticed it immediately! As soon as running the demo script and the examples, the CrowPi will turn on with beautiful background light that can be seen even when all the lights in the room are turned off



Configuring the LCD brightness

The LCD contains a tiny screw on the left side of the power circuit on the CrowPi, this screw will help us to adjust the brightness and the contrast of the LCD screen in case we need to.

Learning how to use this is incredibly important - incase you run into dark LCD screen know that adjusting this potentiometer will solve the problem.



By using a standard Philips drivers, rotate the screw to the right or to the left when running the LCD example script in order to find the suitable brightness for you.

Working with the LCD

The I2C as some other sensors also doesn't work on GPIO Technology instead we use something called "I2C" (The same I2C we used for the light sensor in our previous examples), the address we'll use for the LCD screen is 21, by connecting to this I2C address we'll be able to send commands for example: writing text or numbers, turning on the backlight of the LCD, turning it off, enabling cursor etc …

For controlling the LCD we'll use Adafruit_CharLCDBackpack which is Adafruit framework, makes things a lot of easier for us when working with such complicated product!

```
1  #!/usr/bin/python
2  # -*- coding: utf-8 -*-
3
4  # Example using a character LCD backpack.
5  import time
6
7  import Adafruit_CharLCD as LCD
8
9  # Define LCD column and row size for 16x2 LCD.
10 lcd_columns = 16
11 lcd_rows    = 2
12
13 # Initialize the LCD using the pins
14 lcd = LCD.Adafruit_CharLCDBackpack(address=0x21)
15
16 # Turn backlight on
17 lcd.set_backlight(0)
18
19 # Print a two line message
20 lcd.message('Hello\nworld!')
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python lcd.py
```

Lesson 11

Read / Write RFID card using the RFID module.

The RFID module is one of the most interesting and useful modules in the market, used world wide in wide variety of solutions such as: smart door lock, employee entry card, business cards and even on dog collars?

No matter what kind of project you're into - RFID module will definitely come in use!

What will you learn

At the end of this lesson you'll be able to:

* Control the RFID, Read and Write Data from it and recognise the chips

What will you need

* CrowPi Board after initial installation

* RFID Chip (included with the CrowPi)

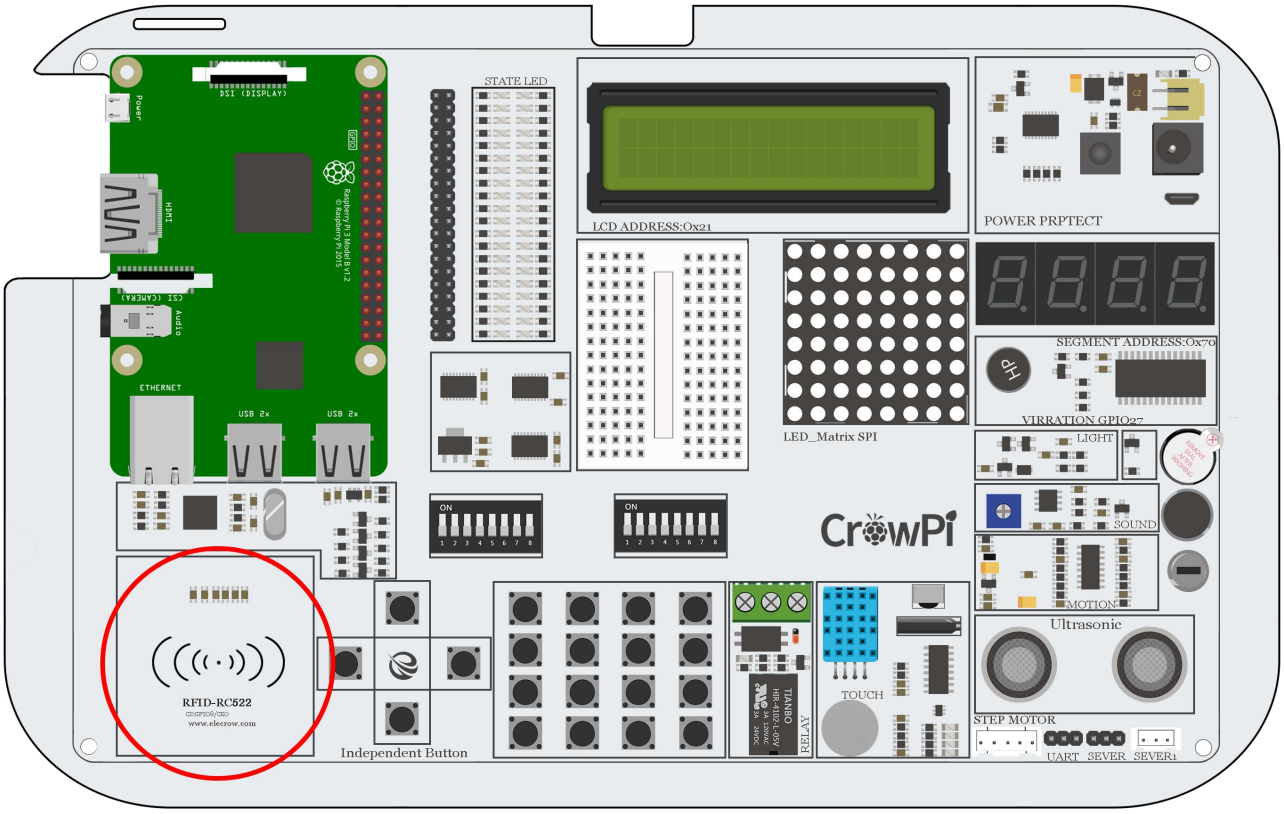
Requires switching modules using the switch

* No

RFID Module location on the CrowPi

The RFID module is located right below the Raspberry Pi (either zero or 3) it looks like a small chip with “wifi” illustration coming out of it which means wireless connectivity (which is what RFID does) in order to use it we’ll need to take the chip or the card that comes with the CrowPi and hand it over the CrowPi RFID Chip area close enough for our script to detect it.

2-4cm should be close enough, have a try!



Working with the RFID

Working with the RFID module is pretty straight forward.

We have 3 functionalities: Authorizing, Read, Write and Deauthorizing.

First step will be when you touch the NFC at that time the module and our script will try to Authorise the chip using the default password configuration (if you haven't changed it, it should work) afterwards, when authorisation is successful, it will read the data and print it out on the screen. After finished it will Deauthorize and quit the script.

In another script example we'll be able to Authorize, Read, Re-write the data to a new data and then Deauthorize.

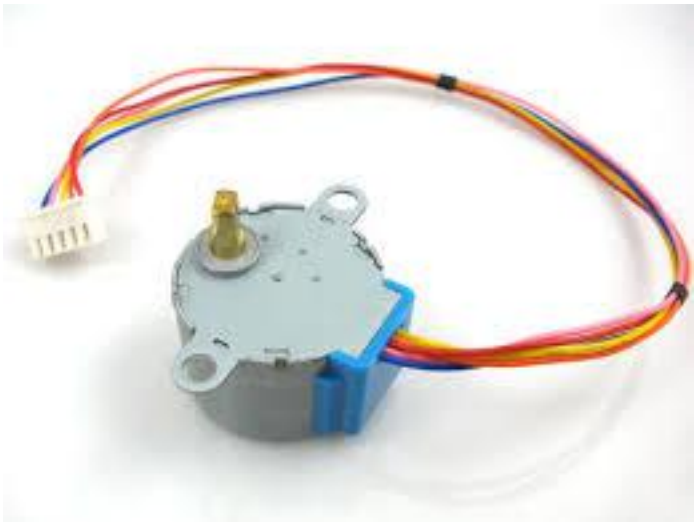
```
23  print("Starting")
24  while run:
25      rdr.wait_for_tag()
26
27      (error, data) = rdr.request()
28      if not error:
29          print("\nDetected: " + format(data, "02x"))
30
31      (error, uid) = rdr.anticoll()
32      if not error:
33          print("Card read UID: "+str(uid[0])+","+str(uid[1])+","+str(uid[2])+","+str(uid[3]))
34
35          print("Setting tag")
36          util.set_tag(uid)
37          print("\nAuthorizing")
38          #util.auth(rdr.auth_a, [0x12, 0x34, 0x56, 0x78, 0x96, 0x92])
39          util.auth(rdr.auth_b, [0x74, 0x00, 0x52, 0x35, 0x00, 0xFF])
40          print("\nReading")
41          util.read_out(4)
42          print("\nDeauthorizing")
43          util.deauth()
44
45          time.sleep(1)
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python RFID_Read.py
```

Lesson 12

Using the step motor and making step movements.



Step motor is a great way to control movements, used in big variety of projects such robots, automatic coffee machine, 3D printers and more! Learning how to use the step motor can give you a huge boost on abilities compared to others!

What will you learn

At the end of this lesson you'll be able to:

* You will learn how to control the step motor and make steps movements

What will you need

* CrowPi Board after initial installation

* Step motor (included with CrowPi kit)

Requires switching modules using the switch

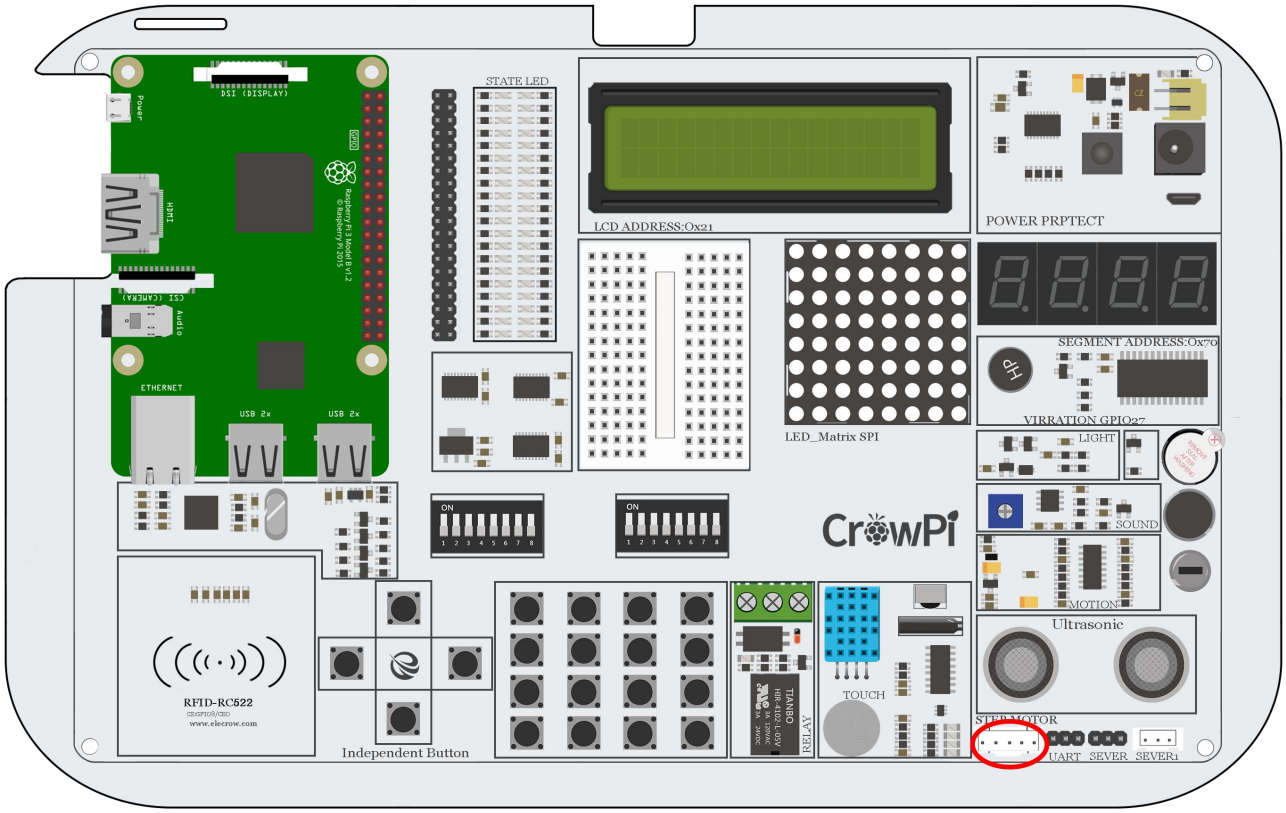
* **Yes**, Right switch - pins number 3,4,5,6 - turn it on by switching it UP (refer to page number 5 if you forgot how to switch the sensors)

Step Motor Module location on the CrowPi

The step motor is an independent module that we'll need to connect to the board

We'll need to take the step motor which included with the kit and connect it to our CrowPi into a dedicated place that located on the CrowPi Board,

Refer to the following picture, connect the Step motor where the red circle is:



If the module gets a bit hot don't worry! That's totally normal and not dangerous at all.

Working with the Step motor

Working with the Step motor module is pretty straight forward.

The step motor is connected to 4 GPIO pins which each time we turn on one by one very quickly which makes the step motor “push” forward and make a step. We can use the function turnSteps to tell how many steps we want to make and turnDegrees to make a quarter turns.

```
121  def main():
122
123          print("moving started")
124          motor = Stepmotor()
125          print("One Step")
126          motor.turnSteps(1)
127          sleep(0.5)
128          print("20 Steps")
129          motor.turnSteps(20)
130          sleep(0.5)
131          print("quarter turn")
132          motor.turnDegrees(90)
133          print("moving stopped")
134          motor.close()
135
136  if __name__ == "__main__":
137      main()
```

Execute the following commands and try it by yourself:

```
1   cd /home/pi/Desktop/CrowPi/
2   sudo python stepmotor.py
```

Lesson 13

Controlling servos motors using the servo interfaces.

Servo is a really cool module that lets us mechanically control devices and move parts. Using such servo we can make a smart trash bin, a candy box with smart opening / closing door and many other interesting projects!

