Adeept

Starter kit for Raspberry Pi

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GitHub python™

Component List

1x DC Motor
1x L9110 motor driver
1x LCD1602
1x ADC0832
1x 74HC595
1x 7-Segment Display
1x Light Sensor (Photoresistor)
1x Analog Temperature Sensor (Thermistor)
1x 40 pin GPIO Extension Board
1x 40 pin GPIO Cable
1x Breadboard Power Supply Module
1x Active Buzzer
2x Switch
1x RGB LED
8x Red LED
4x Green LED
4x Yellow LED
4x Blue LED
16x Resistor(220Ω)
10x Resistor(1kΩ)
5x Resistor(10kΩ)
4x Capacitor (104)
2x Capacitor (10uF)
4x Button (large)
5x Button (small)
1x Button cap (red)
1x Button cap (white)
2x Button cap (blue)
2x NPN Transistor (8050)
2x PNP Transistor (8550)
2x 1N4148 Diode
2x 1N4001 Diode
1x Potentiometer (10KΩ)
1x Breadboard
30x Male to Male Jumper Wires
20x Male to Female Jumper Wires
1x Header (40 pin)
1x Band Resistor Card
1x Project Box

Preface

About This Kit

This is an entry-level learning kit for Raspberry Pi. Some common electronic components and sensors are included. Through the learning, you will get a better understanding of Raspberry Pi, and be able to make fascinating works based on Raspberry Pi.

About Adeept

Adeept is a technical service team of open source software and hardware. Dedicated to applying the Internet and the latest industrial technology in open source area, we strive to provide best hardware support and software service for general makers and electronic enthusiasts around the world. We aim to create infinite possibilities with sharing. No matter what field you are in, we can lead you into the electronic world and bring your ideas into reality.

If you have any problems for learning, please contact us at support@adeept.com. We will do our best to help you solve the problem.

Content

About the Raspberry Pi

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

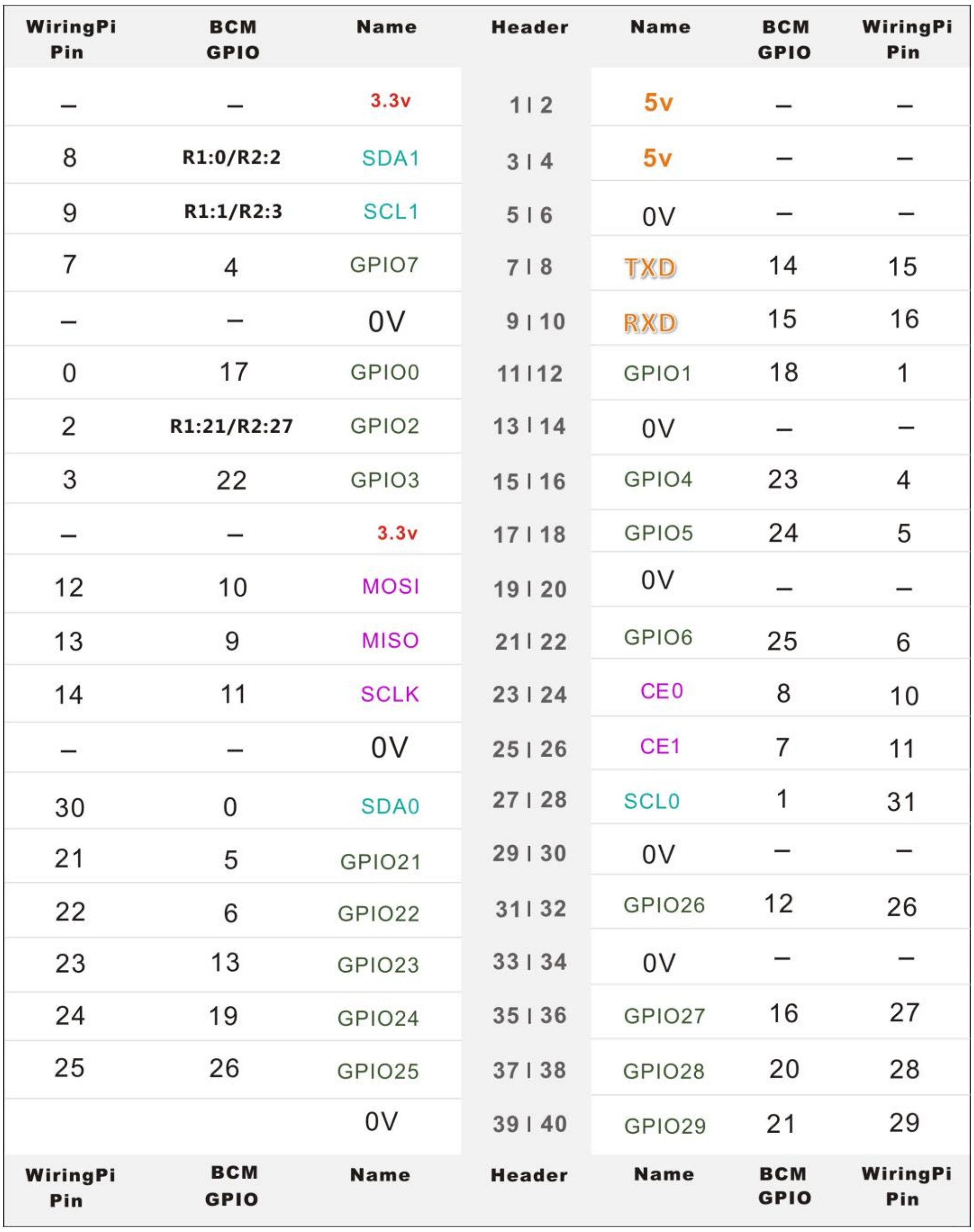
What's more, the Raspberry Pi has the ability to interact with the outside world, and has been used in a wide array of digital maker projects, from music machines and parent detectors to weather stations and tweeting birdhouses with infra-red cameras. We want to see the Raspberry Pi being used by kids all over the world to learn to program and understand how computers work.

Learn more at:

www.adeept.com

https://www.raspberrypi.org/help/what-is-a-raspberry-pi/

Raspberry Pi Pin Numbering Introduction



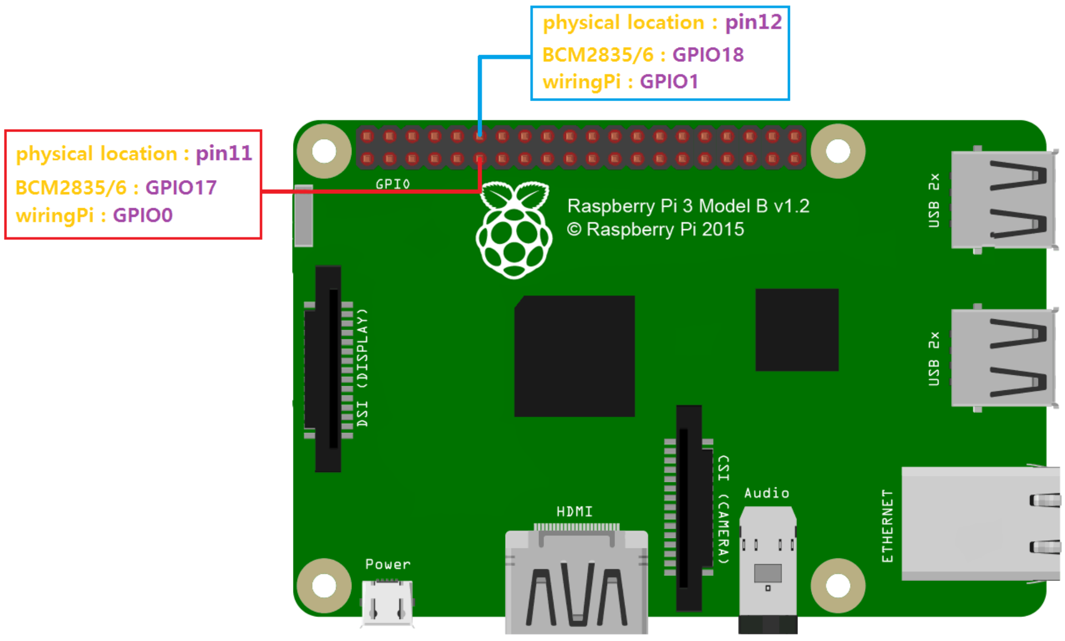
WiringPi Pin	BCM GPIO	Name	Header	Name	BCM GPIO	WiringPi Pin
–	–	3.3v	1 I 2	5v	–	–
8	R1:0/R2:2	SDA1	3 I 4	5v	–	–
9	R1:1/R2:3	SCL1	5 I 6	0V	–	–
7	4	GPIO7	7 I 8	TXD	14	15
–	–	0V	9 I 10	RXD	15	16
0	17	GPIO0	11 I 12	GPIO1	18	1
2	R1:21/R2:27	GPIO2	13 I 14	0V	–	–
3	22	GPIO3	15 I 16	GPIO4	23	4
–	–	3.3v	17 I 18	GPIO5	24	5
12	10	MOSI	19 I 20	0V	–	–
13	9	MISO	21 I 22	GPIO6	25	6
14	11	SCLK	23 I 24	CE0	8	10
–	–	0V	25 I 26	CE1	7	11
30	0	SDA0	27 I 28	SCL0	1	31
21	5	GPIO21	29 I 30	0V	–	–
22	6	GPIO22	31 I 32	GPIO26	12	26
23	13	GPIO23	33 I 34	0V	–	–
24	19	GPIO24	35 I 36	GPIO27	16	27
25	26	GPIO25	37 I 38	GPIO28	20	28
		0V	39 I 40	GPIO29	21	29
WiringPi Pin	BCM GPIO	Name	Header	Name	BCM GPIO	WiringPi Pin

There are three methods for numbering Raspberry Pi's GPIO:

1. Numbering according to the physical location of the pins, from left to right, top to bottom – the left is odd, and the right is even.

2. Numbering according the GPIO registers of BCM2835/2836/2837 SOC.

3. Numbering according the GPIO library wiringPi.


physical location : pin12
BCM2835/6 : GPIO18
wiringPi : GPIO1
physical location : pin11
BCM2835/6 : GPIO17
wiringPi : GPIO0
GPIO
Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015
USB 2x
USB 2x
DSI (DISPLAY)
CSI (CAMERA)
Audio
HDMI
ETHERNET
Power

Raspberry Pi GPIO Library Introduction

Currently, there are two major GPIO libraries for Raspberry Pi: RPi.GPIO and wiringPi.

RPi.GPIO:

RPi.GPIO is a python module to control Raspberry Pi GPIO channels. For more information, please visit:

https://pypi.python.org/pypi/RPi.GPIO/

For examples and documentation:
http://sourceforge.net/p/raspberry-gpio-python/wiki/Home/

The RPi.GPIO module is pre-installed in the official Raspbian operating system, thus you can use it directly.

wiringPi:

The wiringPi is a GPIO access library written in C language for BCM2835/6/7 SOC used in the Raspberry Pi. It's released under the GNU LGPLv3 license and is usable from C and C++ and many other languages with suitable wrappers. It's designed to be familiar to people who have used the Arduino "wiring" system.

For more information about wiringPi, please visit: http://wiringpi.com/

Install wiringPi:

Step 1: Get the source code

```
$ git clone git://git.drogon.net/wiringPi
```

Step 2: Compile and install

```
$ cd wiringPi
$ git pull origin
$ sudo ./build
```

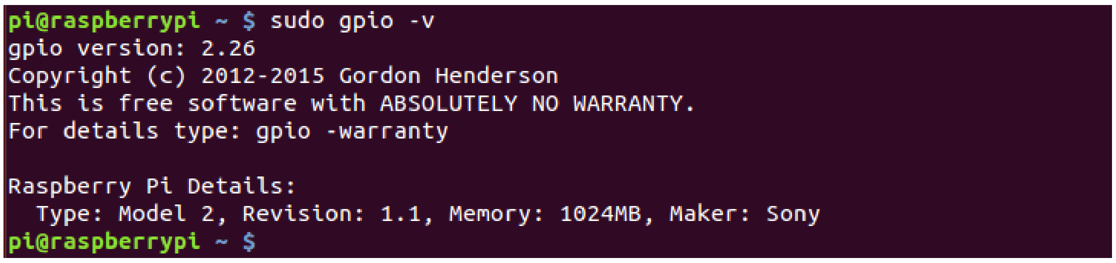
Press Enter, and the script "*build*" will automatically compile wiringPi source code and then install it to the Raspberry Pi.

Next, verify whether the wiringPi is installed successfully or not:

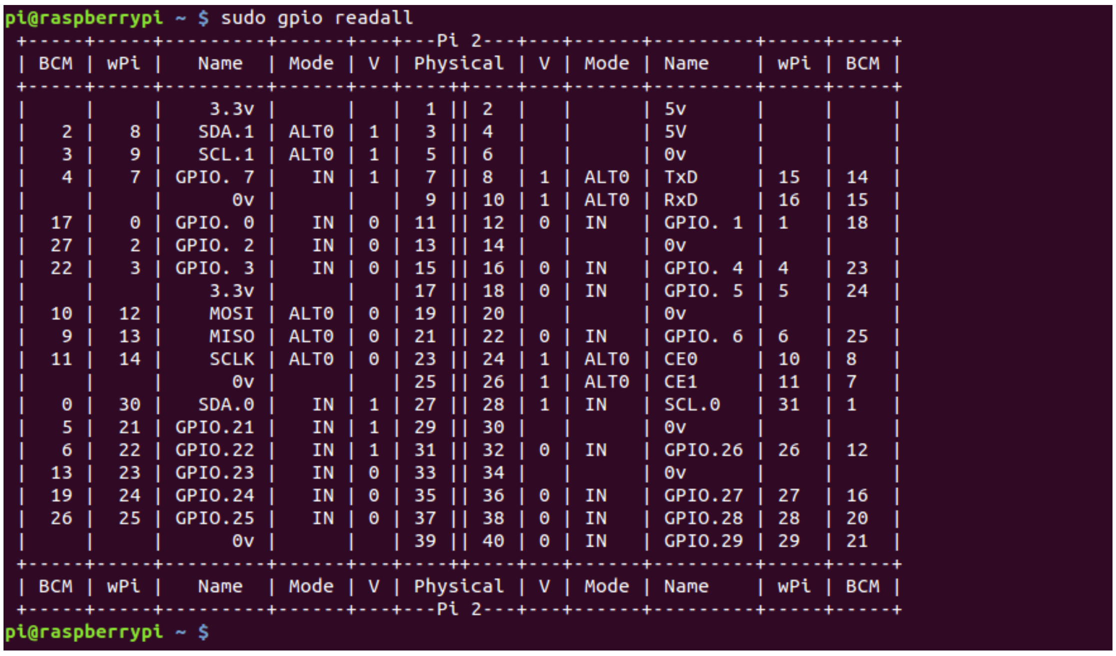
wiringPi includes a command-line utility gpio which can be used to program and set up the GPIO pins. You can use it to read and write the pins or even control them from shell scripts.