In this tutorial we'll learn how to use the servo using the interface that we installed on top of the CrowPi.

What will you learn

At the end of this lesson you'll be able to:

* Connect and control the servo in multiple directions

What will you need

* CrowPi Board after initial installation

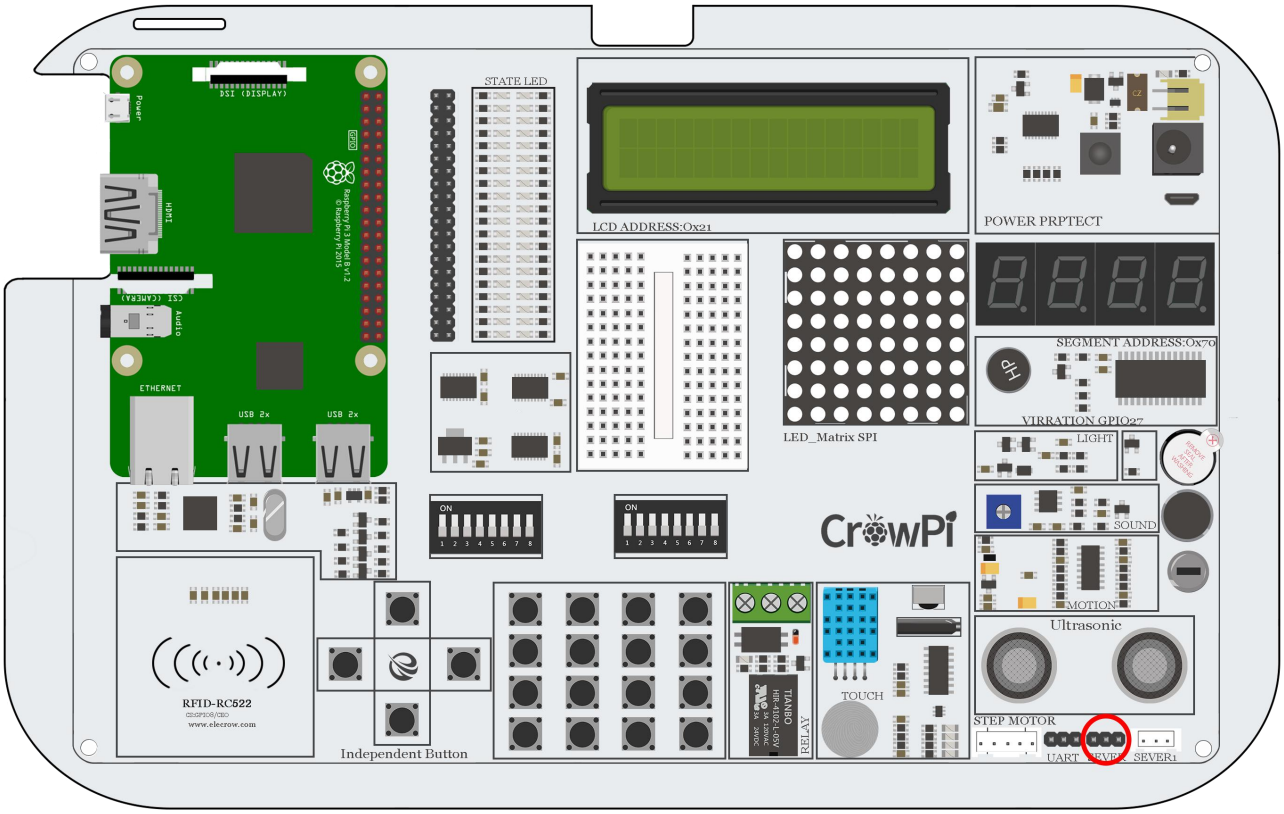
* Micro servo (comes with the CrowPi)

Requires switching modules using the switch

* **Yes**, Right switch - pins numbers 7,8 - turn it on by switching it UP (refer to page number 5 if you forgot how to switch the sensors)

Servo Module location on the CrowPi

The CrowPi contains 2 servos interfaces which both can be used for the purpose of controlling the servo. In this tutorial, we'll use interface number one which marked as "Servo1".



You can always use the other interface as well but you'll need to modify the example script to the suitable GPIO pins.

The servo contains 3 pins: Positive, Negative and DATA Pin.

Positive pin is always the red cable, the negative pin is the black one (also called ground) and the data cable is usually colourful one.

Connect it as following

* **Red Cable (Positive) goes to the middle pin of the first servo**
* **Black Cable (Negative also called Ground) goes to the right pin of the first servo**
* **Colourful cable (might be blue or orange) goes to the GPIO pin on the left side of the first servo.**

Working with the Servo

Working with the servo is plain simple. Let's overview our example code to understand it further:

The servo pin is number 37 (the most left one we connected which is the GPIO)

Every time the script will set direction to the servo module to turn left we set degree of 100,10 to turn right we set degree of -100, -10.

The servo uses GPIO BOARD pin number 37.

You can play with the degrees and see where the servo will turn !

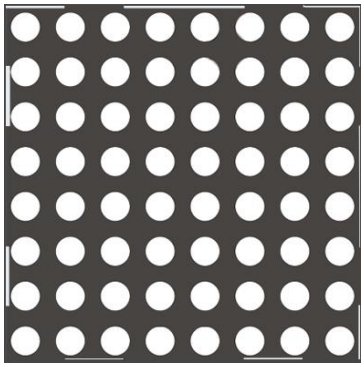
```
46  def main():
47
48      servo_pin = 37
49      s = sg90(servo_pin,0)
50
51      try:
52          while True:
53              print "Turn left ..."
54              s.setdirection( 100, 10 )
55              time.sleep(0.5)
56              print "Turn right ..."
57              s.setdirection( -100, -10 )
58              time.sleep(0.5)
59      except KeyboardInterrupt:
60          s.cleanup()
61
62  if __name__ == "__main__":
```

Execute the following commands and try it by yourself:

```
1   cd /home/pi/Desktop/CrowPi/
2   sudo python servo.py
```

Lesson 14

Controlling the 8x8 Matrix LED.



The matrix LED plays important rule in every blinking LED project.

Even tho you might not see it at first glance, the Matrix LED can do way beyond blinking red shiny LED's, It can be used to show information, text, emojis and even … Chinese characters! Perfect to show information in fun and unique way and maybe even make a game like snake or a count down timer!

What will you learn

At the end of this lesson you'll be able to:

* Control Matrix LED, show text, control the speed and information flow

What will you need

* CrowPi Board after initial installation

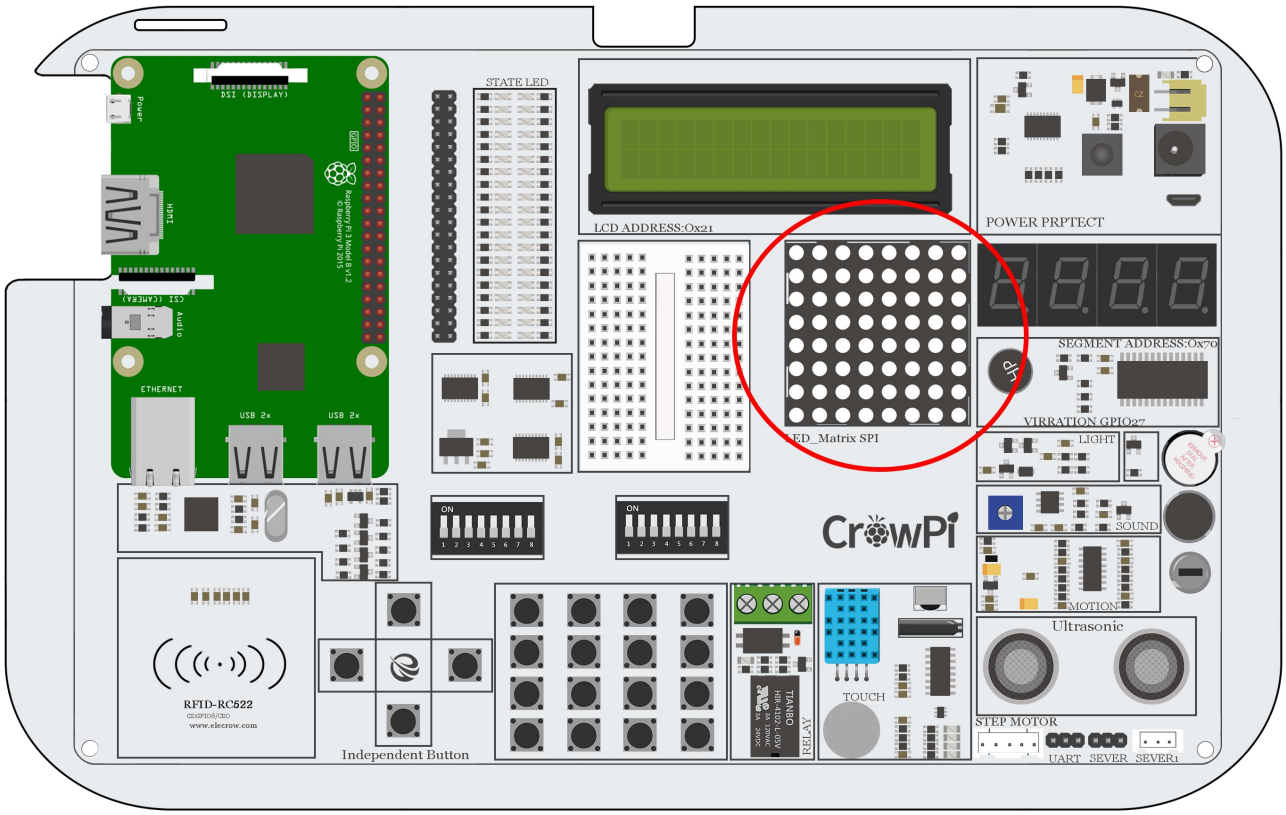
Requires switching modules using the switch

* No

Matrix Module location on the CrowPi

The matrix module is a big square module located on the left side of the segment LED and right under the LCD display. It can be easily recognised by small white dots which functions as micro LED's.

Don't let the small size of white circles mislead you, this matrix LED can bright a dark place with ease!



Working with the Matrix Display

The Matrix LED demo we prepared contains everything from everything. Each line contains example of demo text including show long text, controlling the speed of the text, choosing random words from a list and much more.

In the script we make a string with a message for example “Hello World” and then we use the function show_message() to show the message on the Matrix Display.

We can control properties like delay which makes the message go faster or slower .. for example scroll_delay 0 will be pretty quick while delay of 0.1 will slow the message flow in a bit …

The Matrix LED unlike other modules uses SPI interface to be controlled from.

Try multiple examples and change the code to see what happens!

```
def demo(n, block_orientation, rotate):
    # create matrix device
    serial = spi(port=0, device=1, gpio=noop())
    device = max7219(serial, cascaded=n or 1, block_orientation=block_orientation, rotate=rotate or 0)
    print("Created device")

    # start demo
    msg = "MAX7219 LED Matrix Demo"
    print(msg)
    show_message(device, msg, fill="white", font=proportional(CP437_FONT))
    time.sleep(1)

    msg = "Fast scrolling: Lorem ipsum dolor sit amet, consectetur adipiscing\
    elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut\
    enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut\
    aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in\
    voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint\
    occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit\
    anim id est laborum."
    msg = re.sub(" +", " ", msg)
    print(msg)
    show_message(device, msg, fill="white", font=proportional(LCD_FONT), scroll_delay=0)
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python matrix_demo.py
```

Lesson 15

Controlling the 7 Segment Display.

The segment LED is a really useful display when it comes to numbers and data

It can show us the time, count how many times we did certain things and even be used to scare our friends with fake time bomb!

Segment LED is used in many industrial solutions such as elevators! And using it will definitely bring use for you in the future!

What will you learn

At the end of this lesson you'll be able to:

* Control the segment LED and show different numbers and data on it

What will you need

* CrowPi Board after initial installation

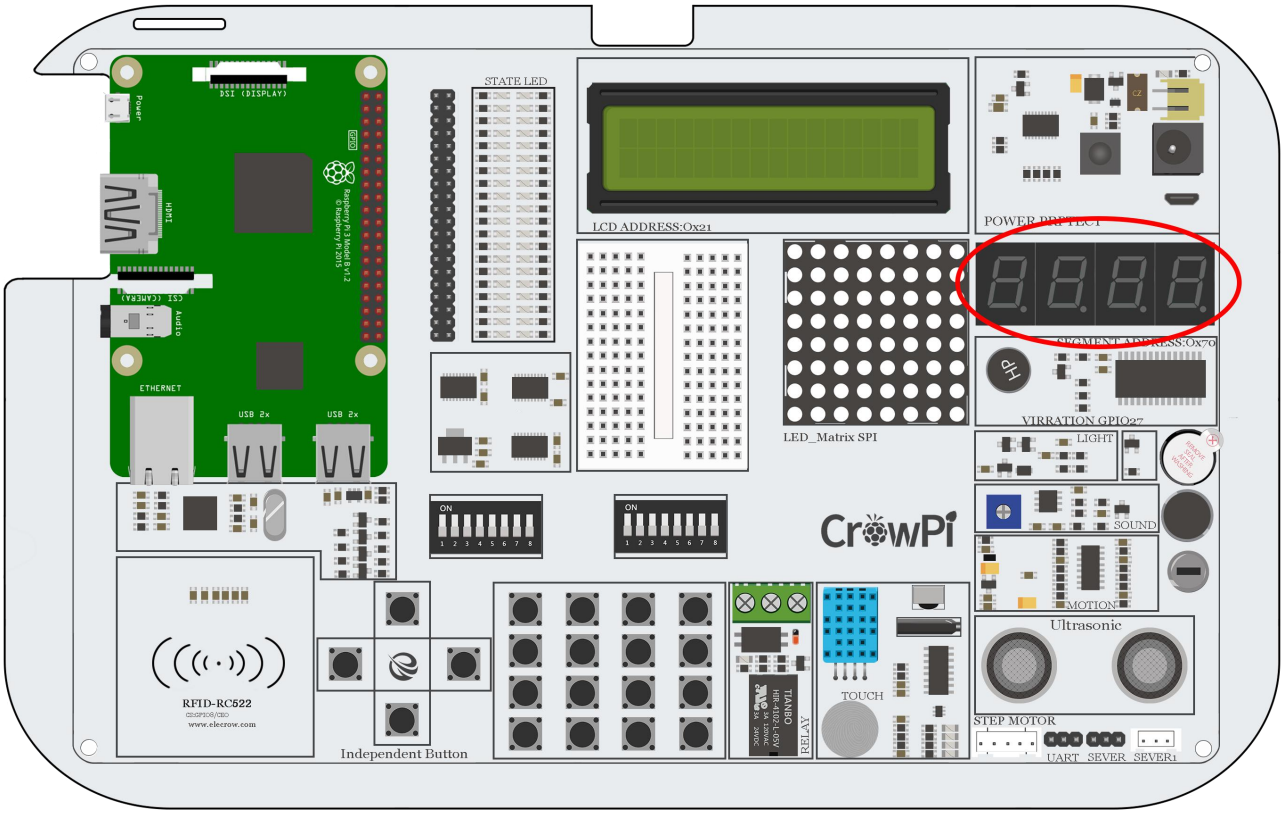
Requires switching modules using the switch

* No

Segment Display location on the CrowPi

The segment LED located right on top of the vibration sensor and besides the Matrix LED, when turned off it can be easily recognised with 4 eight numbers …

As soon as you'll use the Segment LED module, the dark colour will turn into shiny and bright Red, which you'll be able to control what type of data will be shown on!



Adjusting Raspberry Pi System timezone

In our example we'll show how to show the time using the segment display, in order to do that first we'll need to have the right time configured in the system otherwise we'll see different that from what it should be, we'll do it by opening the "Terminal" and running the following command: "sudo dpkg-reconfigure tzdata"

```
pi@raspberrypi:~/Desktop/CrowPi $ sudo dpkg-reconfigure tzdata
```

After pressing enter a new window will open up with options for many countries and regions, navigate using the keyboard arrows for the country that is suitable for your place.

After choosing the right country / region - navigate to <OK> button and press enter to accept the new configuration - that's it!

You're ready to go with your clock which is now configured to the right timezone.

Working with the Segment Display

In our example we'll demonstrate a clock.

We'll use the time and date time modules to get the Raspberry Pi system time, we'll set the segment I2C address to 70 and then we'll set the current time of the system on the segment display using segment.write_display() we use the function set_digit() with the number of the digit 0,1,2,3 to set the location where we want to show the number.

Try to play around with this clock example and see what you can make by yourself!

```
#!/usr/bin/python

import time
import datetime

from Adafruit_LED_Backpack import SevenSegment

# ===========================================================================
# Clock Example
# ===========================================================================
segment = SevenSegment.SevenSegment(address=0x70)

# Initialize the display. Must be called once before using the display.
segment.begin()

print "Press CTRL+Z to exit"

# Continually update the time on a 4 char, 7-segment display
while(True):
  now = datetime.datetime.now()
  hour = now.hour
  minute = now.minute
  second = now.second

  segment.clear()
  # Set hours
  segment.set_digit(0, int(hour / 10))     # Tens
  segment.set_digit(1, hour % 10)          # Ones
  # Set minutes
  segment.set_digit(2, int(minute / 10))   # Tens
  segment.set_digit(3, minute % 10)        # Ones
  # Toggle colon
  segment.set_colon(second % 2)              # Toggle colon at 1Hz

  # Write the display buffer to the hardware.  This must be called to
  # update the actual display LEDs.
  segment.write_display()

  # Wait a quarter second (less than 1 second to prevent colon blinking getting$
  time.sleep(0.25)
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python segment.py
```

Lesson 16

Detecting touch using the Touch Sensor

The touch sensor is pretty useful when it comes to buttons functionality.

Sometimes you are not willing to push a regular button but you feel like doing a touch movement same like your mobile phone screen or your iPad - the touch sensor was made for this purpose exactly.

The touch sensor comes in use in games like who touch the the pad as soon as possible or when you want to activate something by touch and not by pressing a button.

Many products in the market use touch instead of button pressing so learning how to use that type of sensor can definitely come in great use!

What will you learn

At the end of this lesson you'll be able to:

* Use and detect a touch over the touch sensor surface

What will you need

* CrowPi Board after initial installation

Requires switching modules using the switch

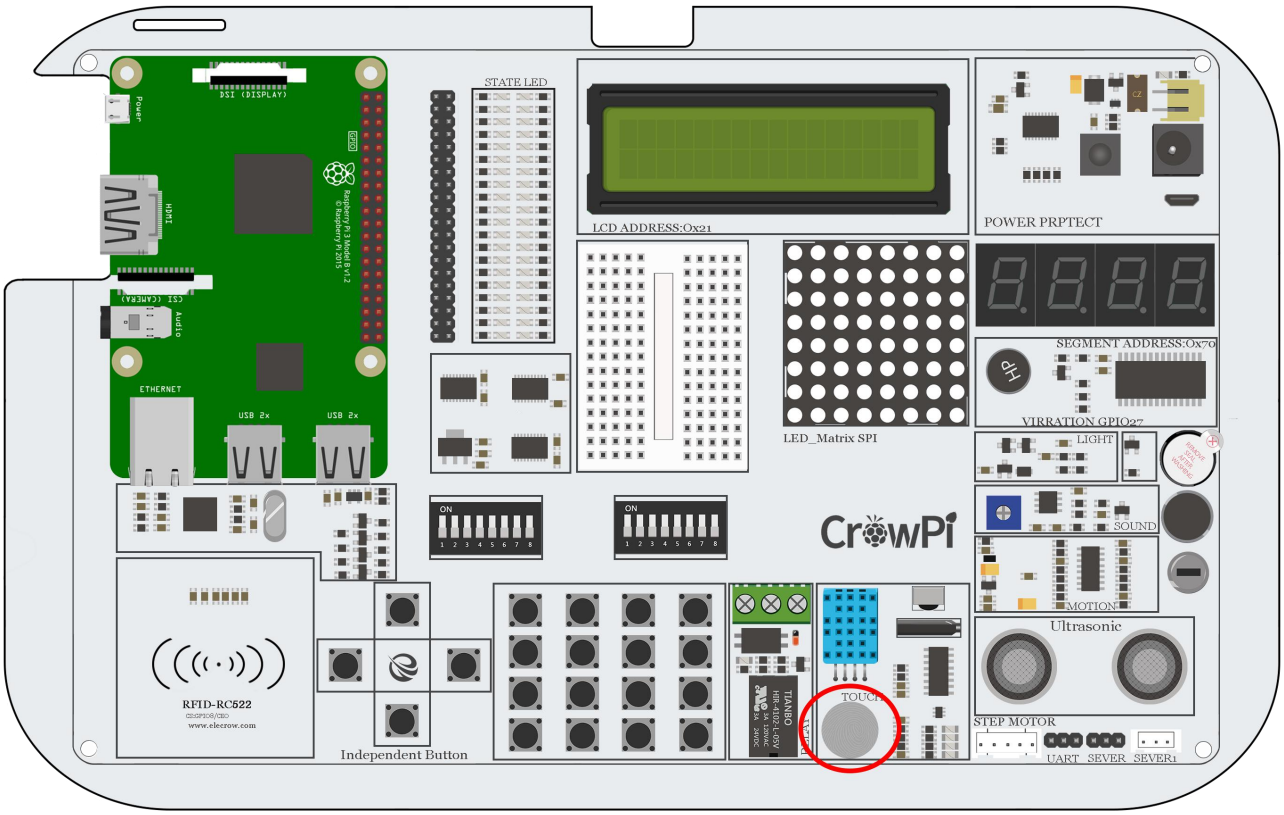
* No

Touch Sensor location on the CrowPi

The touch sensor is located right under the DH11 sensor and next to the relay.

The good location over the CrowPi allows it easy access and convenient touching surface.

Make sure to keep your hands off the sensor when not in use to avoid false positive alerts!



Working with the touch sensor

The touch sensor operates like any other button module with one difference that instead of pushing or clicking - we touch!

By touching the touch sensor the module will close a circuit which will indicate GPIO Input as HIGH, when you release the finger from the sensor the GPIO will go back to low indicate that currently nothing touches the sensor.

The touch sensor uses GPIO BOARD 11 pin.

```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# http://elecrow.com/

import RPi.GPIO as GPIO
import time

# define touch pin
touch_pin = 11

# set board mode to GPIO.BOARD
GPIO.setmode(GPIO.BOARD)
# set GPIO pin to INPUT
GPIO.setup(touch_pin, GPIO.IN, pull_up_down=GPIO.PUD_UP)

try:
    while True:
        # check if touch detected
        if(GPIO.input(touch_pin)):
            print('Touch Detected')
        time.sleep(0.1)
except KeyboardInterrupt:
    # CTRL+C detected, cleaning and quitting the script
    GPIO.cleanup()
```

Execute the following commands and try it by yourself:

```
1   cd /home/pi/Desktop/CrowPi/
2   sudo python touch.py
```

Lesson 17

Detecting tilt using the Tilt Sensor.

The tilt sensor is another one of my favourite sensors over the CrowPi.

The tilt sensor allows us to detect a tilt for either right or left, it can be extremely useful in scenario where you want to know if the surface is straight or tilted and also to which side it's tilted if at all.

Tilt sensor is used in robotics and other industries to make sure things are kept straight, what kind of project you'll choose to do with it?

What will you learn

At the end of this lesson you'll be able to:

* Control the tilt sensor and recognise a right side or left side tilt.

What will you need

* CrowPi Board after initial installation

Requires switching modules using the switch

* **Yes**, the right switch - pin number 2 - switch it on by turning it UP (refer to page number 5 if you forgot how to switch the sensors)

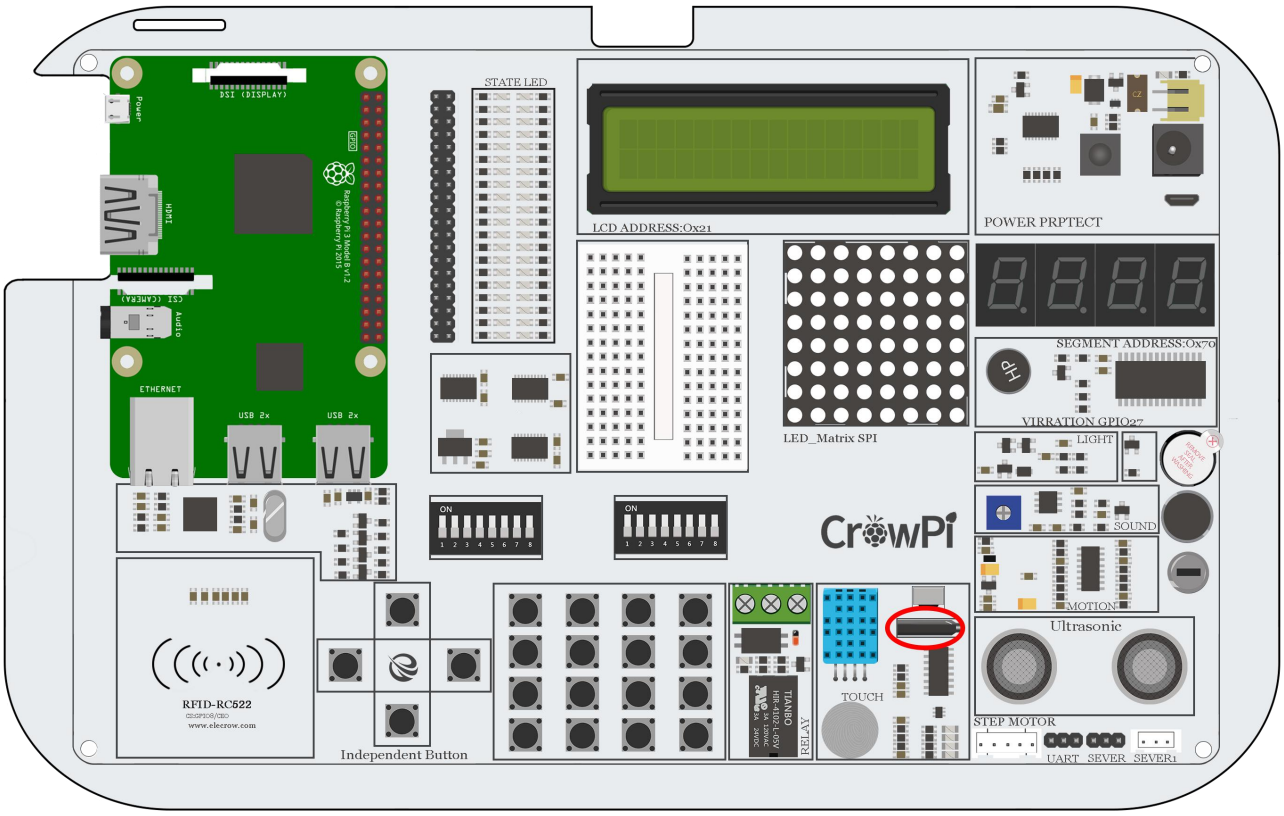
Tilt Sensor location on the CrowPi

The tilt sensor is a small long black sensor located next to the DH11 sensor and the Ultrasonic.

It can be easily recognisable by the sound it makes when you shake the board to the sides, like a small ball is rolling from side to side …

Sometimes you might confuse the sound as if something broken inside the CrowPi but let us assure you that it's perfectly normal!

If they tilt sensor doesn't make any sound when tilted to right or left, it's something we should probably worry about.