You can verify whether the wiringPi is installed successfully or not by the following commands:

$ sudo gpio -v


```
pi@raspberrypi ~ $ sudo gpio -v
gpio version: 2.26
Copyright (c) 2012-2015 Gordon Henderson
This is free software with ABSOLUTELY NO WARRANTY.
For details type: gpio -warranty

Raspberry Pi Details:
  Type: Model 2, Revision: 1.1, Memory: 1024MB, Maker: Sony
pi@raspberrypi ~ $
```

$ sudo gpio readall


```
pi@raspberrypi ~ $ sudo gpio readall
 +-----+-----+---------+------+---+---Pi 2---+---+------+---------+-----+-----+
 | BCM | wPi |   Name  | Mode | V | Physical | V | Mode | Name    | wPi | BCM |
 +-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
 |     |     |    3.3v |      |   |  1 || 2  |   |      | 5v      |     |     |
 |   2 |   8 |   SDA.1 | ALT0 | 1 |  3 || 4  |   |      | 5V      |     |     |
 |   3 |   9 |   SCL.1 | ALT0 | 1 |  5 || 6  |   |      | 0v      |     |     |
 |   4 |   7 | GPIO. 7 |   IN | 1 |  7 || 8  | 1 | ALT0 | TxD     | 15  | 14  |
 |     |     |      0v |      |   |  9 || 10 | 1 | ALT0 | RxD     | 16  | 15  |
 |  17 |   0 | GPIO. 0 |   IN | 0 | 11 || 12 | 0 | IN   | GPIO. 1 | 1   | 18  |
 |  27 |   2 | GPIO. 2 |   IN | 0 | 13 || 14 |   |      | 0v      |     |     |
 |  22 |   3 | GPIO. 3 |   IN | 0 | 15 || 16 | 0 | IN   | GPIO. 4 | 4   | 23  |
 |     |     |    3.3v |      |   | 17 || 18 | 0 | IN   | GPIO. 5 | 5   | 24  |
 |  10 |  12 |    MOSI | ALT0 | 0 | 19 || 20 |   |      | 0v      |     |     |
 |   9 |  13 |    MISO | ALT0 | 0 | 21 || 22 | 0 | IN   | GPIO. 6 | 6   | 25  |
 |  11 |  14 |    SCLK | ALT0 | 0 | 23 || 24 | 1 | ALT0 | CE0     | 10  | 8   |
 |     |     |      0v |      |   | 25 || 26 | 1 | ALT0 | CE1     | 11  | 7   |
 |   0 |  30 |   SDA.0 |   IN | 1 | 27 || 28 | 1 | IN   | SCL.0   | 31  | 1   |
 |   5 |  21 | GPIO.21 |   IN | 1 | 29 || 30 |   |      | 0v      |     |     |
 |   6 |  22 | GPIO.22 |   IN | 1 | 31 || 32 | 0 | IN   | GPIO.26 | 26  | 12  |
 |  13 |  23 | GPIO.23 |   IN | 0 | 33 || 34 |   |      | 0v      |     |     |
 |  19 |  24 | GPIO.24 |   IN | 0 | 35 || 36 | 0 | IN   | GPIO.27 | 27  | 16  |
 |  26 |  25 | GPIO.25 |   IN | 0 | 37 || 38 | 0 | IN   | GPIO.28 | 28  | 20  |
 |     |     |      0v |      |   | 39 || 40 | 0 | IN   | GPIO.29 | 29  | 21  |
 +-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
 | BCM | wPi |   Name  | Mode | V | Physical | V | Mode | Name    | wPi | BCM |
 +-----+-----+---------+------+---+---Pi 2---+---+------+---------+-----+-----+
pi@raspberrypi ~ $
```

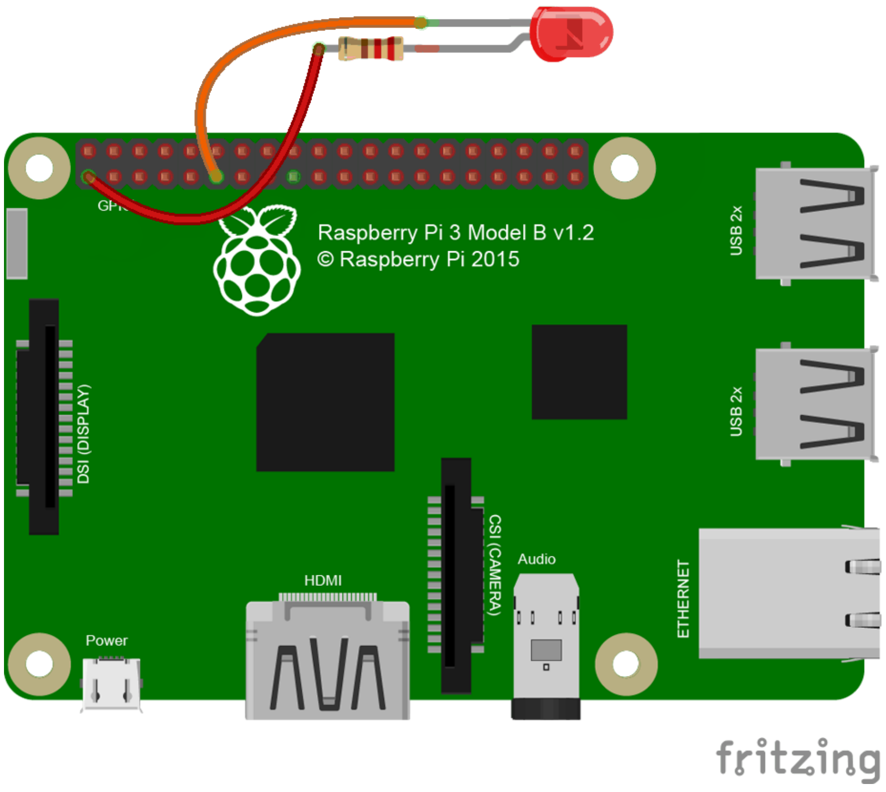
If the information above is shown, it indicates that the wiringPi has been installed successfully.

How to Use wiringPi and RPi.GPIO

For how to use the wiringPi C library and RPi.GPIO Python module, here we take a blinking LED for example.

Step 1: Build the circuit according to the following schematic diagram

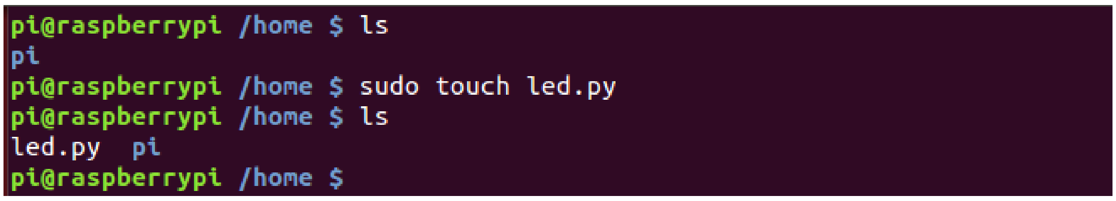
Note: Resistance = 220Ω



For Python users:

Step 2: Create a file named *led.py*

$ sudo touch led.py

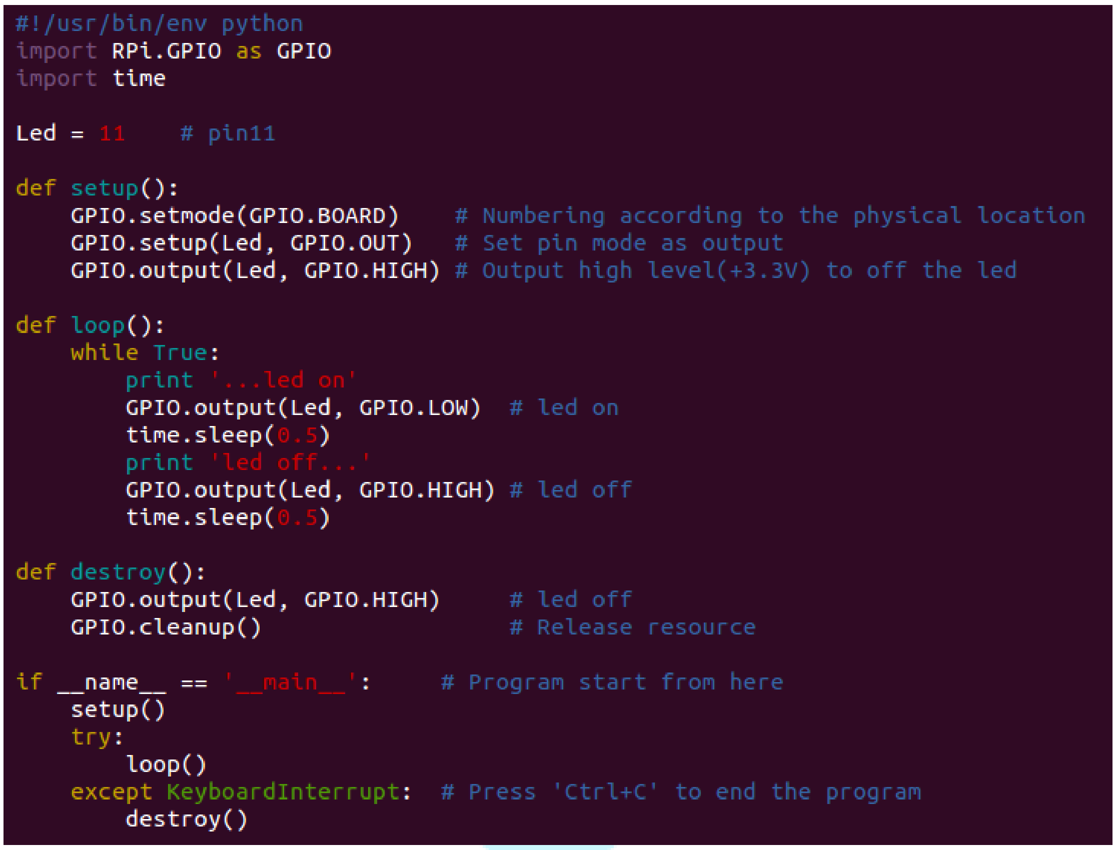


```
pi@raspberrypi /home $ ls
pi
pi@raspberrypi /home $ sudo touch led.py
pi@raspberrypi /home $ ls
led.py  pi
pi@raspberrypi /home $
```

Step 3: Open the file *led.py* with vim or nano

$ sudo vim led.py

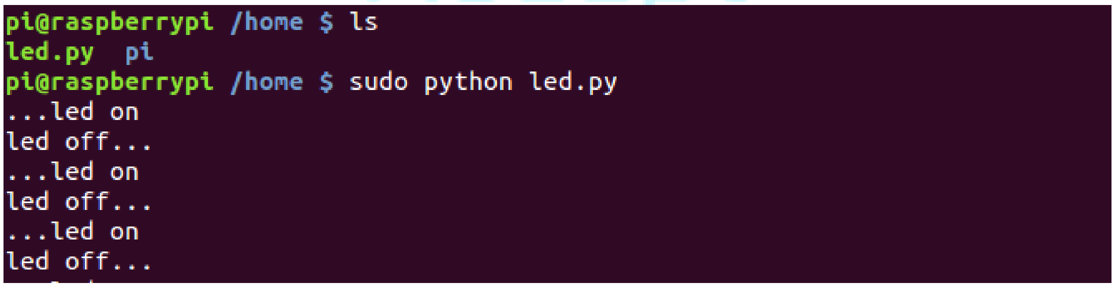
Write the following source code, then save and exit.



```
#!/usr/bin/env python
import RPi.GPIO as GPIO
import time

Led = 11    # pin11

def setup():
    GPIO.setmode(GPIO.BOARD)    # Numbering according to the physical location
    GPIO.setup(Led, GPIO.OUT)   # Set pin mode as output
    GPIO.output(Led, GPIO.HIGH) # Output high level(+3.3V) to off the led

def loop():
    while True:
        print '...led on'
        GPIO.output(Led, GPIO.LOW)  # led on
        time.sleep(0.5)
        print 'led off...'
        GPIO.output(Led, GPIO.HIGH) # led off
        time.sleep(0.5)

def destroy():
    GPIO.output(Led, GPIO.HIGH)     # led off
    GPIO.cleanup()                  # Release resource

if __name__ == '__main__':     # Program start from here
    setup()
    try:
        loop()
    except KeyboardInterrupt:  # Press 'Ctrl+C' to end the program
        destroy()
```

Step 4: Run

```
$ sudo python led.py
```



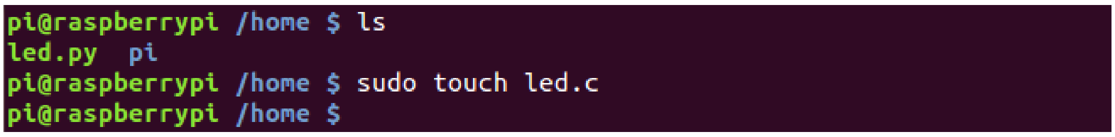
```
pi@raspberrypi /home $ ls
led.py  pi
pi@raspberrypi /home $ sudo python led.py
...led on
led off...
...led on
led off...
...led on
led off...
```

Now you should see the LED blinking. Press **Ctrl**+**C** and the program execution will be terminated.