Working with the tilt sensor

Working with the tilt sensor is fairly easy, when the tilt sensor tilted to the left side, it will activate a circuit which will send INPUT signal of GPIO HIGH.

When the sensor is tilted to the right side, the circuit will open and the INPUT would be GPIO LOW.

That way we can use this data and print if the tilt sensor is either on the left side or the right side!

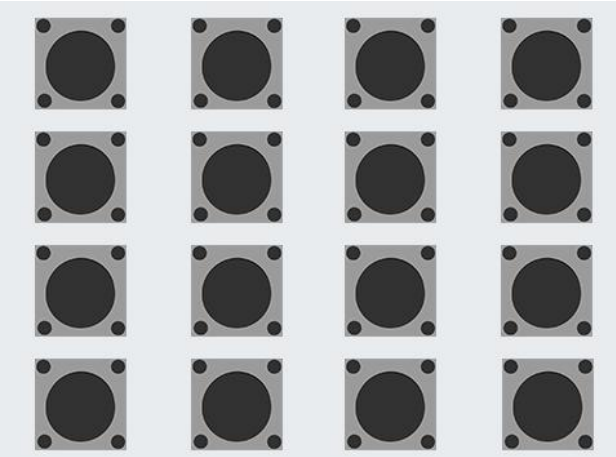
```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# http://elecrow.com/

import time
import RPi.GPIO as GPIO

# define tilt pin
tilt_pin = 15

# set GPIO mode to GPIO.BOARD
GPIO.setmode(GPIO.BOARD)
# set puin as input
GPIO.setup(tilt_pin, GPIO.IN)

try:
    while True:
        # positive is tilt to left negative is tilt to right
        if GPIO.input(tilt_pin):
            print "[-] Left Tilt"
        else:
            print "[-] Right Tilt"
        time.sleep(1)
except KeyboardInterrupt:
    # CTRL+C detected, cleaning and quitting the script
```

Execute the following commands and try it by yourself:

```
1   cd /home/pi/Desktop/CrowPi/
2   sudo python tilt.py
```

Lesson 18

Using and controlling the Button Matrix.



The matrix button is a module with 16 independent buttons around the CrowPi board, can be used for widely projects like secret code keypad, a memory game or just controlling anything you want!

The wide possibility of the buttons allows you to make anything from anywhere!

What will you learn

At the end of this lesson you'll be able to:

* Understand how button matrix works and how to control it through the GPIO pins

What will you need

* CrowPi Board after initial installation

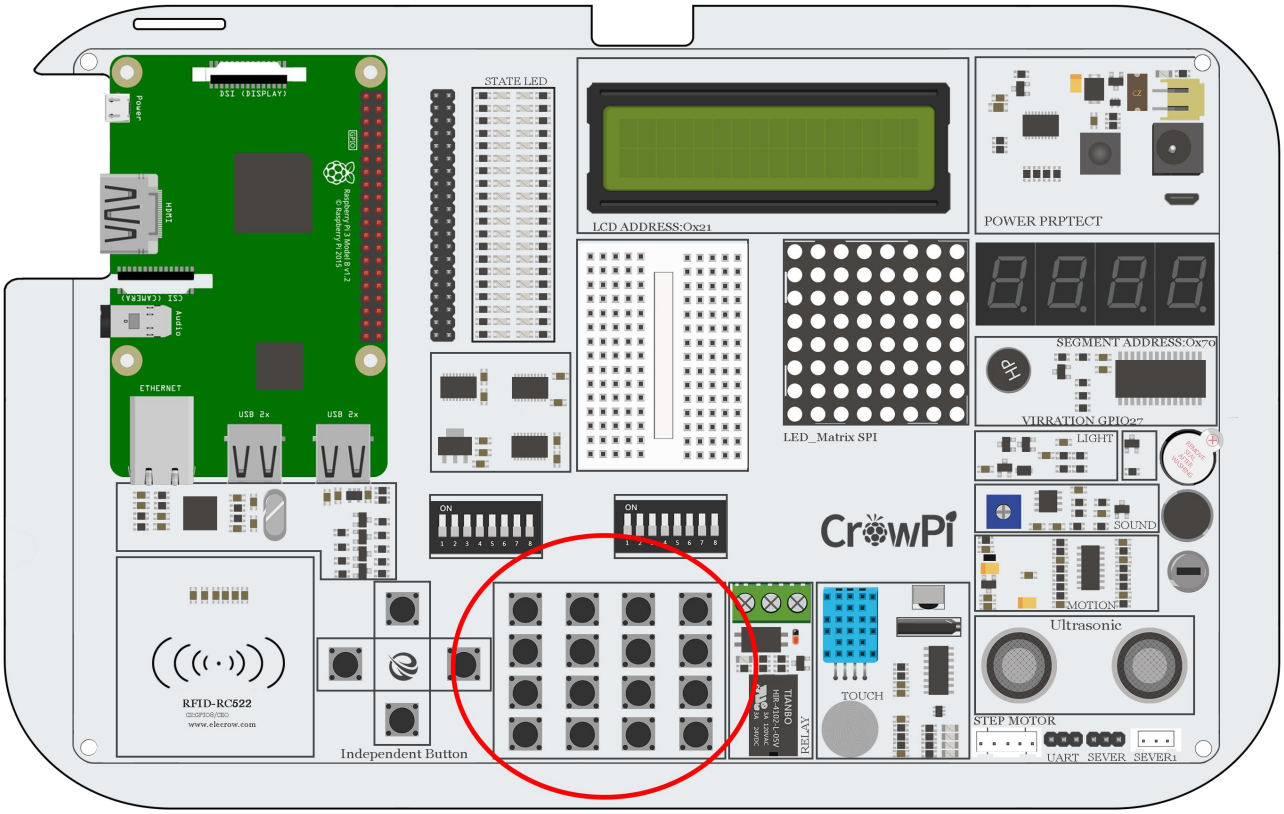
Requires switching modules using the switch

* **Yes**, the left switch - turn ALL the pins ON by turning them UP (refer to page number 5 if you forgot how to switch the sensors)

Button Matrix location on the CrowPi

The button Matrix located near the independent buttons and the relay, can easily be detected by the “Matrix” figure of many buttons together, don’t accidentally think that all those buttons are separate modules .. even tho they look so - they all work as one!

The buttons great location allows it easy access with the tip of the fingers while still being able to use and see the other sensors over the CrowPi board.



Working with Button Matrix

The button matrix is built into columns and rows of 4 each, we configure the matrix rows and columns with their GPIO pins and initialise the object called ButtonMatrix() into buttons variable.

afterwards, we are being able to go for each button on the buttons and detect if it's been clicked.

Over our example - if the button been pressed we activate activateButton() which will print the button number which been pressed. You can modify this module to be able to do anything you could imagine if the button been pressed or not!

```
44  def main():
45
46      # initial the button matrix
47      buttons = ButtonMatrix()
48      try:
49          while(True):
50              for j in range(len(buttons.columnPins)):
51                  # set each output pin to low
52                  GPIO.output(buttons.columnPins[j],0)
53                  for i in range(len(buttons.rowPins)):
54                      if GPIO.input(buttons.rowPins[i]) == 0:
55                          # button pressed, activate it
56                          buttons.activateButton(i,j)
57                          # do nothing while button is being held down
58                          while(buttons.buttonHeldDown(i)):
59                              pass
60                  # return each output pin to high
61                  GPIO.output(buttons.columnPins[j],1)
62      except KeyboardInterrupt:
63          GPIO.cleanup()
64
65  if __name__ == "__main__":
66      main()
```

Execute the following commands and try it by yourself:

```
1  cd /home/pi/Desktop/CrowPi/
2  sudo python button_matrix.py
```

Lesson 19

Controlling and using the IR sensor

In this lesson we'll learn how to use the IR receiver and receive IR (infra red) codes by air from our mini IR remote.

Using this method is extremely useful as we can set different actions for different button over the IR remote; for example: we can turn on different LED by each button press or maybe control the servo movements! How about … turning off the alarm? Anything is possible after learning this lesson.

What will you learn

At the end of this lesson you'll be able to:

* Control the IR receiver and send signals via the IR remote

What will you need

* CrowPi Board after initial installation
* IR remote (comes with the CrowPi Kit)

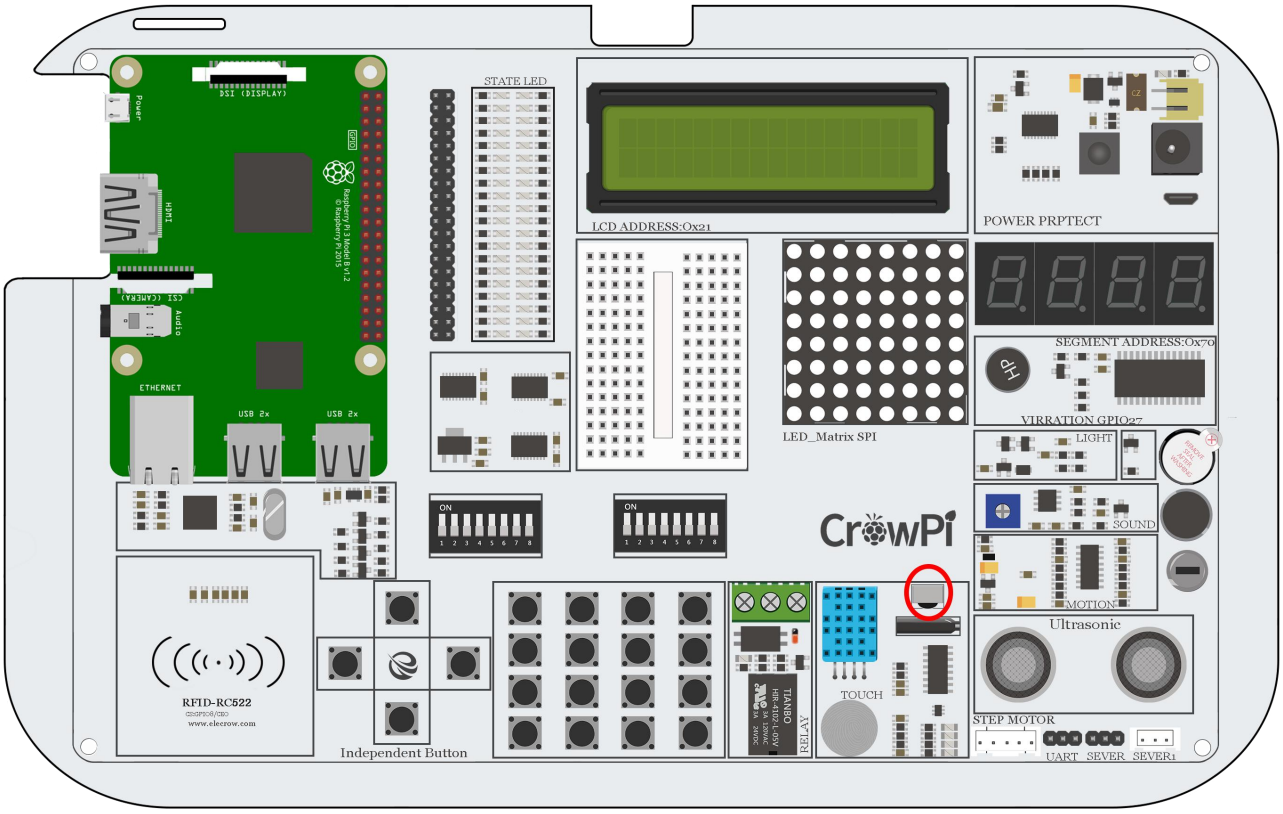
Requires switching modules using the switch

* No

IR sensor location on the CrowPi

The IR sensor located on the right side of the DH11 sensor and right under the CrowPi logo. It can be seen as 3 pins small LED which we will use as a receiver for our remote to receive the codes.

We'll also need the IR remote that comes included with the CrowPi kit, make sure to get it out and ready for our lesson!



Working with IR Receiver

Working with the IR receiver isn't as difficult as it sounds.

The IR receiver using a library called LIRC and Python-LIRC in order to receive those codes we send using the remote and make certain actions based on them.

The Out variable contains the button we pressed, we can make if parameters to check if we clicked certain buttons and then execute commands based on that that information.

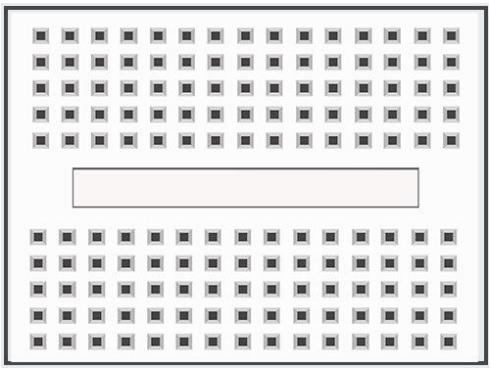
```
import socket, signal
import lirc, time, sys
import RPi.GPIO as GPIO
from  array import array

GPIO.setmode(11)
GPIO.setup(17, 0)
GPIO.setup(18, 0)
PORT = 42001
HOST = "localhost"
Socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)

Lirc = lirc.init("keys")
#lirc.set_blocking(False, Lirc)         # Un-Comment to stc

def handler(signal, frame):
        Socket.close()
        GPIO.cleanup()
        exit(0)

signal.signal(signal.SIGTSTP, handler)

def sendCmd(cmd):
    n = len(cmd)
    a = array('c')
    a.append(chr((n >> 24) & 0xFF))
    a.append(chr((n >> 16) & 0xFF))
    a.append(chr((n >> 8) & 0xFF))
    a.append(chr(n & 0xFF))
    Socket.send(a.tostring() + cmd)

while True:

        Out = lirc.nextcode()
        print Out[0]
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python IR.py
```

Lesson 20

Making your own custom circuit using the Bread Board



Breadboard is extremely useful part in the CrowPi which will allow us to make our own custom circuits and functions.

After we've learned how to use all those sensors, it's time for us to learn how to make our own!

In this lesson you'll create your first custom circuit using blinking LED example!

What will you learn

At the end of this lesson you'll be able to:

* Create your custom circuit on top of the breadboard, make blinking LED.

What will you need

* CrowPi Board after initial installation
* Jumpers
* 3mm / 5mm LED's
* Resistors

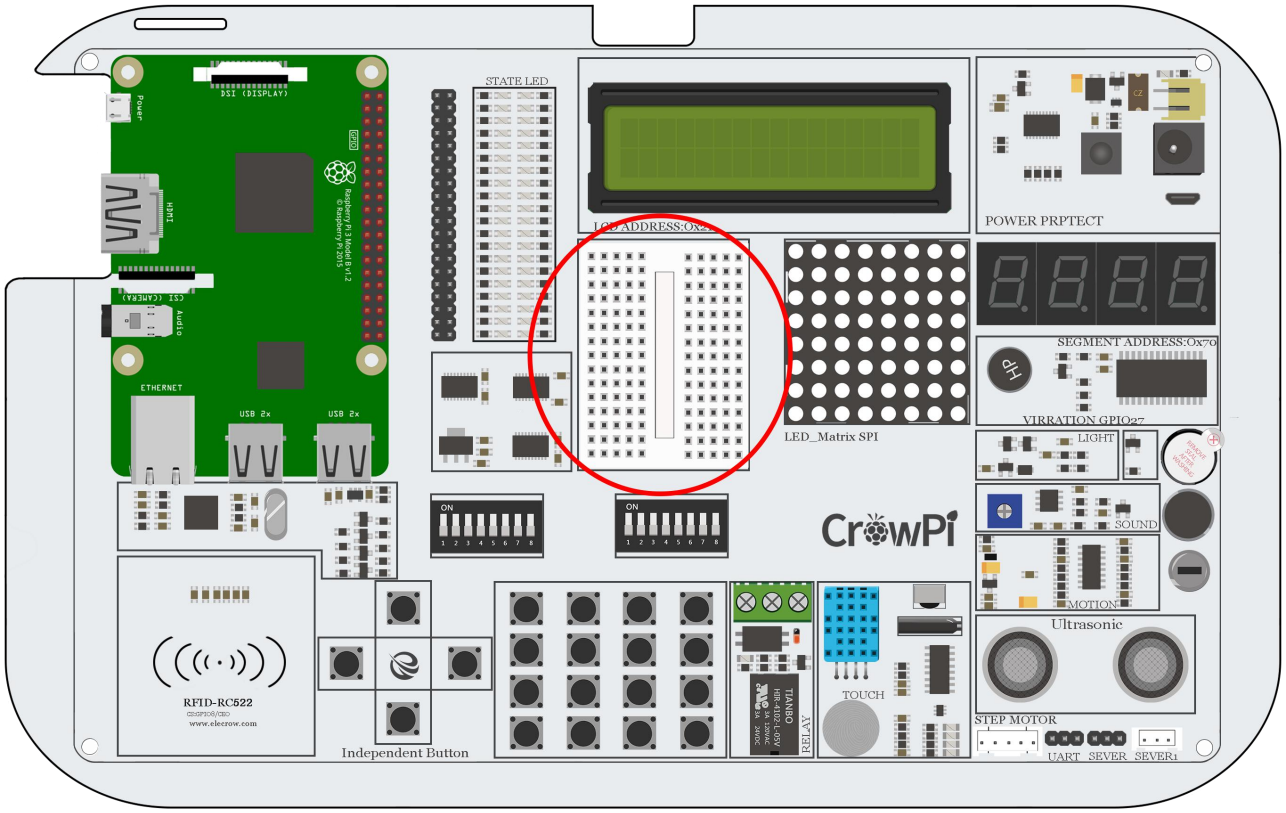
Requires switching modules using the switch

* **Yes**, We'll use the servo pins to make custom circuits, pins numbers 7,9 turn them ON by switching it UP (refer to page number 5 if you forgot how to switch the sensors)

Bread Board location on the CrowPi

The breadboard is located right in the middle of the CrowPi, it looks like small white board with many holes inside which are used to create custom circuit.

On the other hand we'll also use the servo's interfaces which we showed before in our tutorials specifically SERVO1 Interface for making our custom circuit.



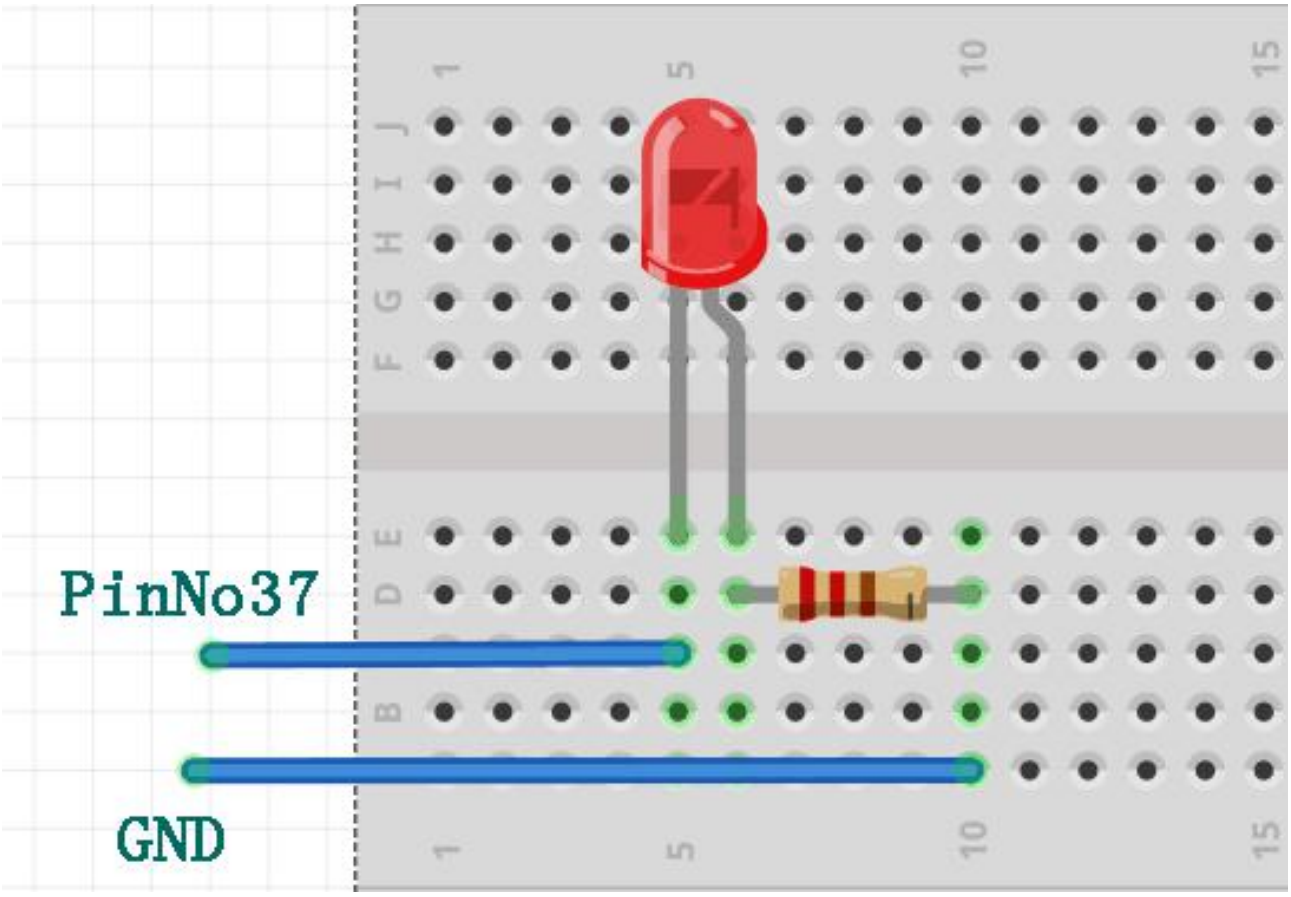
The “Blinking LED” circuit

We’ll be making a custom circuit that his function will literally be blinking LED.

Before we start make sure to switch the right switch properly !

In order to do that we’ll need to use GPIO as output and GND as we did before in our previous lessons. We’ll use the servo interface (specifically SERVO1 Interface) on GPIO 37.

The first thing will be to create the custom circuit, take a look at the following picture:



You can refer to this picture to make your circuit on the breadboard.

Don’t forget that PinNo37 is located on the SERVO1 Interface GPIO port.

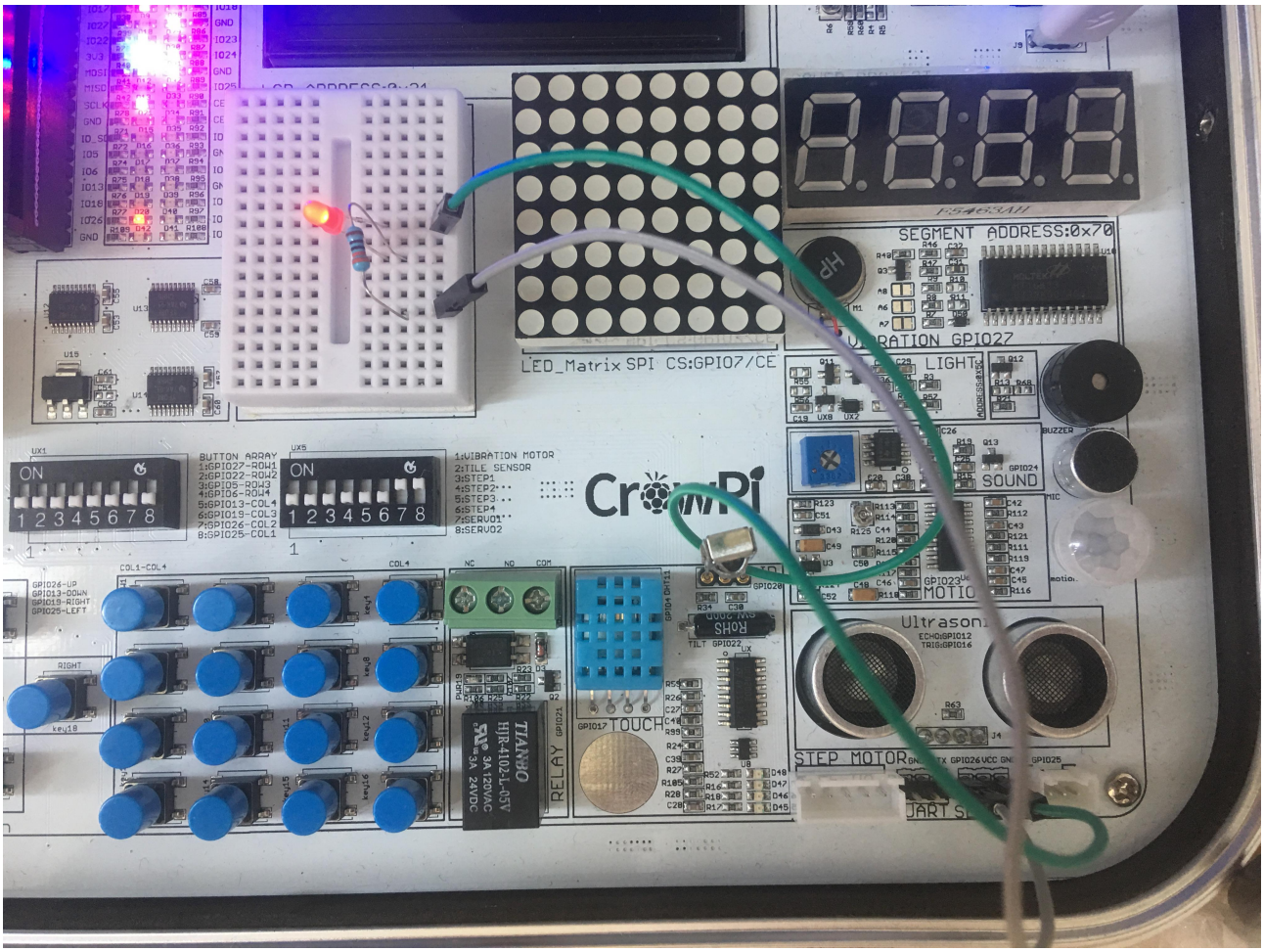
The GND is located on the SERVO1 Interface as well on the GND port.

We'll need to take one resistor that comes with the CrowPi package and wire it to the negative side of the LED **(the negative side of the LED is the shorter leg between the 2 LED legs)**

From the other side of the resistor we'll wire it directly with jumper to the GND pin on the SERVO1 interface.

The other LED leg would be the positive pin which we'll wire it directly into the GPIO37 pin on SERVO1 to be able to control it and make it blink!

The final result should look similar:



Working with the blinking LED

After we've successfully made the blinking LED circuit it's time to make the code that will control it.

In our code, we'll send GPIO.HIGH to our SERVO GPIO PIN which has the LED connected to, wait 0.2 seconds and turn it off with GPIO.LOW.

We'll repeat that infinity times which will make the LED turn on and off and basically blink!

```
#!/usr/bin/python
# -*- coding: utf-8 -*-
# http://elecrow.com/

import time
import RPi.GPIO as GPIO

# define LED pin
led_pin = 37

# set GPIO mode to GPIO.BOARD
GPIO.setmode(GPIO.BOARD)
# set puin as input
GPIO.setup(led_pin, GPIO.OUT)

try:
    while True:
        # turn on LED
        GPIO.output(led_pin, GPIO.HIGH)
        # Wait half a second
        time.sleep(0.2)
        # turn off LED
        GPIO.output(led_pin, GPIO.LOW)
        # Wait half a second
        time.sleep(0.2)
except KeyboardInterrupt:
    # CTRL+C detected, cleaning and quitting the script
    GPIO.cleanup()
```

Execute the following commands and try it by yourself:

```
cd /home/pi/Desktop/CrowPi/
sudo python blinking_led.py
```

Lesson 21

Taking a picture using the Raspberry Pi camera

How can we use CrowPi camera? Don’t worry, it will be easy if you follow the following step.