For C language users:

Step 2: Create a file named *led.c*

```
$ sudo touch led.c
```

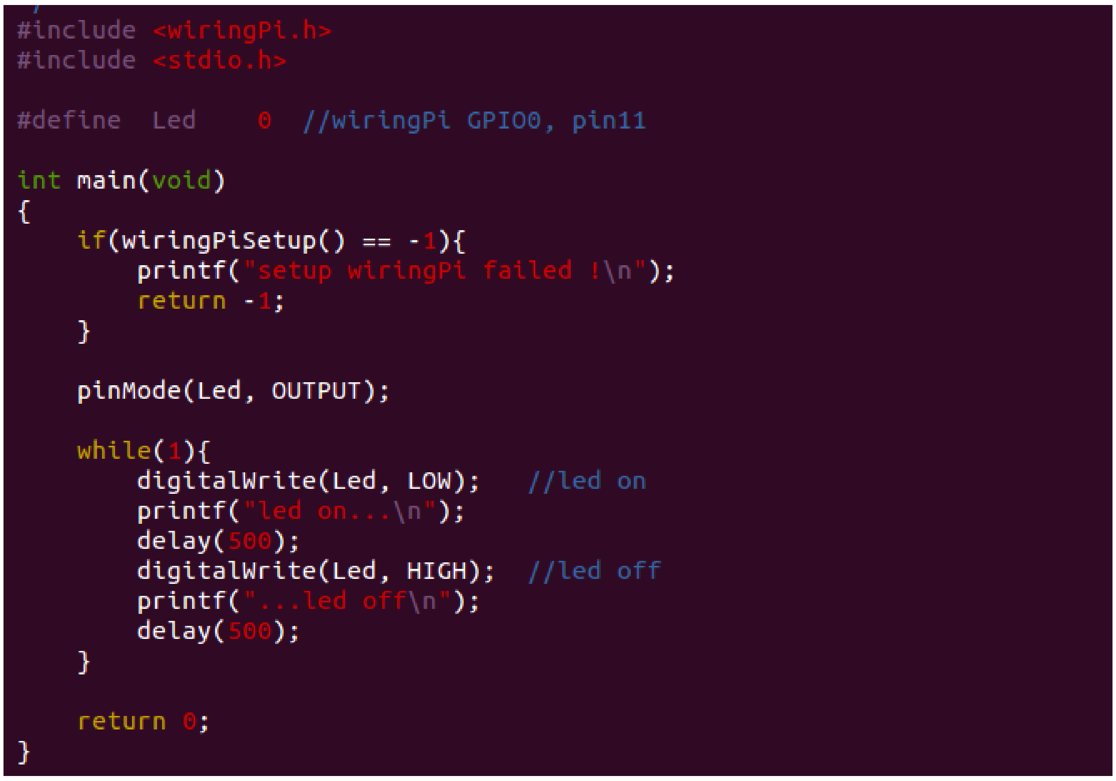


```
pi@raspberrypi /home $ ls
led.py  pi
pi@raspberrypi /home $ sudo touch led.c
pi@raspberrypi /home $
```

Step 3: Open the file *led.c* with vim or nano

$ sudo vim led.c

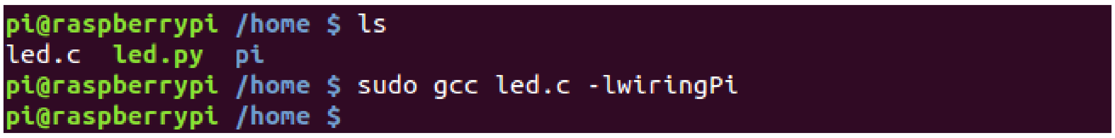
Write the following source code, then save and exit.



```
#include <wiringPi.h>
#include <stdio.h>

#define  Led     0  //wiringPi GPIO0, pin11

int main(void)
{
    if(wiringPiSetup() == -1){
        printf("setup wiringPi failed !\n");
        return -1;
    }

    pinMode(Led, OUTPUT);

    while(1){
        digitalWrite(Led, LOW);   //led on
        printf("led on...\n");
        delay(500);
        digitalWrite(Led, HIGH);  //led off
        printf("...led off\n");
        delay(500);
    }

    return 0;
}
```

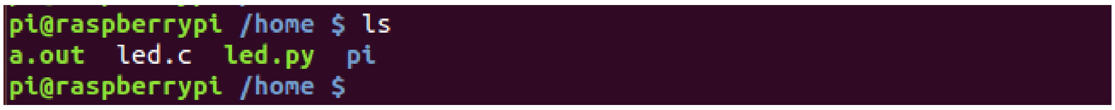
Step 4: Compile the code

$ sudo gcc led.c -lwiringPi



```
pi@raspberrypi /home $ ls
led.c  led.py  pi
pi@raspberrypi /home $ sudo gcc led.c -lwiringPi
pi@raspberrypi /home $
```

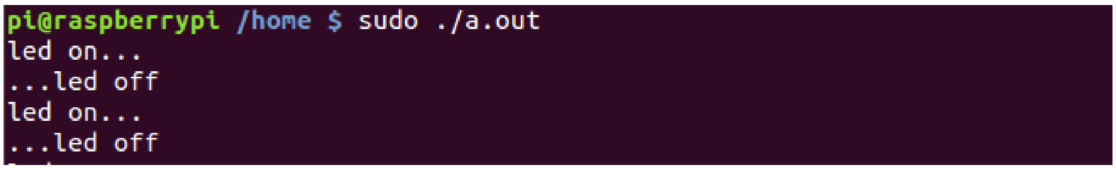
After the command is executed, you'll find a file named *a.out* appear in the current directory. It is an executable program.



```
pi@raspberrypi /home $ ls
a.out  led.c  led.py  pi
pi@raspberrypi /home $
```

Step 5: Run

$ sudo ./a.out



```
pi@raspberrypi /home $ sudo ./a.out
led on...
...led off
led on...
...led off
```

Now you should see that the LED is blinking. Press **Ctrl**+**C**, and the program execution will be terminated.

Resources:

http://sourceforge.net/p/raspberry-gpio-python/wiki/Examples/

http://wiringpi.com/reference/

NOTE:

Before you continue learning, please copy the source code provided with the kit to your Raspberry Pi's */home/* directory, or download the source code directly from our github repository:

C Language Source Code:

$ git clone https://github.com/adeept/Starter_Kit_C_Code_for_RPi.git

Python Source Code:

$ git clone https://github.com/adeept/Starter_Kit_Python_Code_for_RPi.git

Lesson 1 Blinking LED

Overview

In this tutorial, we will start the journey of learning Raspberry Pi. To begin with simple experiments, we will first learn how to control an LED.

Components

- 1* Raspberry Pi
- 1* 220Ω Resistor
- 1* LED
- 1* Breadboard
- 2* Jumper wires

Principle

In this lesson, we will program the Raspberry Pi to output high level (+3.3V) and low level (0V), and then make an LED which is connected to the Raspberry Pi GPIO flicker with a certain frequency.

1. What is LED?

The LED is the abbreviation of light emitting diode. It is usually made of gallium arsenide, gallium phosphide semiconductor materials. The LED has two electrodes, a positive electrode and a negative electrode. It lights up only when a forward current passes, and it can flash red, blue, green or yellow, etc. The color of light depends on the materials it is made.

In general, the drive current for LED is 5-20mA. Therefore, in reality it usually needs an extra resistor for current limitation so as to protect the LED.

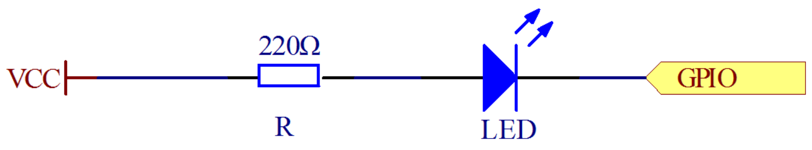
2. What is resistor?

The main function of the resistor is to limit current. In the circuit, the character 'R' represents resistor, and the unit of resistance is ohm(Ω).

A band resistor is used in this experiment. It is a resistor with a surface coated with some particular color through which the resistance can be identified directly.

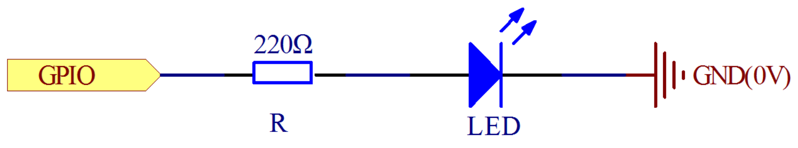
There are two methods for connecting an LED with Raspberry Pi GPIO:

①



As shown in the schematic diagram, the anode of the LED is connected to VCC (+3.3V), and the cathode to the Raspberry Pi GPIO. When the GPIO outputs low level, the LED is on; when it outputs high, the LED is off.

②



As shown in the schematic diagram above, the anode of LED is connected to Raspberry Pi GPIO after a resistor, and the cathode is connected to ground (GND). When the GPIO outputs high level, the LED is on; when it outputs low level, the LED is off.

The resistance of a current-limiting resistor is calculated as follows: 5~20mA current is required to make an LED on, and the output voltage of the Raspberry Pi GPIO is 3.3V, so we can get the resistance:

$$R = U / I = 3.3V / (5\sim20mA) = 165\Omega\sim660\Omega$$

In this experiment, we use a 220ohm resistor.

The experiment is made based on method ① – use pin 11 of Raspberry Pi to control an LED. When pin 11 of Raspberry Pi is programmed to output low level, the LED will light up. Next, delay for some time. And then program pin 11 to high level to make the LED off. Repeat the above process and you can get a blinking LED then.

3. Key functions

For C language users:

- int wiringPiSetup (void)

The function must be called at the start of your program, or your program will fail to work. You may experience symptoms from it simply not working to segfaults and timing issues.

Note: This function needs to be called with root privileges.

- void pinMode (int pin, int mode)

This function sets the mode of a pin to either **INPUT**, **OUTPUT**, **PWM_OUTPUT** or **GPIO_CLOCK**. Note that only wiringPi pin 1 (BCM_GPIO 18) supports PWM output and only wiringPi pin 7 (BCM_GPIO 4) supports CLOCK output mode.

The function has no effect when in Sys mode. If you need to change the pin mode, then you can do it with the gpio program in a script before you starting your program.

- void digitalWrite (int pin, int value)

Write the value **HIGH** or **LOW** (1 or 0) to a given pin which must have been set previously as output. *WiringPi* treats any non-zero number as HIGH, while 0 is the only representation of LOW.

- void delay (unsigned int howLong)

This function causes program execution to pause for at least howLong milliseconds. Due to the multi-tasking nature of Linux it could be longer. Note that the maximum delay is an unsigned 32-bit integer or approximately 49 days.

For Python users:

- GPIO.setmode(GPIO.BOARD)

There are two ways of numbering the IO pins on a Raspberry Pi within RPi.GPIO. The first is using the **BOARD** numbering system. This refers to the pin numbers on the P1 header of the Raspberry Pi board. The advantage of this numbering system is that your hardware will always work, regardless of the board revision of the RPi. You will not need to rewire your connector or change your code.

The second numbering system is by the **BCM**(GPIO.BCM) numbers. This is a lower level way of working - it refers to the channel numbers on the Broadcom SOC. You have to always work with a diagram about which channel number goes to which pin on the RPi board. Your script could break between revisions of Raspberry Pi boards.

- GPIO.setup(channel, mode)

The function sets every channel you are using as input(GPIO.IN) or output(GPIO.OUT).

- GPIO.output(channel, state)

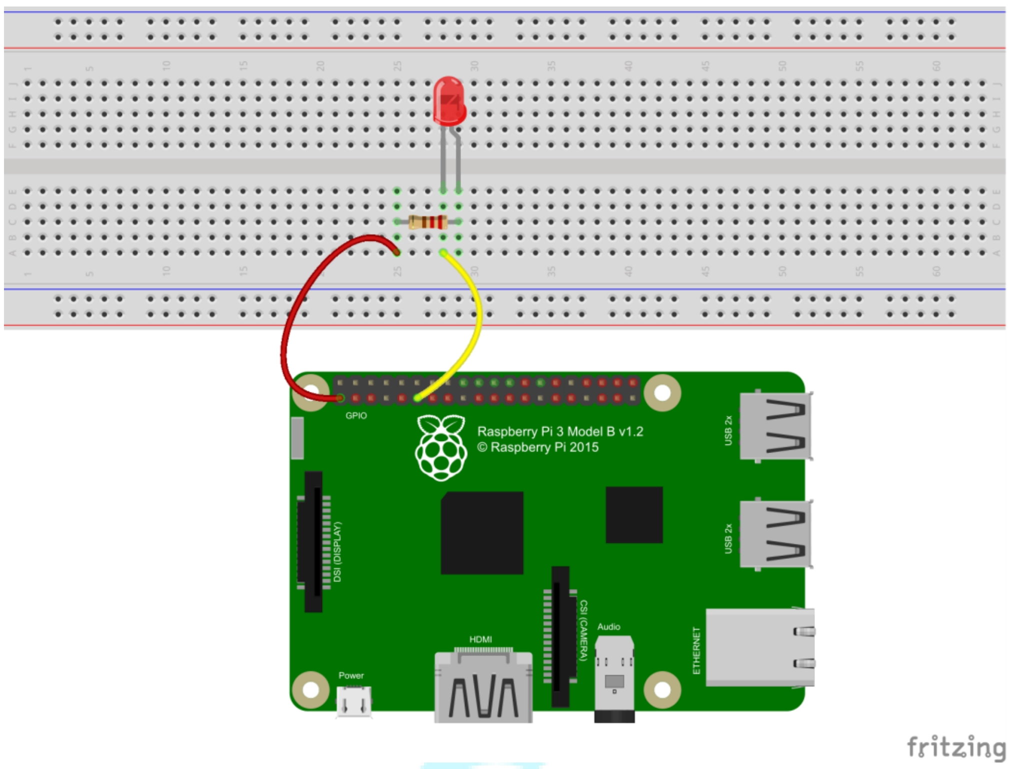
The function sets the output state of a GPIO pin. The argument channel is the channel number based on the numbering system you have specified (BOARD or BCM). **State** can be 0 / GPIO.LOW / False or 1 / GPIO.HIGH / True.

- GPIO.cleanup( )

At the end any program, it is a good habit to clean up all the resources you might have used. This is no different from RPi.GPIO. By returning all channels you have used back to input without pull up/down, you can avoid accidental damage to your RPi caused by pin shortout. Note that this will only clean up GPIO channels that your script ever has used. And it also clears the pin numbering system in use.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi /01_blinkingLed/blinkingLed.c)

```
#include <wiringPi.h>
#include <stdio.h>

#define  LedPin    0

int main(void)
{
    if(wiringPiSetup() == -1){ //when initialize wiringPi failed, print message to
screen
        printf("setup wiringPi failed !\n");
        return -1;
    }

    pinMode(LedPin, OUTPUT);

    while(1){
        digitalWrite(LedPin, LOW);   //led on
        printf("led on...\n");
        delay(500);
        digitalWrite(LedPin, HIGH);  //led off
        printf("...led off\n");
        delay(500);
    }

    return 0;
}
```

Step 3: Compile

```
$ gcc blinkingLed.c -o led -lwiringPi
```

Note: The parameter '-o' is to specify a file name for the compiled executable program. If you do not use this parameter, the default file name is *a.out*.

Step 4: Run

```
$ sudo ./led
```

For Python users:

Step 2: Edit and save the code with vim or nano.