What will you learn

At the end of this lesson you'll be able to:

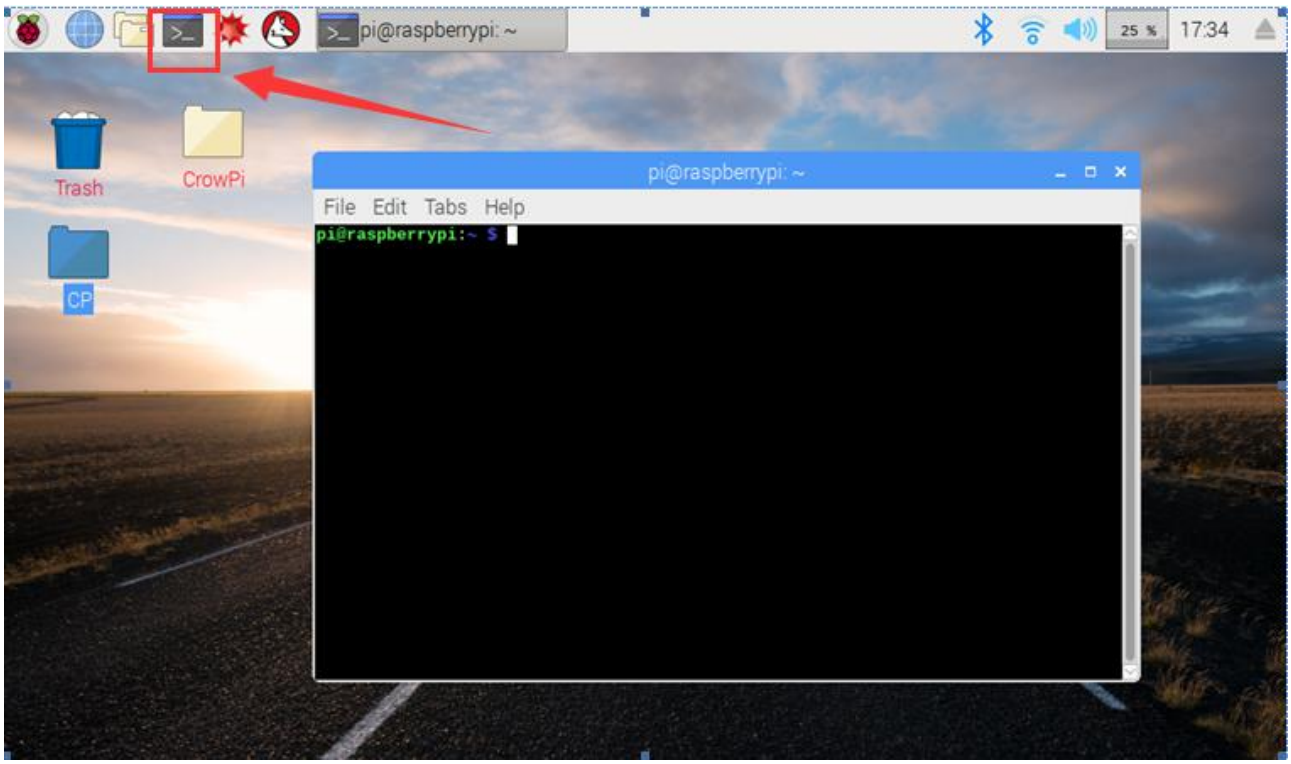
* Take picture using the CrowPi Raspberry Pi camera

What will you need

* CrowPi Board after initial installation

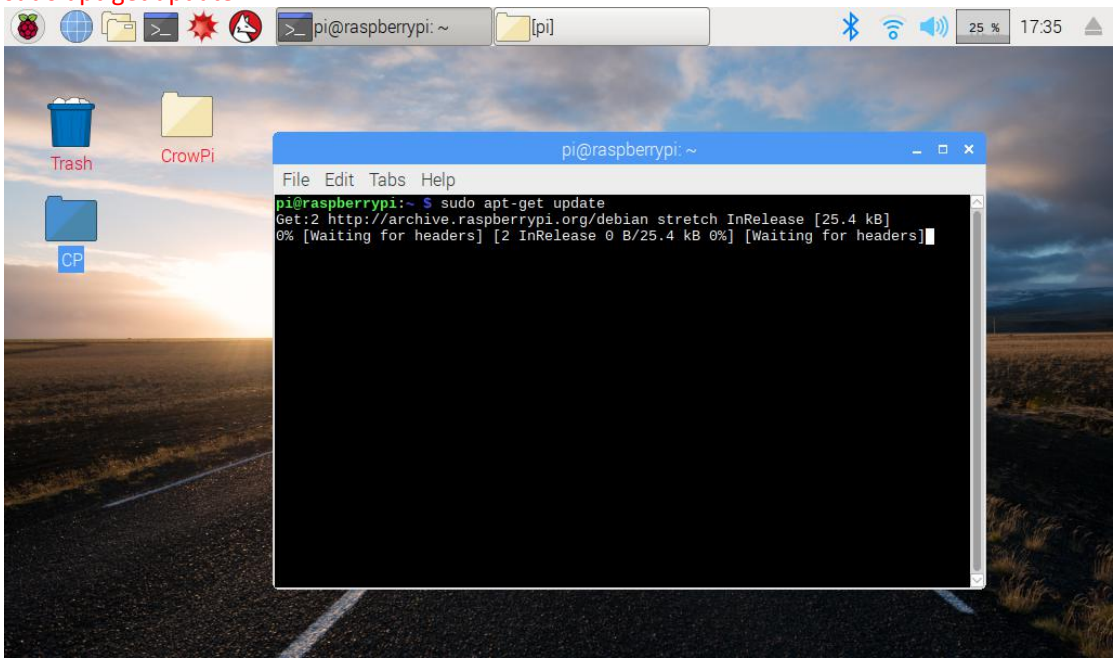
STEPS

Open the CrowPi’s terminal and type the command below.

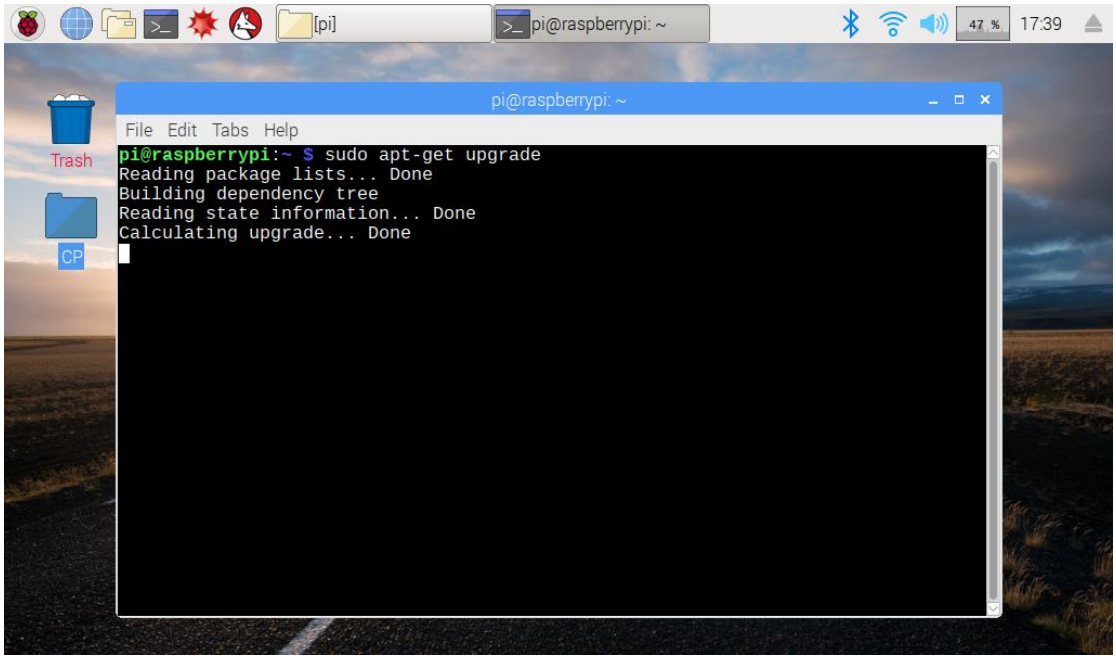


1 Update software source with run:

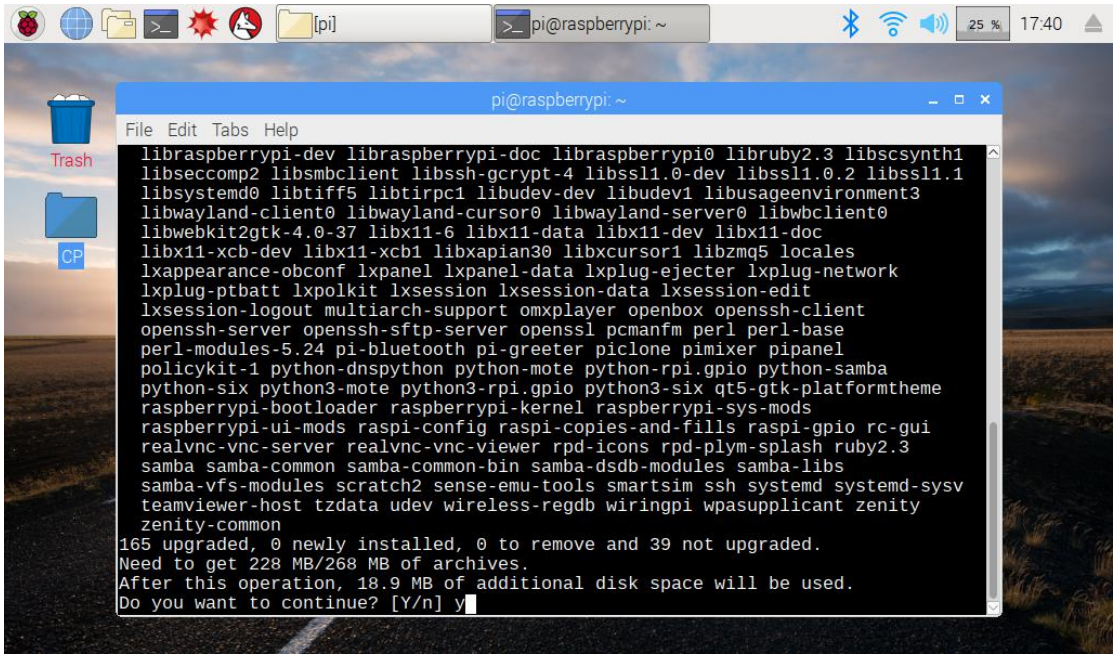
sudo apt-get update



sudo apt-get upgrade

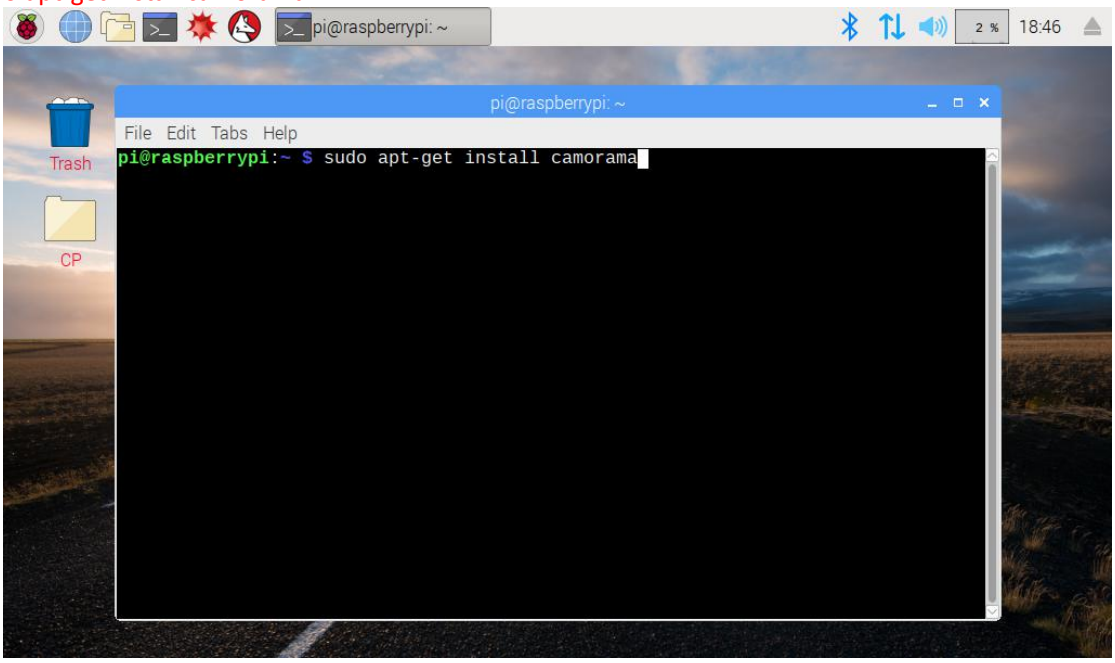


When you run “apt-get upgrade”, you will be asked if you want to continue(as shown below), please enter y.