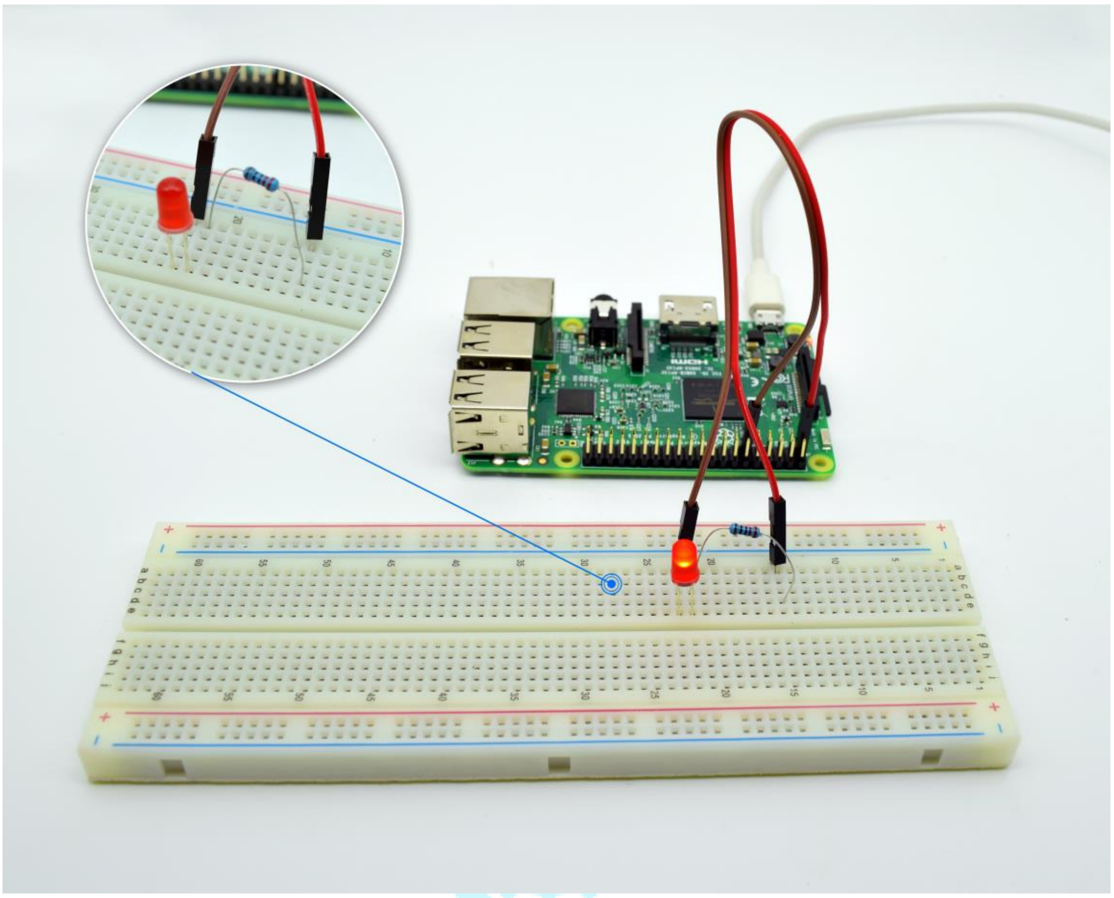
(Code path: /home/Starter_Kit_Python_Code_for_RPi/01_blinkingLed_1.py)

```
#!/usr/bin/env python
import RPi.GPIO as GPIO
import time

LedPin = 11    # pin11

def setup():
    GPIO.setmode(GPIO.BOARD)       # Numbers GPIOs by physical location
    GPIO.setup(LedPin, GPIO.OUT)   # Set LedPin's mode is output
    GPIO.output(LedPin, GPIO.HIGH) # Set LedPin high(+3.3V) to off led

def loop():
    while True:
        print '...led on'
        GPIO.output(LedPin, GPIO.LOW)  # led on
        time.sleep(0.5)
        print 'led off...'
        GPIO.output(LedPin, GPIO.HIGH) # led off
        time.sleep(0.5)

def destroy():
    GPIO.output(LedPin, GPIO.HIGH)     # led off
    GPIO.cleanup()                     # Release resource

if __name__ == '__main__':     # Program start from here
    setup()
    try:
        loop()
    except KeyboardInterrupt:  # When 'Ctrl+C' is pressed, the child program destroy()
will be  executed.
        destroy()
```

Step 3: Run

```
$ sudo python 01_blinkingLed_1.py
```

Now you can see the LED blinking.



Lesson 2 Buzzer

Overview

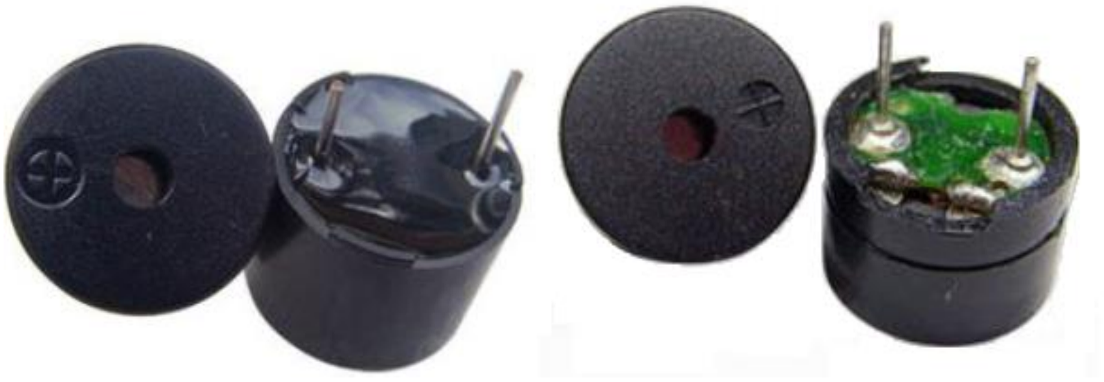
In this lesson, we will learn how to program the Raspberry Pi to make an active buzzer beep.

Components

- 1* Raspberry Pi
- 1* Active buzzer
- 1* 1 kΩ Resistor
- 1* NPN Transistor (S8050)
- 1* Breadboard
- Several jumper wires

Principle

A buzzer or beeper is an audio signaling device. As a type of electronic buzzer with an integrated structure, which uses DC power supply, buzzers are widely used in computers, printers, photocopiers, alarms, electronic toys, automotive electronic equipments, telephones, timers and other electronic products for voice devices. Buzzers can be categorized as active and passive buzzers (See the following pictures).

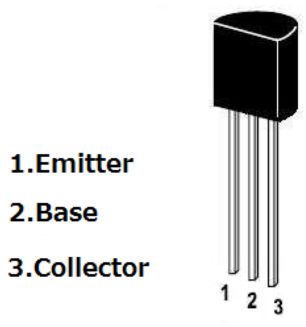


Place the pins of the buzzer face up, and then you can see the two types of buzzer are different - the buzzer with a green circuit board onside is a passive one.

In this lesson, the buzzer we used is active buzzer. Active buzzers will sound as long as they are powered. We can program to make the Raspberry Pi output alternating high and low levels to make the buzzer beep.

A slightly larger current is needed to make a buzzer beep. However, the output current of Raspberry Pi GPIO is too low, so we need a transistor to help.

The main function of a transistor is to enlarge the voltage or current. It can also be used to control the circuit conduction or deadline. Transistors can be divided into two kinds: NPN, like the S8050 we provided; PNP, like the S8550 provided. The transistor we use is as shown below:



There are two kinds of driving circuit for the buzzer:

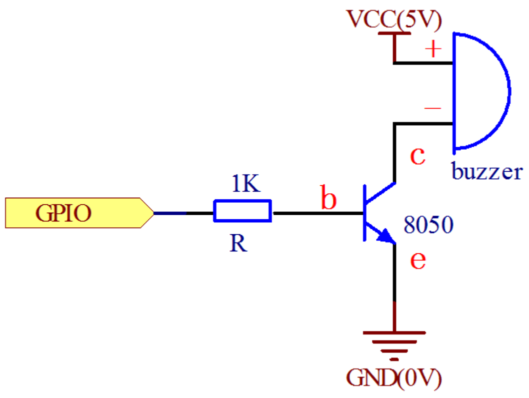


Figure 1

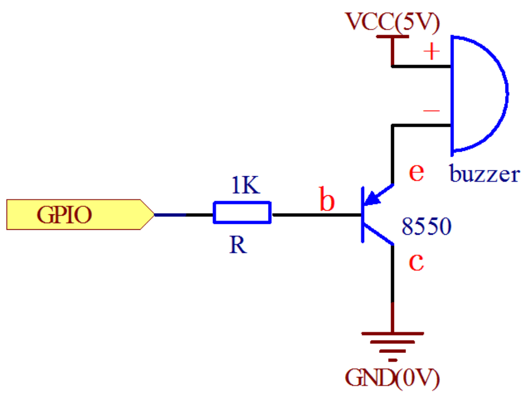


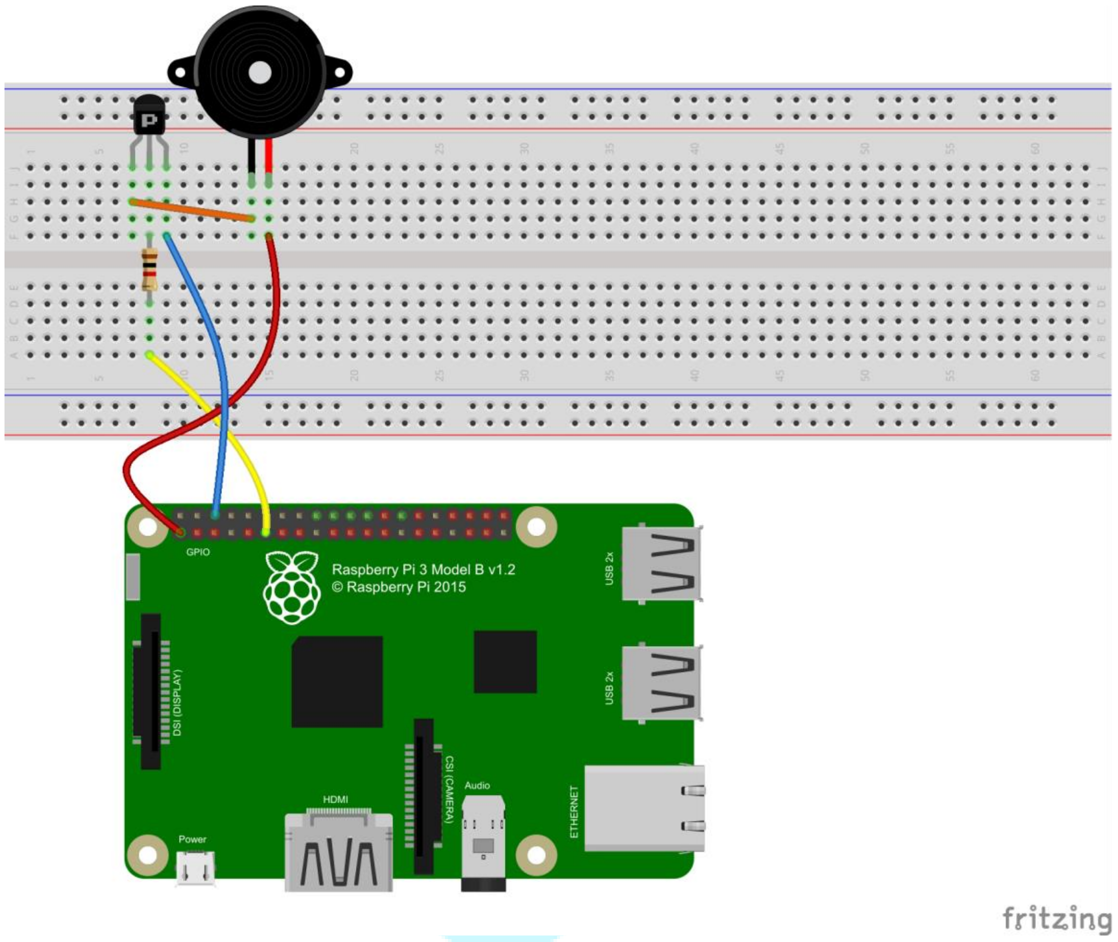
Figure 2

Figure 1: Set the Raspberry Pi GPIO as a high level. Then the transistor S8050 will conduct and the buzzer will make sounds. Set the GPIO as low, and the transistor S8050 will be de-energized and the buzzer stops beeping.

Figure 2: Set the Raspberry Pi GPIO as low level. The transistor S8550 will be energized and the buzzer will beep. Set the GPIO as a high, then the transistor S8550 will be de-energized and the buzzer beeping will stop.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/02_buzzer/buzzer.c)

Step 3: Compile

```
$ gcc buzzer.c -o buzzer -lwiringPi
```

Step 4: Run

```
$ sudo ./buzzer
```

For Python users:

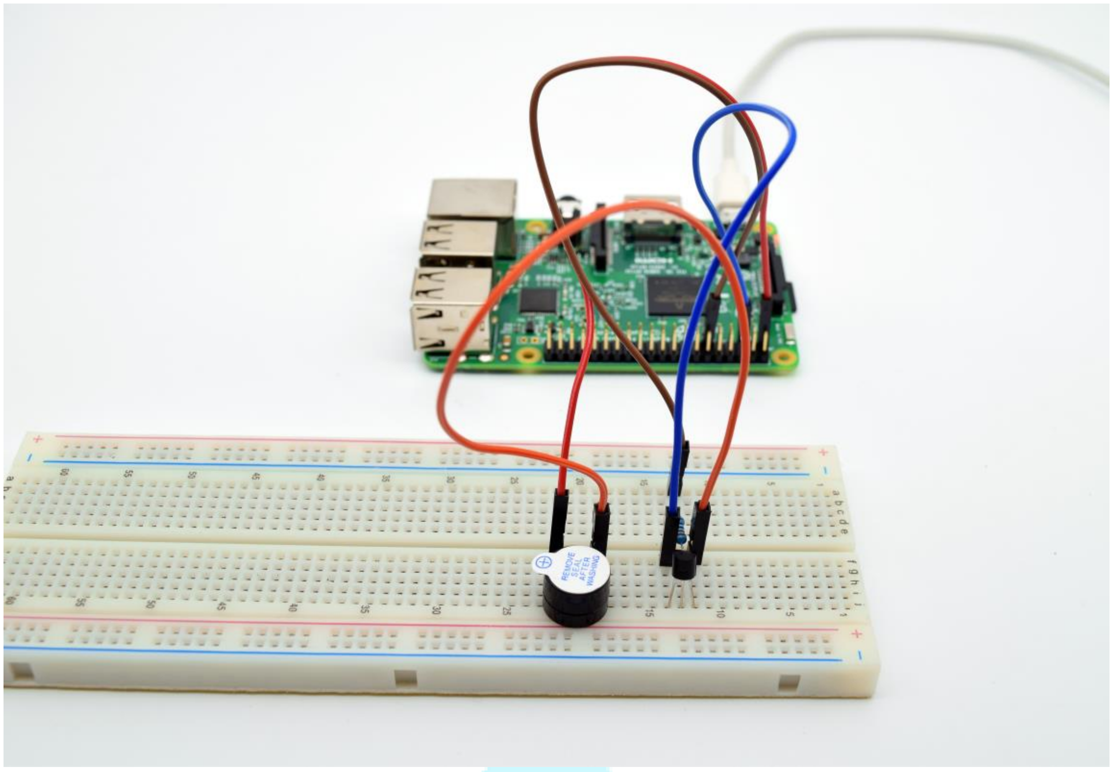
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/02_buzzer.py)

Step 3: Run

```
$ sudo python 02_buzzer.py
```

Now you can hear the buzzer beeping.



Summary

After learning this lesson, you can master the basic principle of the buzzer and transistor. Also you've learned how to program the Raspberry Pi and then control the buzzer. Now you can use what you've learned in this lesson to make some interesting things!

Lesson 3 Controlling an LED by Button

Overview

In this lesson, we will learn how to detect the status of a button, and then toggle the status of the LED based on the status of the button.

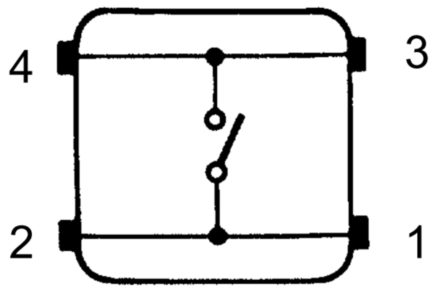
Components

- 1* Raspberry Pi
- 1* Button
- 1* LED
- 1* 220Ω Resistor
- 1* Breadboard
- Several jumper wires

Principle

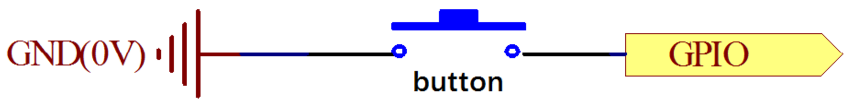
1. Button

Buttons are a common component used to control electronic devices. They are usually used as switches to connect or disconnect circuits. Although buttons come in a variety of sizes and shapes, the one used in this experiment will be a 12mm button as shown below.

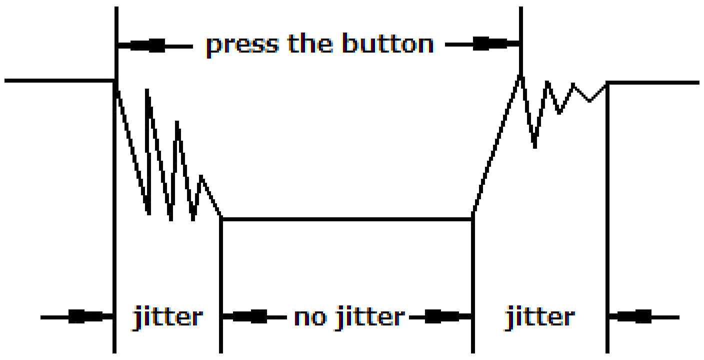


The button we used is a normally open type one. The two contacts of a button are in the off state under the normal conditions; only when the button is pressed they are closed.

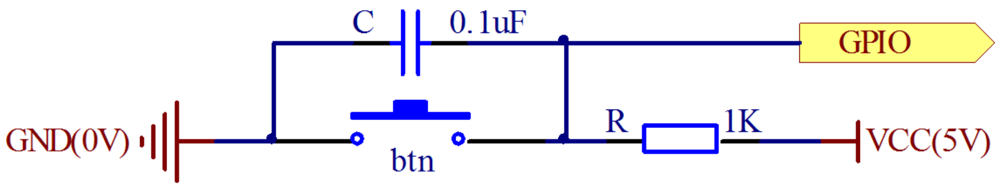
The schematic diagram is as follows:



The button jitter must happen in the process of using. The jitter waveform is as the flowing:



Each time you press the button, the Raspberry Pi will regard you have pressed the button many times due to the jitter of the button. You should deal with the jitter of buttons before using. You can eliminate the jitter through software programming. Besides, you can use a capacitor to solve the issue. Take the software method for example. First, detect whether the level of button interface is low level or high level. If it is low level, 5~10 MS delay is needed. Then detect whether the level of button interface is low or high. If the signal is low, you can infer that the button is pressed once. You can also use a 0.1uF capacitor to avoid the jitter of buttons. The schematic diagram is as shown below:



2. Interrupt

Hardware interrupts were introduced as a way to reduce wasting the processor's valuable time in polling loops, waiting for external events. They may be implemented in hardware as a distinct system with control lines, or they may be integrated into the memory subsystem.

3. Key functions:

For C *language* users:

- void pullUpDnControl (int pin, int pud)

This sets the pull-up or pull-down resistor mode on the given pin, which should be set as an input. Unlike the Arduino, the BCM2835 has both pull-up a down internal resistors. The parameter pud should be; PUD_OFF, (no pull up/down), PUD_DOWN (pull to ground) or PUD_UP (pull to 3.3v). The internal pull up/down resistors have a value of approximately 50KΩ on the Raspberry Pi.

This function has no effect on the Raspberry Pi's GPIO pins when in Sys mode. If you need to activate a pull-up/pull-down, then you can do it with the gpio program in a script before you start your program.

- int digitalRead (int pin)

This function returns the value read at the given pin. It will be HIGH or LOW (1 or 0) depending on the logic level at the pin.

- int wiringPiISR (int pin, int edgeType, void (*function)(void))

This function registers a function to received interrupts on the specified pin. The edgeType parameter is either **INT_EDGE_FALLING**, **INT_EDGE_RISING**, **INT_EDGE_BOTH** or **INT_EDGE_SETUP**. If it is **INT_EDGE_SETUP** then no initialisation of the pin will happen – it's assumed that you have already setup the pin elsewhere (e.g. with the gpio program), but if you specify one of the other types, then the pin will be exported and initialised as specified. This is accomplished via a suitable call to the gpio utility program, so it need to be available.

The pin number is supplied in the current mode – native wiringPi, BCM_GPIO, physical or Sys modes.

This function will work in any mode, and does not need root privileges to work.

The function will be called when the interrupt triggers. When it is triggered, it's cleared in the dispatcher before calling your function, so if a subsequent interrupt fires before you finish your handler, then it won't be missed. (However it can only track one more interrupt, if more than one interrupt fires while one is being handled then they will be ignored)

This function is run at a high priority (if the program is run using sudo, or as root) and executes concurrently with the main program. It has full access to all the global variables, open file handles and so on.

For Python users:

- GPIO.input(channel)

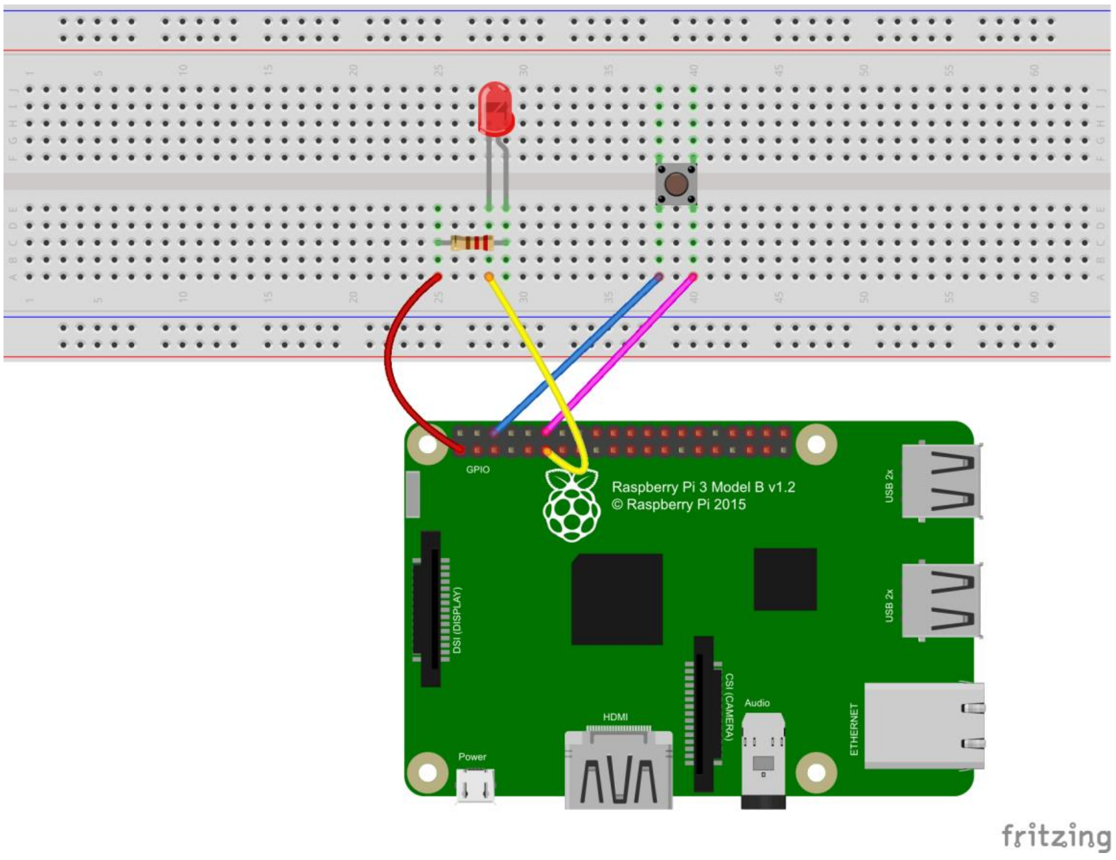
This is used for reading the value of a GPIO pin. Where channel is the channel number based on the numbering system you have specified (BOARD or BCM)). This will return either 0 / GPIO.LOW / False or 1 / GPIO.HIGH / True.

- GPIO.add_event_detect(channel, mode)

The event_detected( ) function is designed to be used in a loop with other things, but unlike polling it is not going to miss the change in state of an input while the CPU is busy working on other things. This could be useful when using something like Pygame or PyQt where there is a main loop listening and responding to GUI events in a timely basis.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/03_btnAndLed/btnAndLed_2.c)

Step 3: Compile

```
$ gcc btnAndLed_2.c -o btnAndLed -lwiringPi
```

Step 4: Run

```
$ sudo ./btnAndLed
```

For Python users:

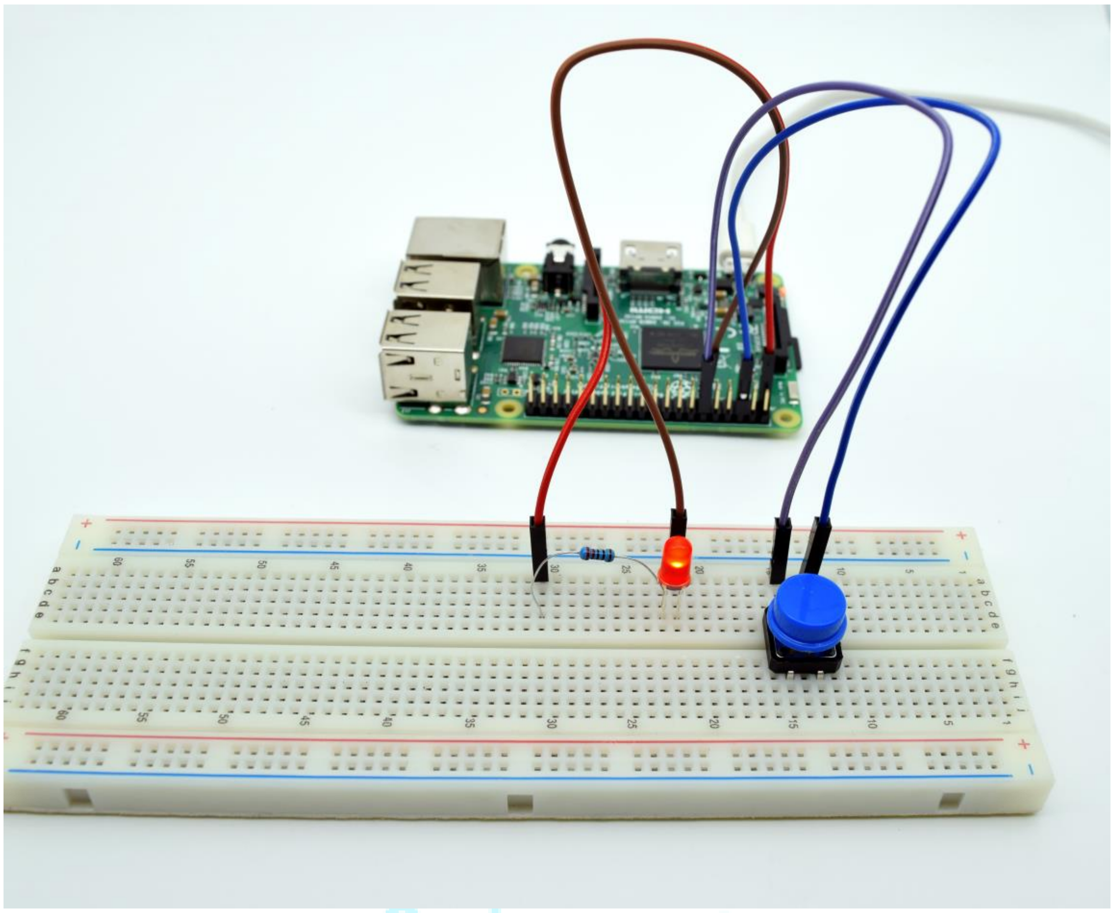
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/03_btnAndLed_1.py)

Step 3: Run

```
$ sudo python 03_btnAndLed_1.py
```

Now press the button, and you can see the state of the LED will be toggled between ON and OFF.



Summary

Through this lesson, you should have learned how to use the Raspberry Pi to detect the status of an external button, and then toggle the status of LED on/off relying on the status of the button detected before.

Lesson 4 LED Flowing Lights

Overview

In the first lesson, we have learned how to make an LED blink by programming the Raspberry Pi. Now we will use the Raspberry Pi to control 8 LEDs, to make 8 LEDs show the effects of flowing.

Components

- 1* Raspberry Pi
- 8* LED
- 8* 220Ω Resistor
- 1* Breadboard
- Several jumper wires

Principle

The principle of this experiment is very simple and quite similar with that in the first lesson.

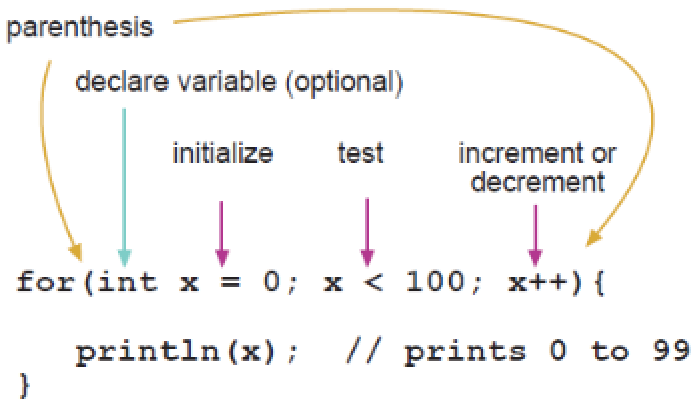
Key function:

- **for statements**

The for statement is used to repeat a block of statements enclosed in curly braces. An increment counter is usually used to increment and terminate the loop. The for statement is useful for any repetitive operation, and is often used in combination with arrays to operate on collections of data/pins.