2 Install the software “camorama” with run:

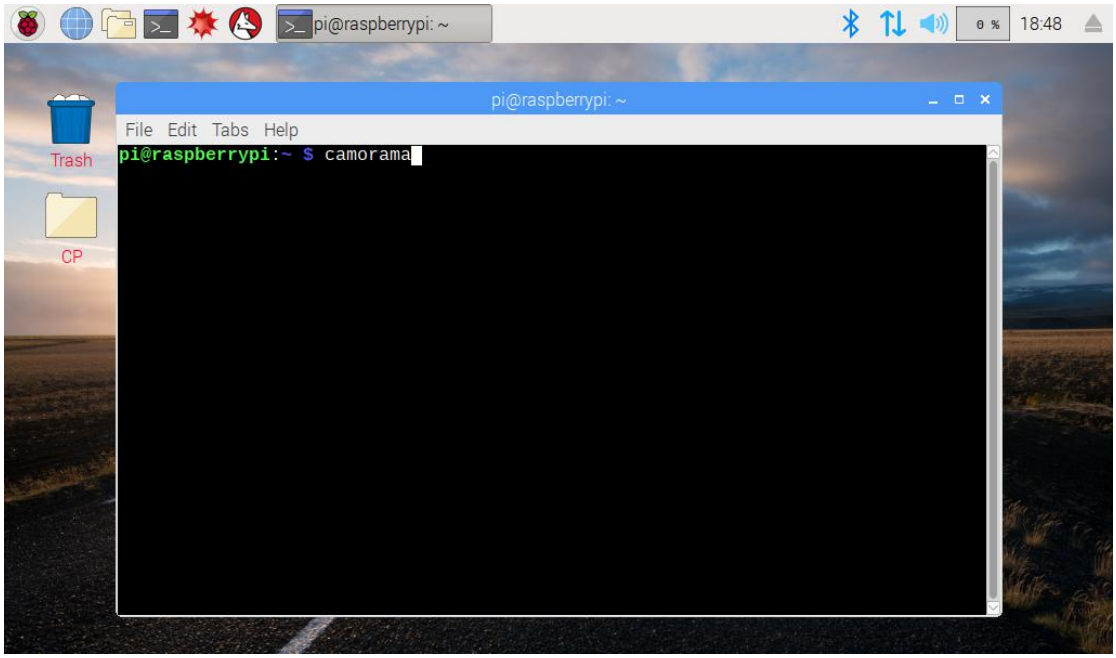
sudo apt-get install camorama



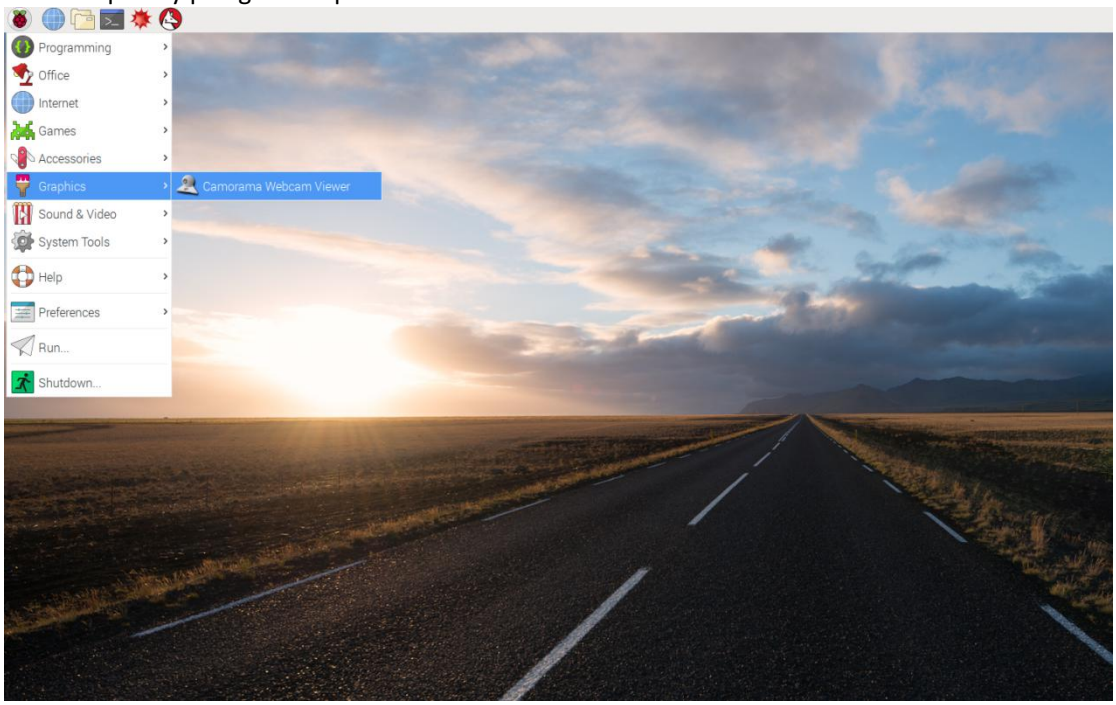
3 After the software is installed, there are two method to open the software:

Method 1:open the software to take photo with run:

camorama

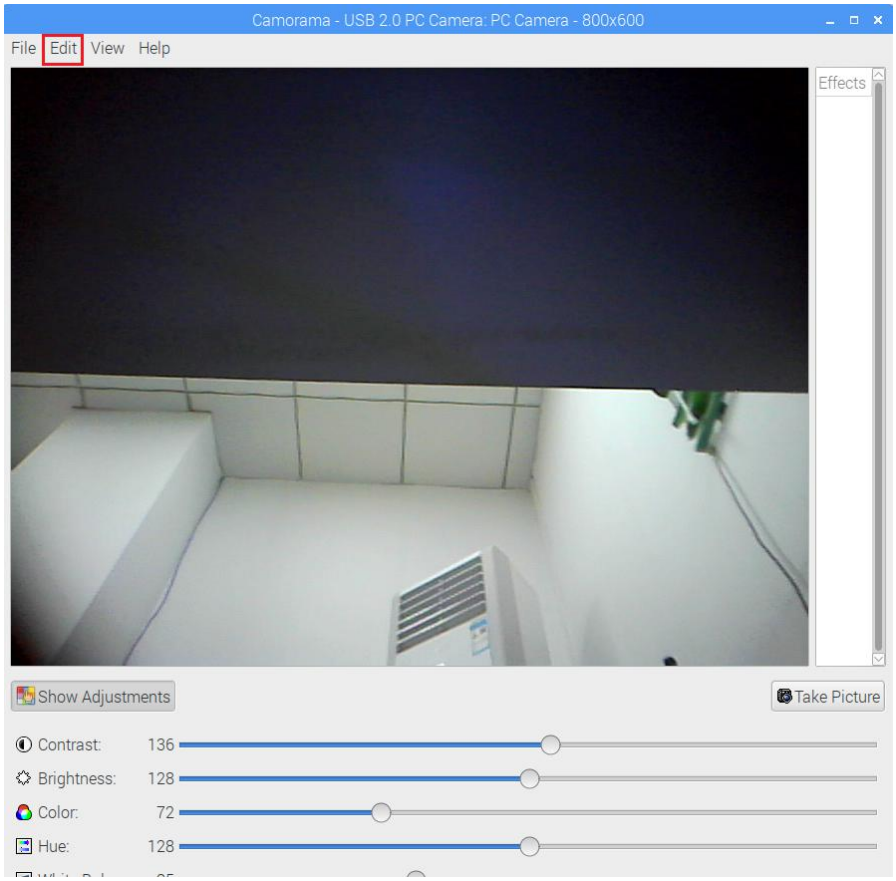


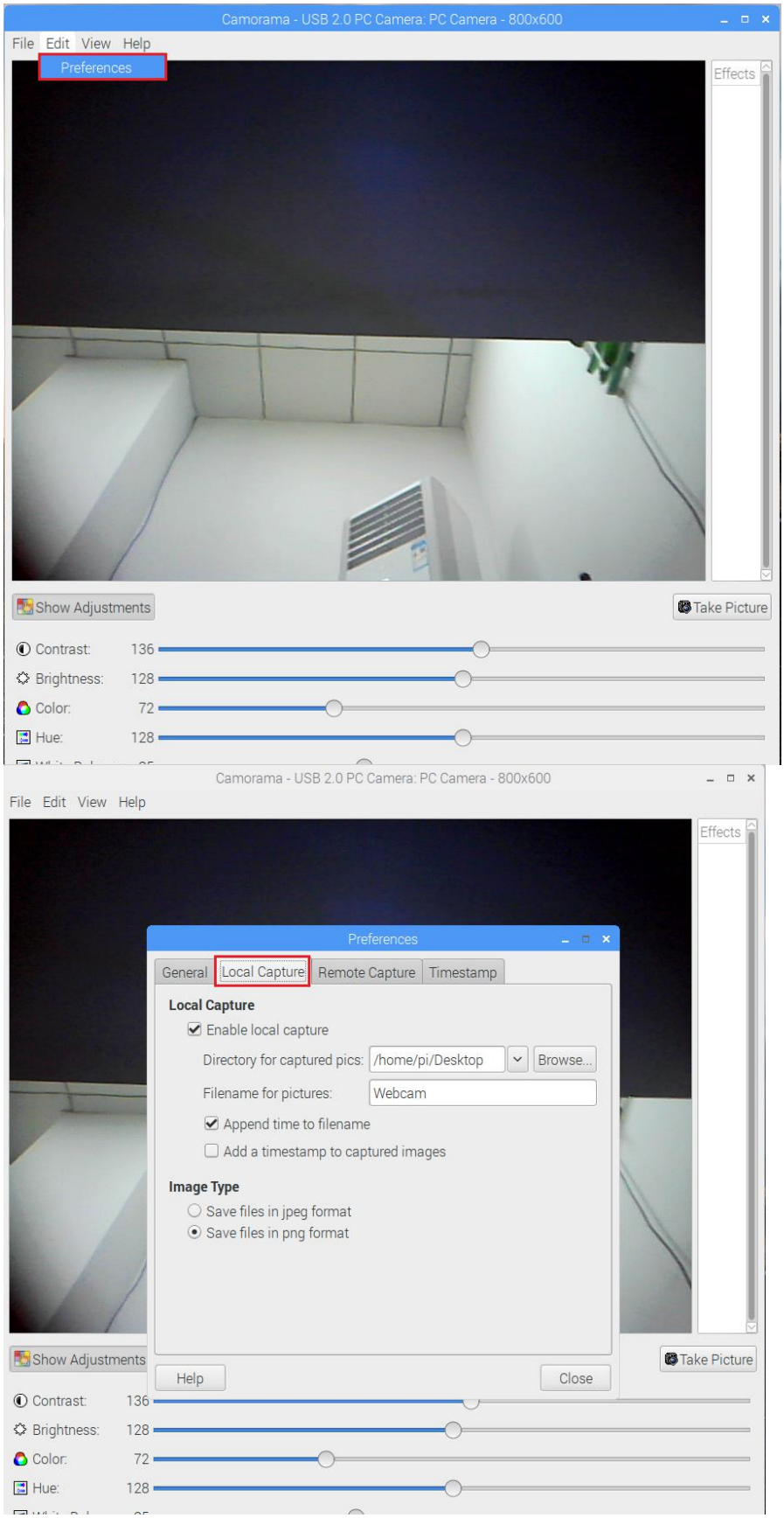
Method 2: Through the desktop icon:
Click”Raspberry pi logo→Graphics→Camorama Webcam Viewer”