There are three parts to the for loop header:

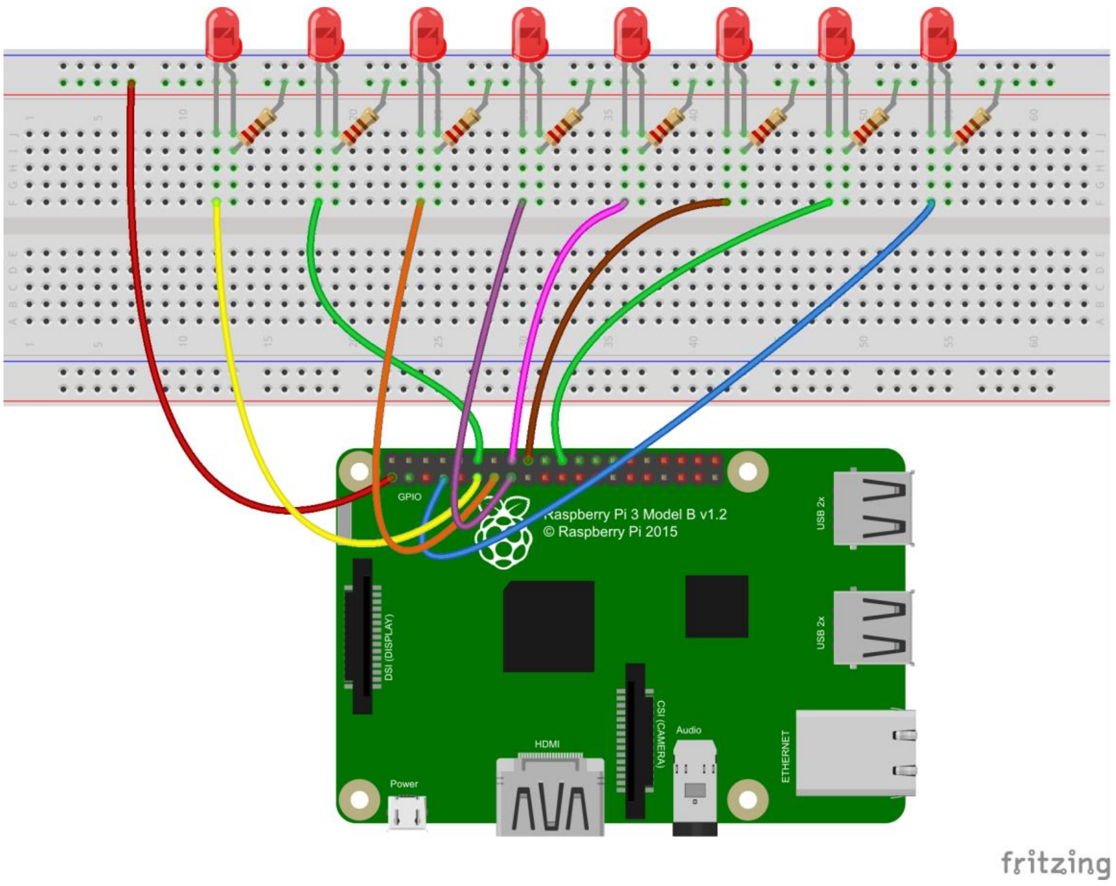
```
for (initialization; condition; increment) {
      //statement(s);
}
```


parenthesis
declare variable (optional)
initialize
test
increment or decrement
for(int x = 0; x < 100; x++){
println(x); // prints 0 to 99
}

The initialization happens first and exactly once. Each time through the loop, the condition is tested; if it's true, the statement block, and the increment is executed, then the condition is tested again. When the condition becomes false, the loop ends.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/04_flowingLed/flowingLed.c)

Step 3: Compile

```
$ gcc flowingLed.c -o flowingLed -lwiringPi
```

Step 4: Run

```
$ sudo ./flowingLed
```

For Python users:

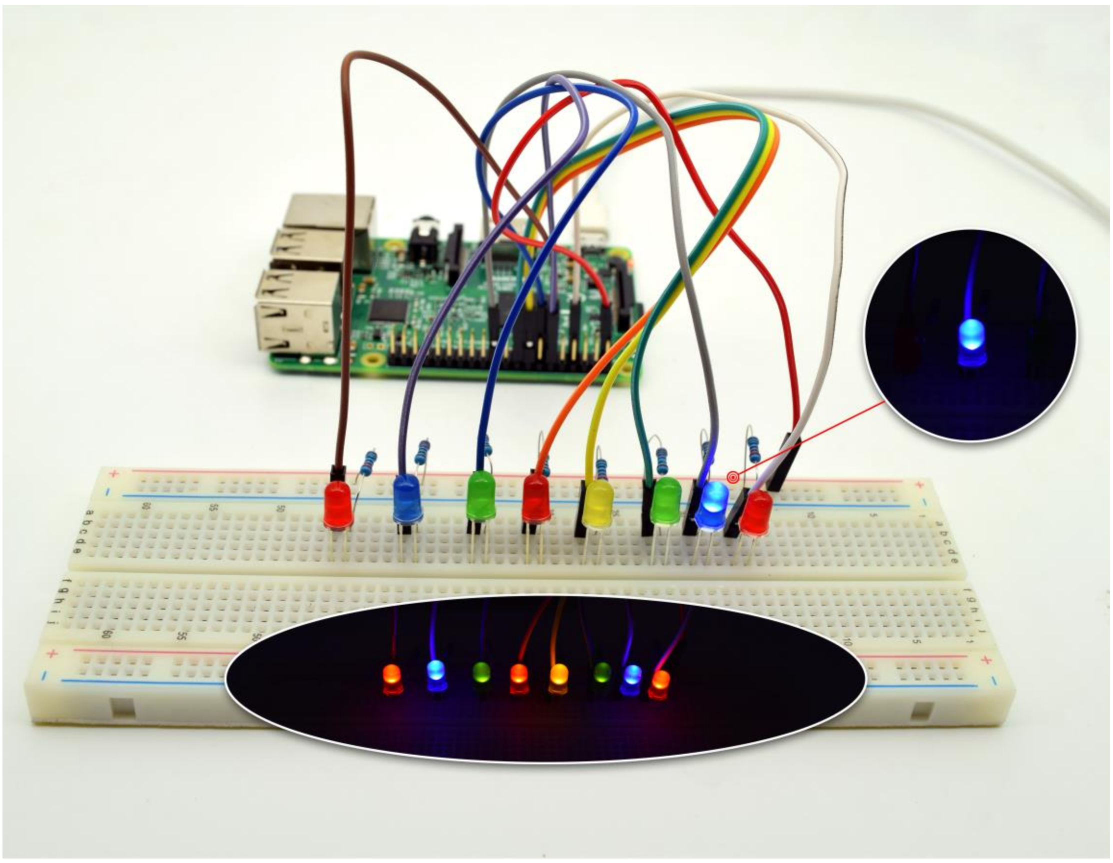
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/04_flowingLed.py)

Step 3: Run

```
$ sudo python 04_flowingLed.py
```

Now, you can see 8 LEDs light up in sequence from the red one on the right side to others on the left, and next from the left to the right. The LEDs flash like flowing water repeatedly in a circular way.



Summary

Through this simple but fun experiment, you should have learned more skills in programming on Raspberry Pi. In addition, you can also modify the circuit and code provided to achieve even more dazzling effects.

Lesson 5 Breathing LED

Overview

In this lesson, we will learn how to program the Raspberry Pi to generate PWM signals. And then we use the PWM square-wave signals to control an LED gradually getting brighter and then slowly dimmer, much like human breath.

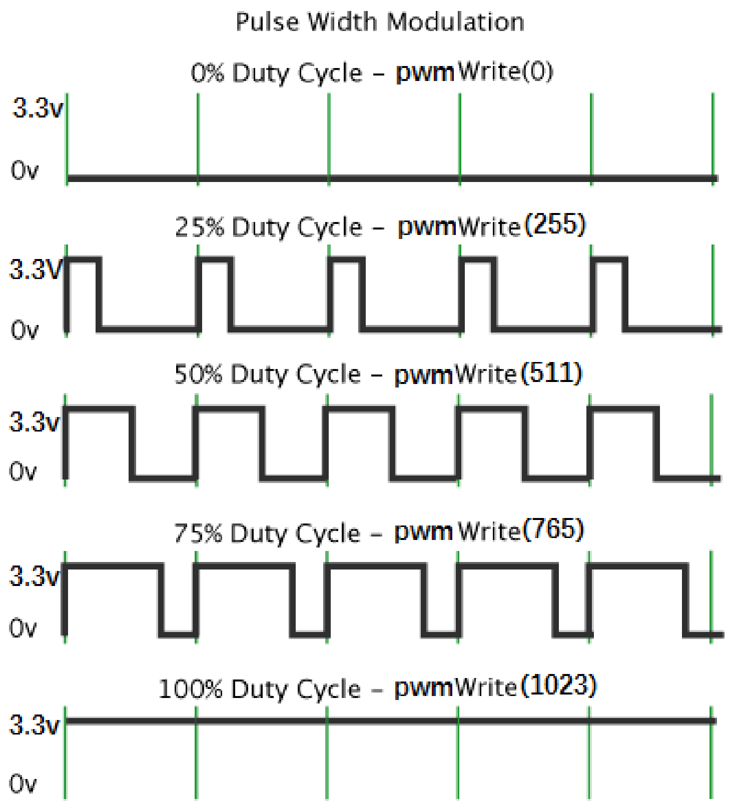
Components

- 1* Raspberry Pi
- 1* LED
- 1* 220Ω Resistor
- 1* Breadboard
- Several jumper wires

Principle

Pulse Width Modulation, or PWM, is a technique for getting analog results with digital means. Digital control is used to create a square wave, a signal switched between on and off. This on-off pattern can simulate voltages in between full on (5 Volts) and off (0 Volts) by changing the portion of the time the signal spends on versus the time that the signal spends off. The duration of "on time" is called the pulse width. To get varying analog values, you change, or modulate, that pulse width. If you repeat this on-off pattern fast enough with an LED for example, the result is as if the signal is a steady voltage between 0 and 5v controlling the brightness of the LED.

In the following figure, the green lines represent a regular time period. This duration or period is the inverse of the PWM frequency. In other words, with Raspberry Pi's PWM frequency at about 500Hz, the green lines would measure 2 milliseconds each. A call to pwmWrite() is on a scale of 0-1023, such that pwmWrite(1023) requests a 100% duty cycle (always on), and pwmWrite(511) is a 50% duty cycle (on half the time) for example.


Pulse Width Modulation
0% Duty Cycle - pwmWrite(0)
3.3v
0v
25% Duty Cycle - pwmWrite(255)
3.3V
0v
50% Duty Cycle - pwmWrite(511)
3.3v
0v
75% Duty Cycle - pwmWrite(765)
3.3v
0v
100% Duty Cycle - pwmWrite(1023)
3.3v
0v

Key functions:

For C language users:

● pwmWrite(int pin, int value)

Writes the value to the PWM register for the given pin. The Raspberry Pi has one on-board PWM pin, pin 1 (BMC_GPIO 18, Phys 12) and the range is 0-1024. Other PWM devices may have other PWM ranges.

This function is not able to control the Pi's on-board PWM when in Sys mode.

For Python users:

● p = GPIO.PWM(channel, frequency)

This is used for creating a PWM.

● p.start(dc)

Start the pwm you have created.

● p.ChangeFrequency(freq)

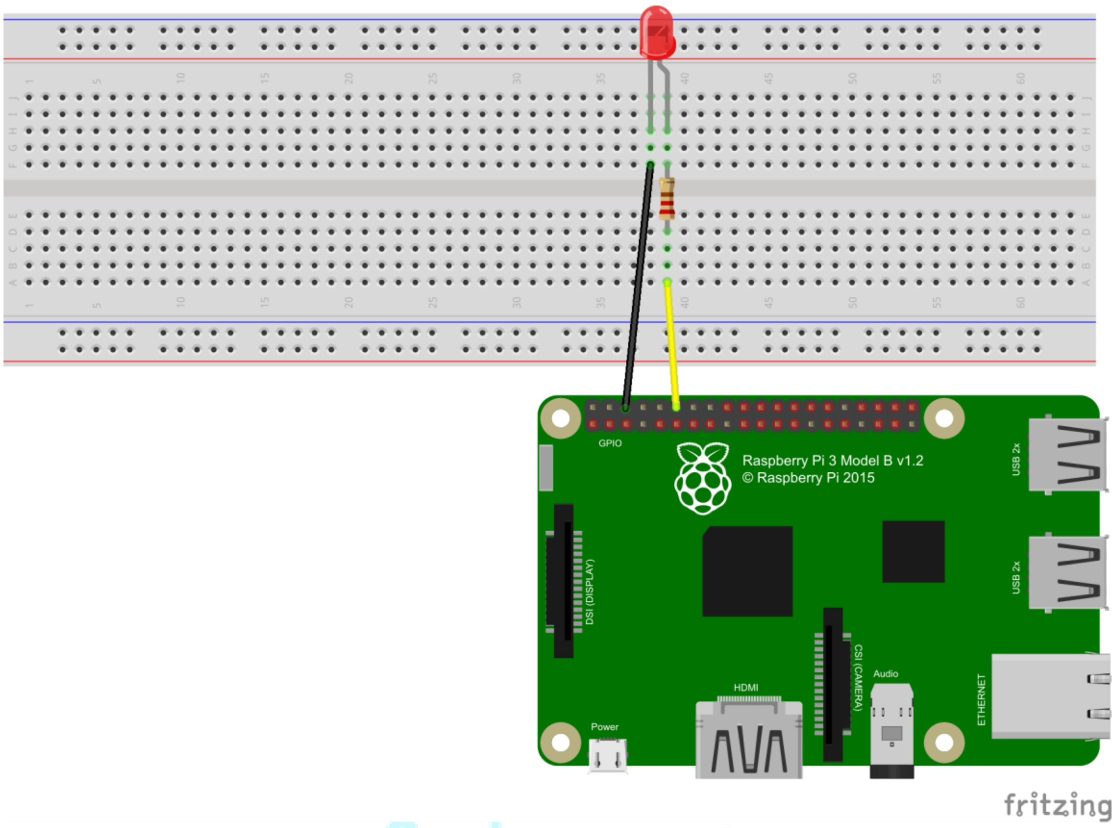
Change the frequency of pwm.

● p.stop( )

Stop the pwm.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/05_breathingLed/breathingLed.c)

Step 3: Compile

```
$ gcc breathingLed.c -o breathingLed -lwiringPi
```

Step 4: Run

```
$ sudo ./breathingLed
```

For Python users:

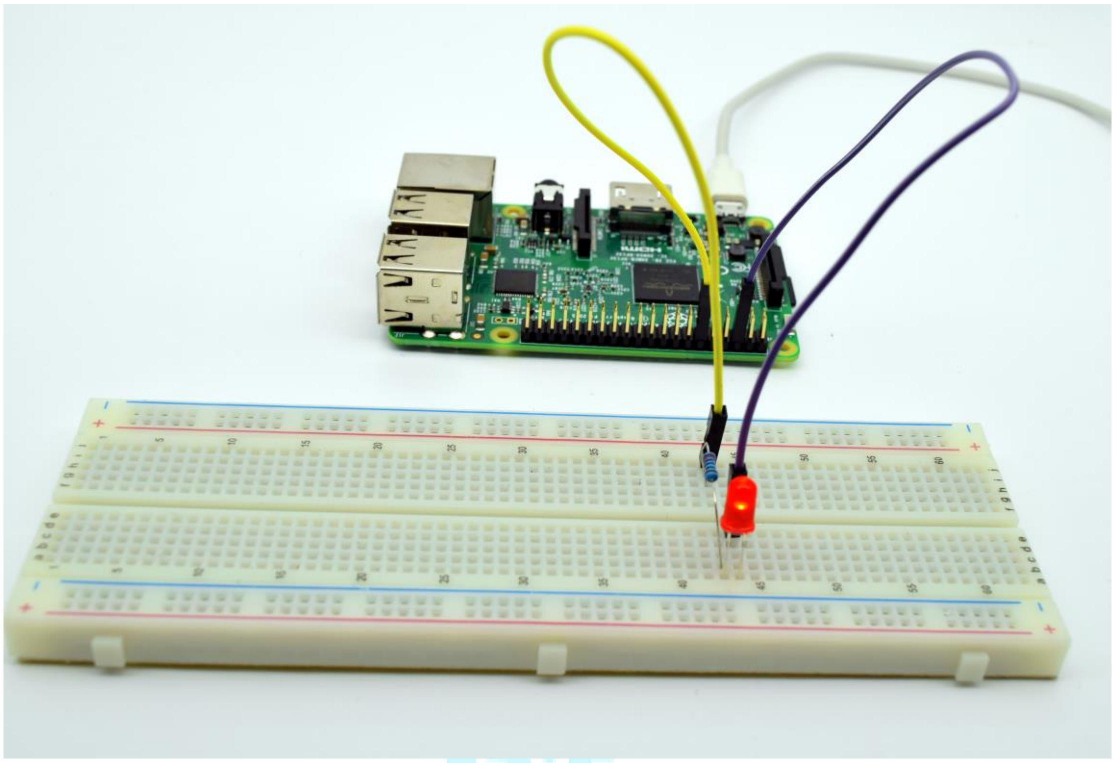
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/05_breathingLed.py)

Step 3: Run

```
$ sudo python 05_breathingLed.py
```

Now, you should see the LED lights up and gets gradually brighter, and then slowly turns dimmer. The process repeats circularly, and with the particular rhythm it looks like animals' breath.



Summary

By learning this lesson, you should have mastered the basic principles of the PWM, and get skilled at the PWM programming on the Raspberry Pi platform.

Lesson 6 Controlling an RGB LED with PWM

Overview

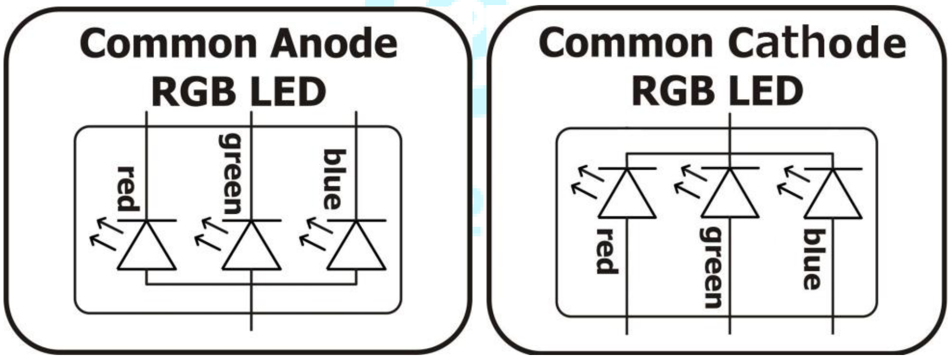
In this lesson, we will program the Raspberry Pi for RGB LED control, and make the RGB LED emit light of various colors.

Components

- 1* Raspberry Pi
- 1* RGB LED
- 3* 220Ω Resistor
- 1* Breadboard
- Several jumper wires

Principle

RGB LEDs consist of three LEDs in different colors: red, green and blue. These three colored LEDs are capable of producing any color. Tri-color LEDs with red, green, and blue emitters, in general use a four-wire connection with one common lead (anode or cathode).



What we use in this experiment is a common anode RGB LED. The longest pin is the common anode of the three LEDs. The pin is connected to the +3.3V pin of the Raspberry Pi, and the rest pins are connected to pin 11, pin 12, and pin 13 of Raspberry Pi with a current limiting resistor between.

In this way, we can control the color of the RGB LED by 3-channel PWM signal.

Key functions:

- int softPwmCreate (int pin, int initialValue, int pwmRange)

This creates a software controlled PWM pin. You can use any GPIO pin and the pin numbering will be that of the wiringPiSetup() function you used. Use 100 for the pwmRange, then the value can be anything from 0 (off) to 100 (fully on) for the given pin.

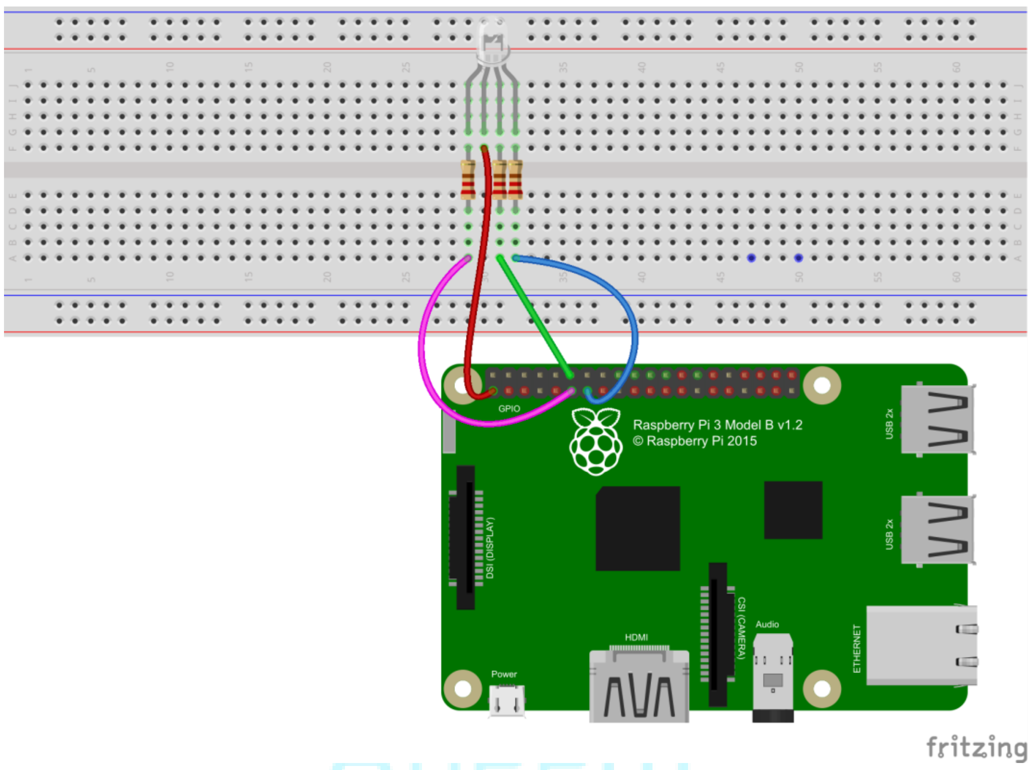
The return value is 0 for success. Anything else and you should check the global errno variable to see what went wrong.

- **void softPwmWrite (int pin, int value)**

This updates the PWM value on the given pin. The value is checked to be in-range and pins that haven't previously been initialised via softPwmCreate will be silently ignored.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/06_rgbLed/rgbLed.c)

Step 3: Compile

```
$ gcc rgbLed.c -o rgbLed -lwiringPi -lpthread
```

NOTE: The compiler option '-lpthread' is required because the implementation of softPwm is based on Linux multithreading.

Step 4: Run

```
$ sudo ./rgbLed
```

For Python users:

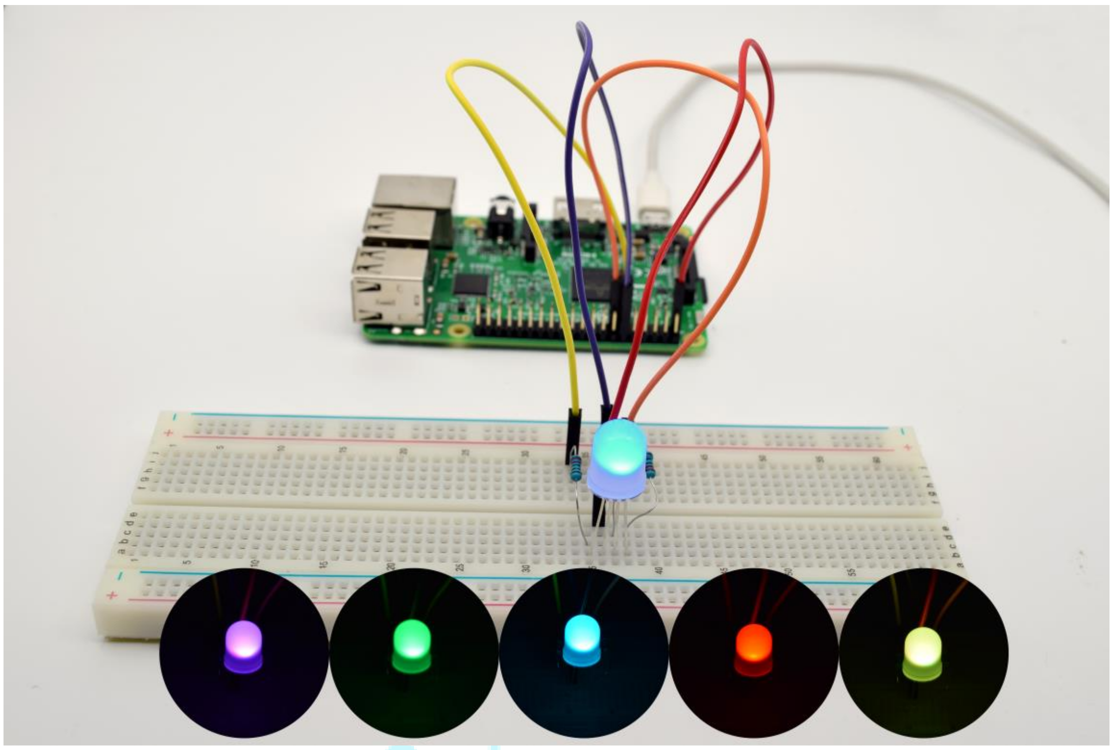
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/06_rgbLed.py)

Step 3: Run

```
$ sudo python 06_rgbLed.py
```

Now, you can see the RGB LED flashing red, green, blue, yellow, white and purple light, and then the RGB LED goes out. Each state lasts for 1s each time, and the LED flashes colors repeatedly in such sequence.



Summary

By learning this lesson, you should have already got the principle and the programming of RGB LED. Now you can use your imagination to achieve even more cool ideas based on what you learned in this lesson.

Lesson 7 7-Segment Display

Overview

In this lesson, we will program the Raspberry Pi to achieve the controlling of a segment display.

Components

- 1* Raspberry Pi
- 1* 220Ω Resistor
- 1* 7-Segment display
- 1* Breadboard
- Several jumper wires

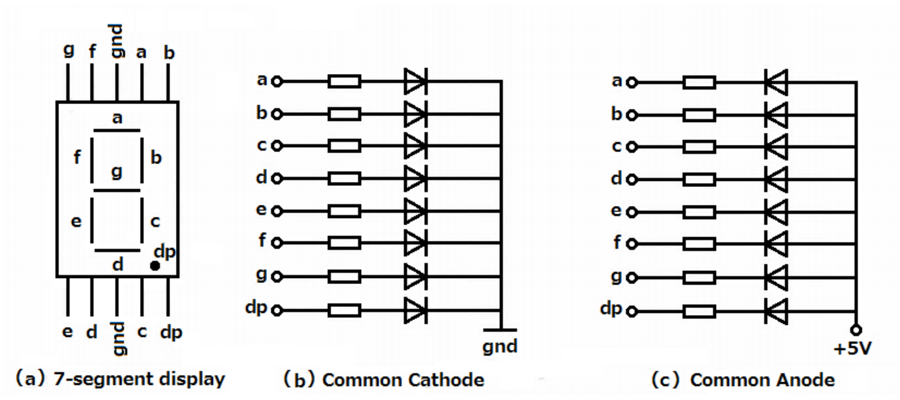
Principle

The seven-segment display is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix displays.

Seven-segment displays are widely used in digital clocks, electronic meters, basic calculators, and other electronic devices that display numerical information.

The seven-segment display is an 8-shaped LED display device composed of eight LEDs (including a decimal point). The segments are named respectively a, b, c, d, e, f, g, and dp.

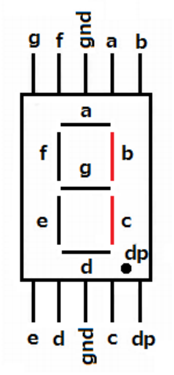
The segment display can be divided into two types: common anode and common cathode segment displays, by internal connections.



For a common-anode LED, the common anode should be connected to the power supply (VCC); for a common-cathode LED, the common cathode should be connected to the ground (GND).

Each segment of a segment display is composed of an LED, so a resistor is needed for protecting the LED.

A 7-segment display has seven segments for displaying a figure and one more for displaying a decimal point. For example, if you want to display a number ‘1’, you should only light the segment b and c, as shown below.