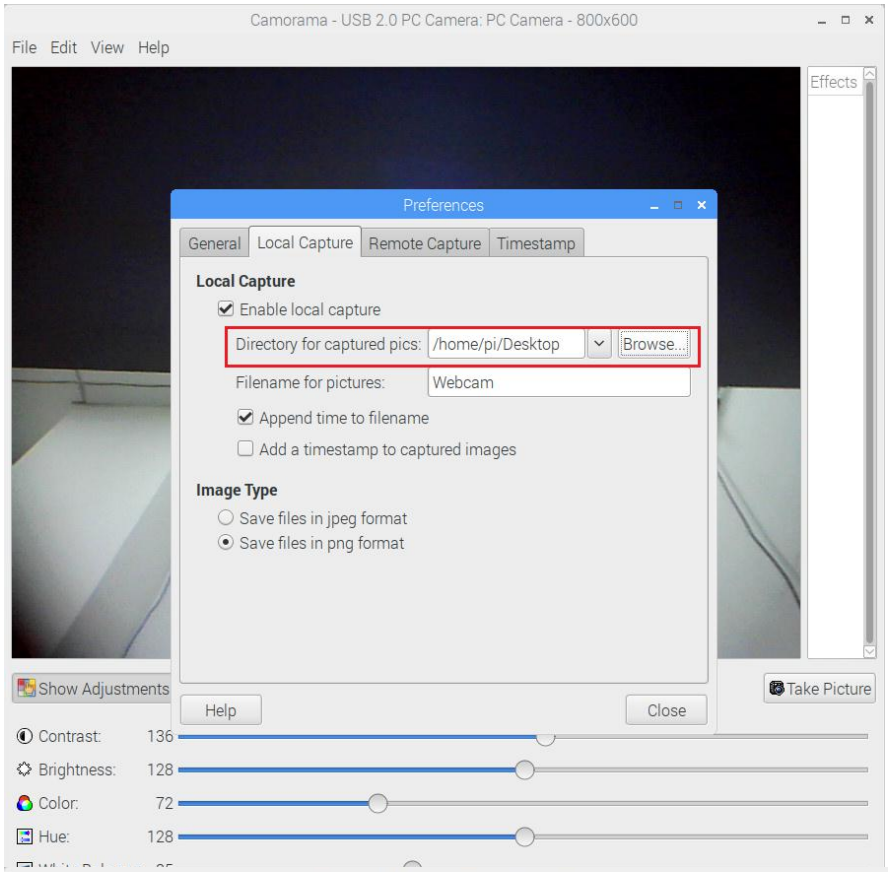


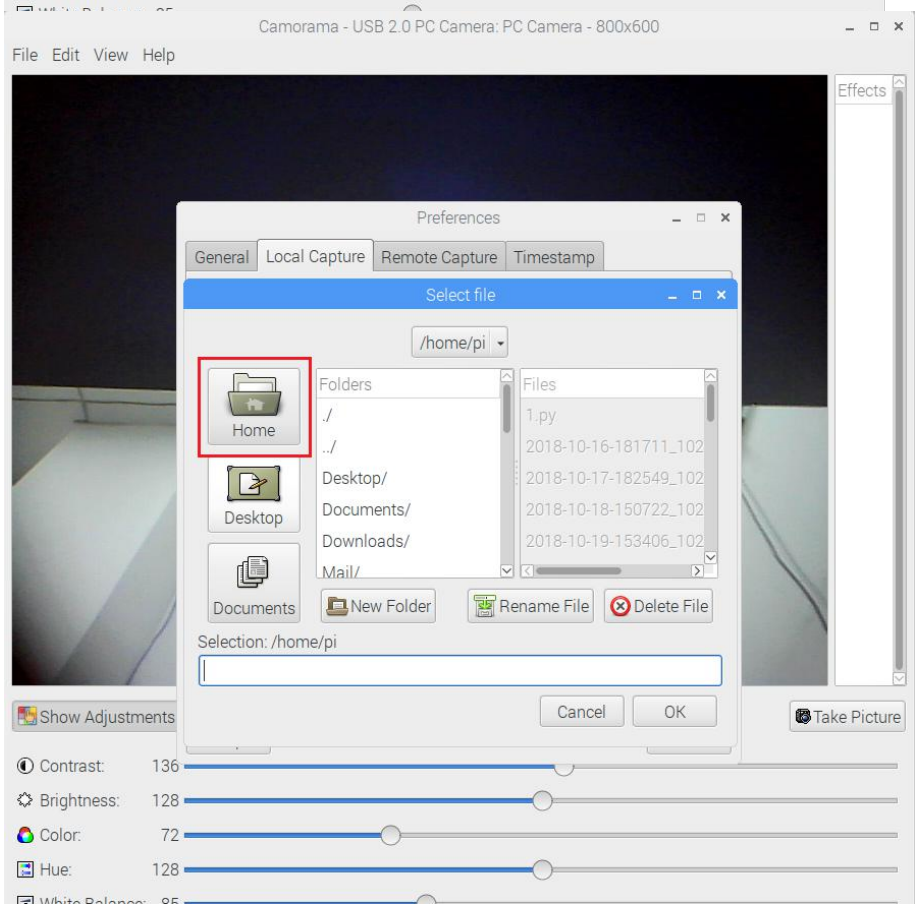
After running the command a video should popup and you should be able to see yourself within of it !

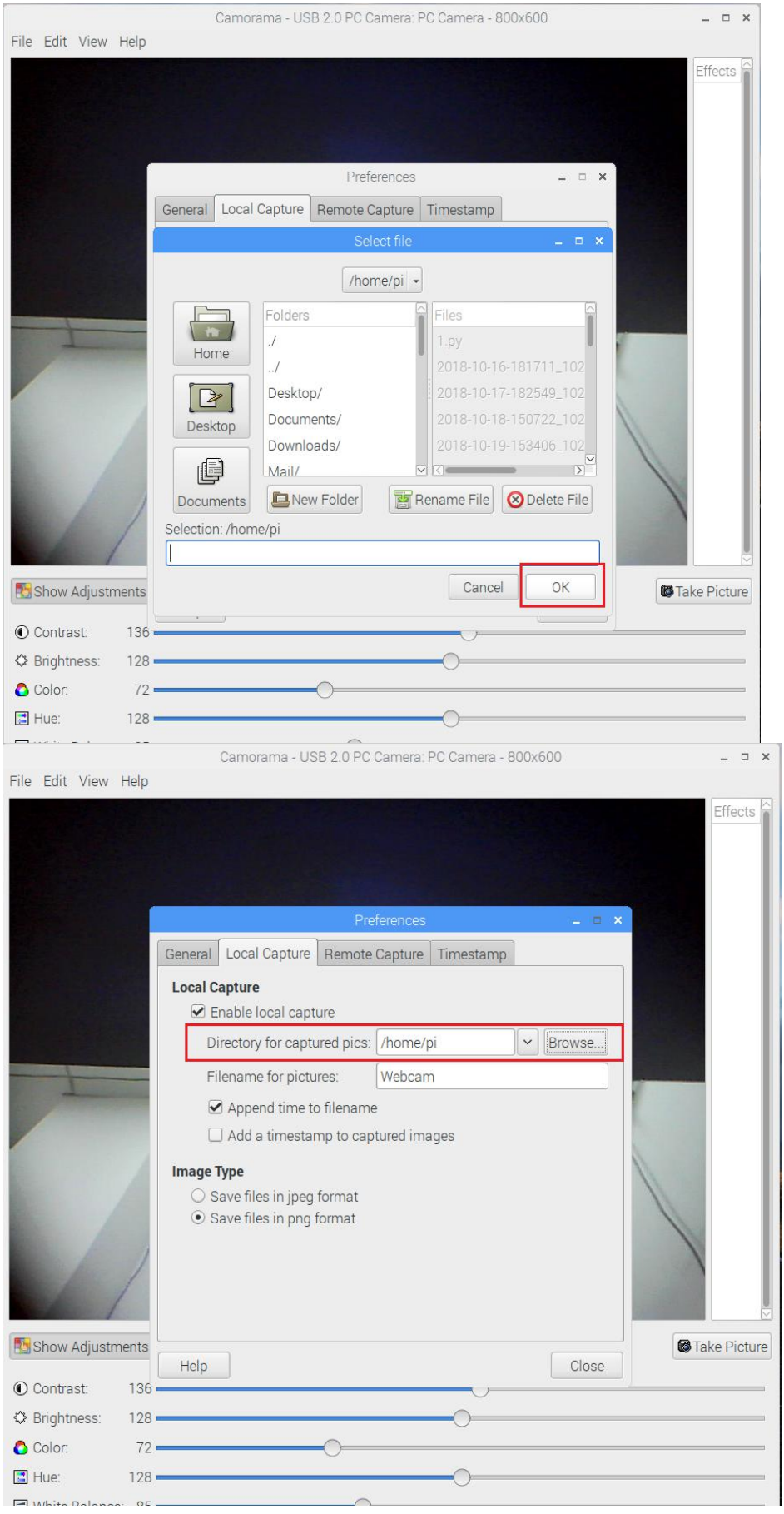
Once you open the software you will see the camera is working. You can take a picture with the key combination CTRL+T and CTRL+Q to exit. You can change the path to save photos by selecting ”Edit→Preferences→Local Capture→Directory for captured pics→Browse…”. After you choose the path where you need to save pictures, click OK, you can see the difference, and finally click close to exit the setting. When you take pictures again, your photo will be saved to your newly set path.



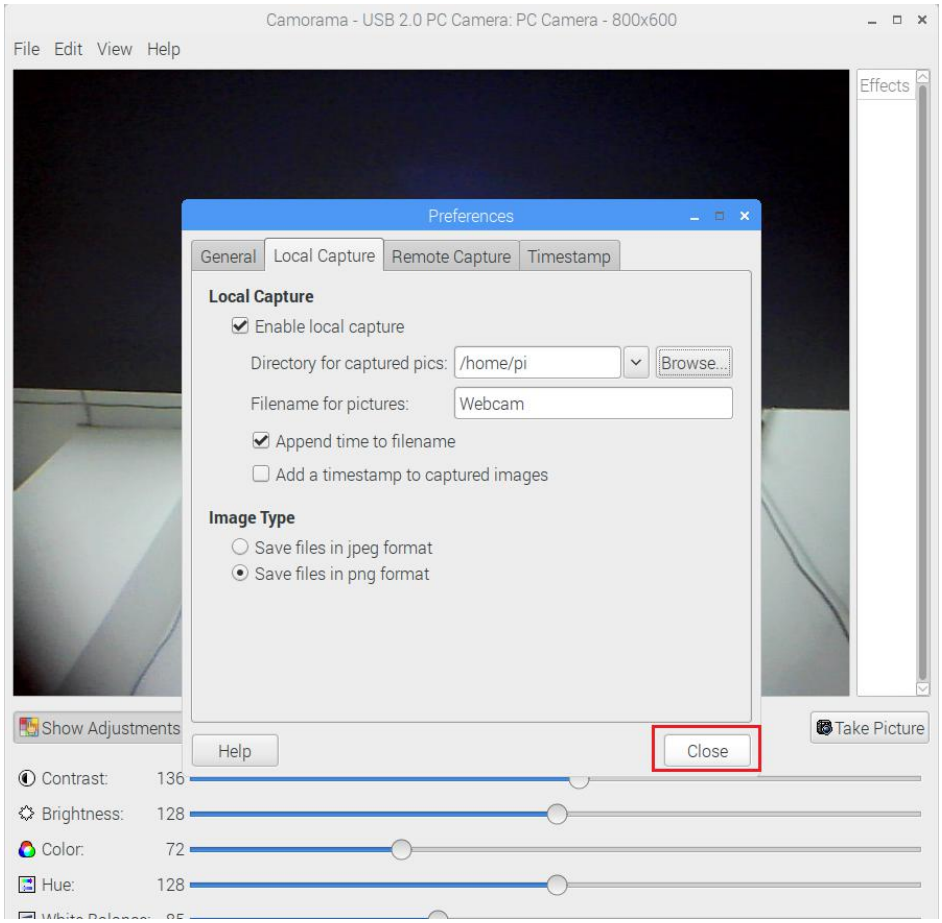

Camorama - USB 2.0 PC Camera: PC Camera - 800x600
File Edit View Help
Preferences
Effects
Show Adjustments
Take Picture
Contrast: 136
Brightness: 128
Color: 72
Hue: 128
Camorama - USB 2.0 PC Camera: PC Camera - 800x600
File Edit View Help
Effects
Preferences
General Local Capture Remote Capture Timestamp
Local Capture
Enable local capture
Directory for captured pics: /home/pi/Desktop
Browse...
Filename for pictures: Webcam
Append time to filename
Add a timestamp to captured images
Image Type
Save files in jpeg format
Save files in png format
Help
Close
Show Adjustments
Take Picture
Contrast: 136
Brightness: 128
Color: 72
Hue: 128


Camorama - USB 2.0 PC Camera: PC Camera - 800x600
File Edit View Help
Effects
Preferences
General
Local Capture
Remote Capture
Timestamp
Local Capture
Enable local capture
Directory for captured pics:
/home/pi/Desktop
Browse...
Filename for pictures:
Webcam
Append time to filename
Add a timestamp to captured images
Image Type
Save files in jpeg format
Save files in png format
Help
Close
Show Adjustments
Take Picture
Contrast: 136
Brightness: 128
Color: 72
Hue: 128


Camorama - USB 2.0 PC Camera: PC Camera - 800x600
File Edit View Help
Effects
Preferences
General
Local Capture
Remote Capture
Timestamp
Select file
/home/pi
Home
Desktop
Documents
Folders
./
../
Desktop/
Documents/
Downloads/
Mail/
Files
1.py
2018-10-16-181711_102
2018-10-17-182549_102
2018-10-18-150722_102
2018-10-19-153406_102
New Folder
Rename File
Delete File
Selection: /home/pi
Cancel
OK
Show Adjustments
Take Picture
Contrast: 136
Brightness: 128
Color: 72
Hue: 128


Camorama - USB 2.0 PC Camera: PC Camera - 800x600
File Edit View Help
Effects
Preferences
General
Local Capture
Remote Capture
Timestamp
Select file
/home/pi
Folders
./
../
Desktop/
Documents/
Downloads/
Mail/
Files
1.py
2018-10-16-181711_102
2018-10-17-182549_102
2018-10-18-150722_102
2018-10-19-153406_102
Home
Desktop
Documents
New Folder
Rename File
Delete File
Selection: /home/pi
Cancel
OK
Show Adjustments
Take Picture
Contrast: 136
Brightness: 128
Color: 72
Hue: 128

Camorama - USB 2.0 PC Camera: PC Camera - 800x600
File Edit View Help
Effects
Preferences
General
Local Capture
Remote Capture
Timestamp
Local Capture
Enable local capture
Directory for captured pics: /home/pi
Browse...
Filename for pictures: Webcam
Append time to filename
Add a timestamp to captured images
Image Type
Save files in jpeg format
Save files in png format
Help
Close
Show Adjustments
Take Picture
Contrast: 136
Brightness: 128
Color: 72
Hue: 128



References and documentations

The Raspberry Pi is an amazing device and definitely what is possible to do with it is beyond imagination.

Nevertheless possible, we made our best effort to make our lesson scripts as explainable as possible with comments inside the code, and precise scripts and explanation combined with screenshoots.

Going through those lessons might be not the only thing you might need to learn how to code in Python and use Raspberry Pi - In this page we decided to collect best links, documentation and references for your own reading and knowledge gathering purposes, without need to search it all around.

https://www.raspberrypi.org/help/ - everything regarding to Raspberry Pi / Raspbian including documentations, user guides, troubleshooting and more.

https://www.raspberrypi.org/documentation/usage/scratch/README.md - getting started with scratch software on the Raspberry Pi

https://learnpythonthehardway.org/ - top recommended python book to learn everything about python from zero to advanced, including python 2.7 version and python 3.

https://www.raspberrypi.org/documentation/linux/usage/commands.md - useful linux commands to get started (Raspbian is based on linux, Debian)

https://elinux.org/ - a very useful wikipedia that contains everything you need to answer your linux and raspberry pi related questions

https://elinux.org/RPi_Distributions - full list of alternative Raspberry pi distribution in case you'd like to try and test other OS's except Raspbian.

https://www.raspberrypi.org/training/online/ - Raspberry Pi Free online training courses by raspberry pi foundation