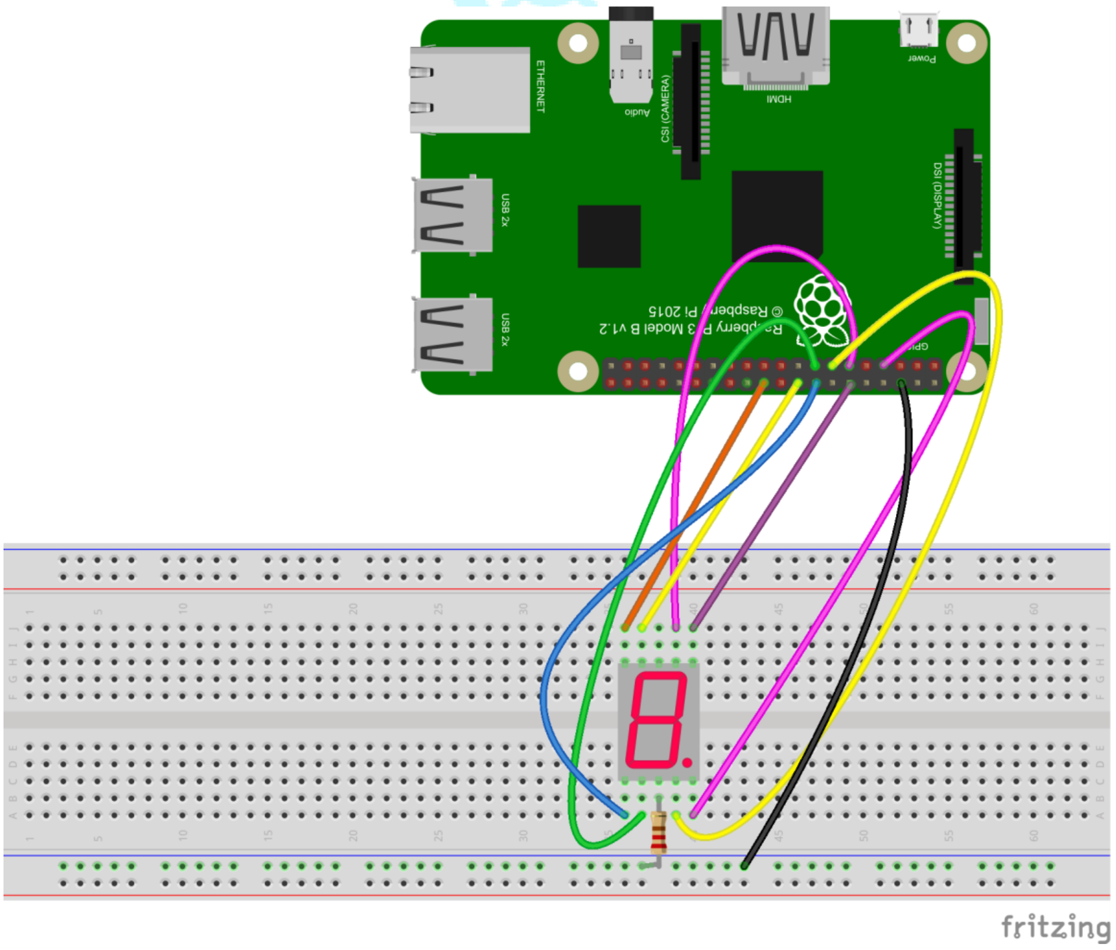
Key function:

- **void digitalWriteByte (int value)**

This writes the 8-bit byte supplied to the first 8 GPIO pins. It’s the fastest way to set all 8 bits at once to a particular value, although it still takes two write operations to the Pi’s GPIO hardware.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/07_segment/segment.c)

Step 3: Compile

```
$ gcc segment.c -o segment -lwiringPi
```

Step 4: Run

```
$ sudo ./segment
```

For Python users:

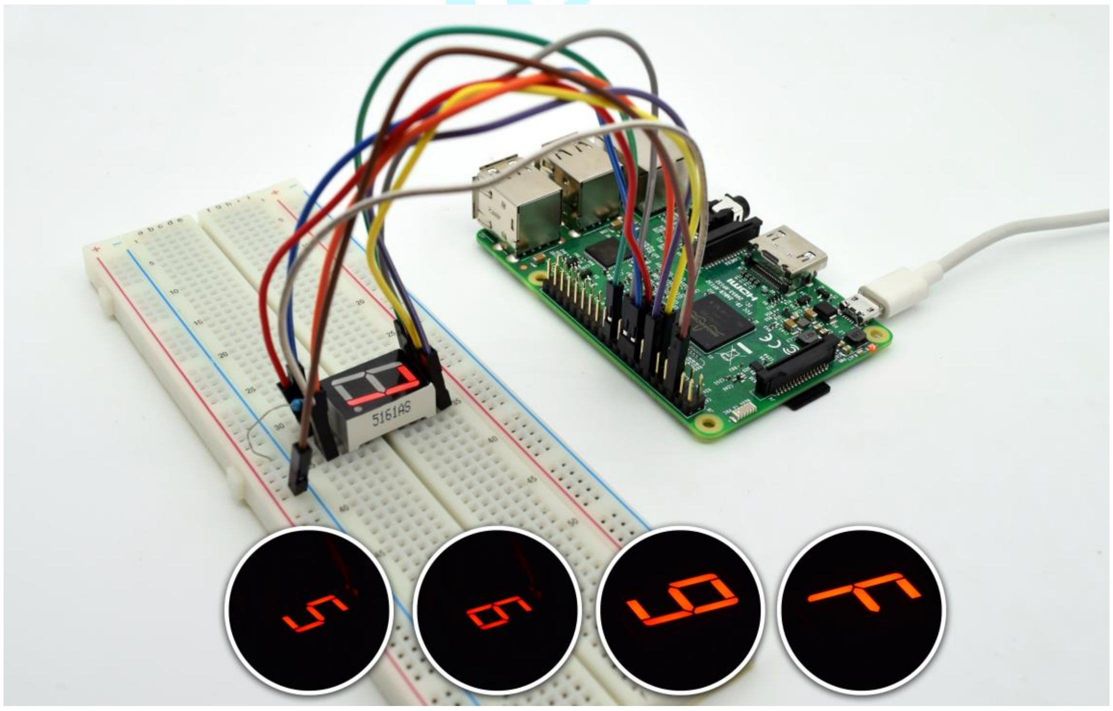
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/07_segment.py)

Step 3: Run

```
$ sudo python 07_segment.py
```

Now, you should see the number 0~9 and character A~F are displayed in turn on the segment display.



Summary

Through this lesson, you should have learned the principle and programming of the segment display. You can use what you've learned in the previous lessons to modify the code provided in this lesson to make cooler works.

Lesson 8 How to drive a 7-segment display with 74HC595

Overview

In this lesson, we will program the Raspberry Pi to drive a 7-segment display based on 74HC595.

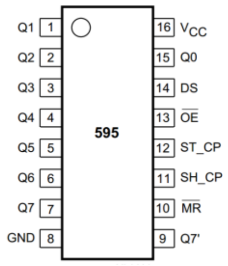
Requirement

- 1* Raspberry Pi
- 1* 220Ω Resistor
- 1* 7-Segment display
- 1* 74HC595
- 1* Breadboard
- Several Jumper wires

Principle

The 74HC595 is an 8-stage serial shift register with a storage register and 3-state outputs. The shift register and storage register have separate clocks. Data is shifted on the positive-going transitions of the SH_CP input. The data in each register is transferred to the storage register on a positive-going transition of the ST_CP input. The shift register has a serial input (DS) and a serial standard output (Q7') for cascading. It is also provided with asynchronous reset (active LOW) for all 8 shift register stages. The storage register has 8 parallel 3-state bus driver outputs. Data in the storage register appears at the output whenever the output enable input (OE) is LOW.

In this experiment, only 3 pins of the Raspberry Pi are used for controlling the dot-matrix display thanks to the 74HC595.



The function of each pin:

DS: Serial data input

Q0-Q7: 8-bit parallel data output

Q7' : Series data output pin, always connected to DS pin of the next 74HC595

OE: Output enable pin, effective at low level, connected to the ground directly

MR: Reset pin, effective at low level, directly connected to 5V high level in practical applications

SH_CP: Shift register clock input

ST_CP: storage register clock input

To save the Raspberry Pi's GPIO, the driver IC 74HC595 is used in this experiment.

Key function:

- sr595Setup (pinBase, numPins, dataPin, clockPin, latchPin)

pinBase is the base pin that you want your shift registers to appear at. The example below uses 100. *numPins* here can be from 1 to 32 – 8 pins per 74×585.

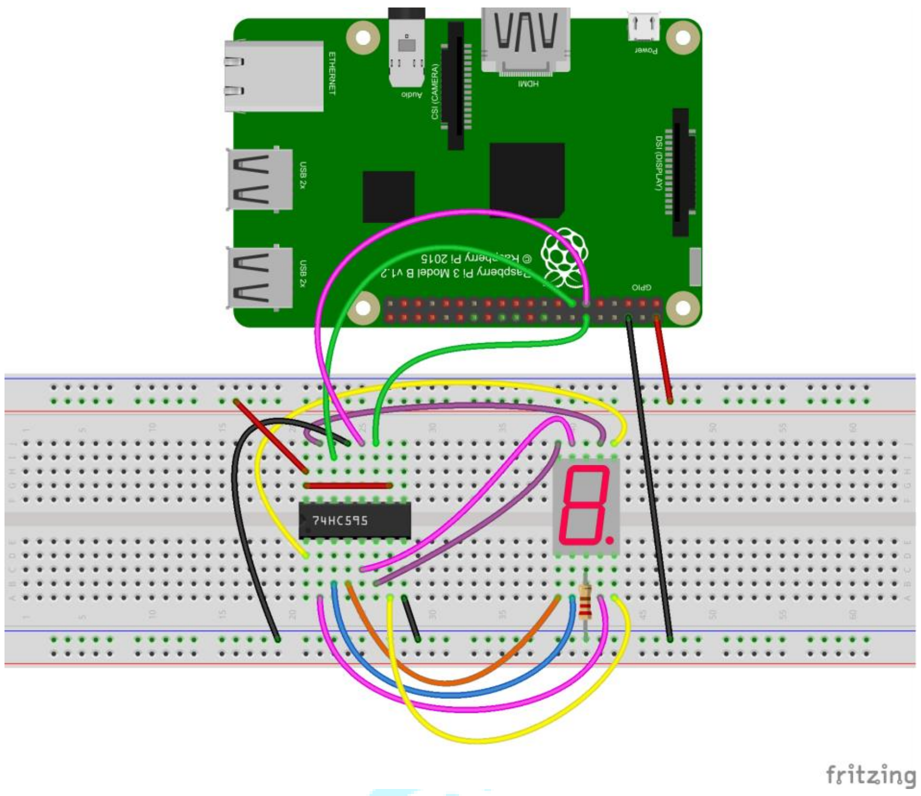
The *dataPin* is connected to the DS pin (14), the *clockPin* is connected to the SHCP pin (11) and the *latchPin* is connected to the STCP pin (12).

If connecting more 74×595's together then you connect the SHCP and STCP pins together and the Q7S output pin (9) to the DS pin on the next one up the line. Data bit zero is Q0 on the first 74×595.

Pins MR (10) should be connected to Vcc, OE (13) connected to 0v, Pin 16 is Vcc and 8 is 0v/Ground.

Procedures

Step 1: Build the circuit(Make sure that the circuit connection is correct and then power on, otherwise it may cause the chips burned.)



C user:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/08_segment_595/segment_595.c)

Step 3: Compile

```
$ gcc segment_595.c -o segment_595 -lwiringPi
```

Step 4: Run

```
$ sudo ./segment_595
```

Python user:

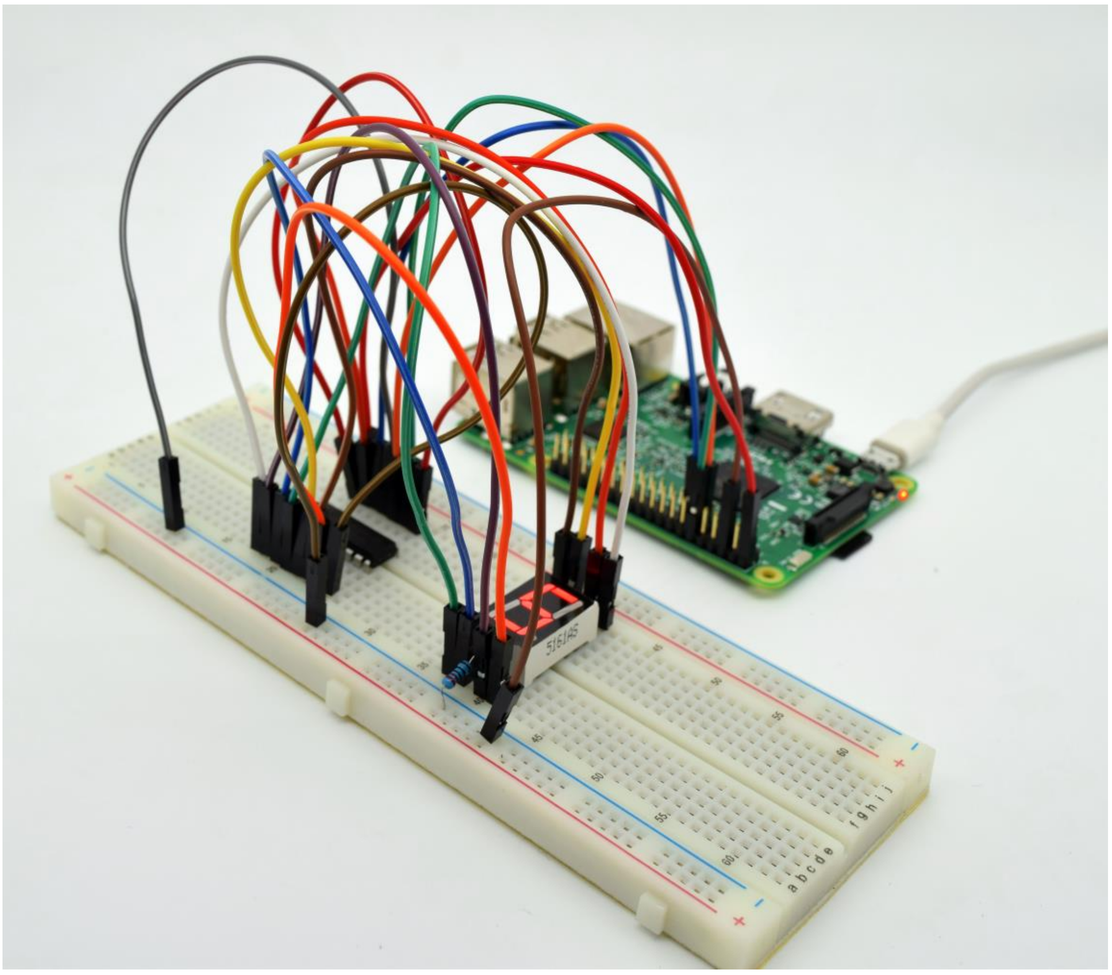
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/08_segment_595.py)

Step 3: Run

```
$ sudo python 08_segment_595.py
```

Now, you should see the number 0~9 and character A~F are displayed in turn on the segment display.


5161AS

Lesson 9 LCD1602

Overview

In this lesson, we will learn how to use a character display device - LCD1602 on the Raspberry Pi platform. We first make the LCD1602 display a string "Hello Geeks!" scrolling, and then display “Adeept” and “www.adeept.com” statically.

Components

- 1* Raspberry Pi
- 1* LCD1602
- 1* 10KΩ Potentiometer
- 1* Breadboard
- Several jumper wires

Principle

LCD1602 is a kind of character LCD display. The LCD has a parallel interface, meaning that the microcontroller has to manipulate several interface pins at once to control the display. The interface consists of the following pins:

● A register select (RS) pin that controls where in the LCD's memory you're writing data to. You can select either the data register, which holds what goes on the screen, or an instruction register, which is where the LCD's controller looks for instructions on what to do next.

● A Read/Write (R/W) pin that selects reading mode or writing mode

● An Enable pin that enables writing to the registers

● 8 data pins (D0-D7). The status of these pins (high or low) is the bits that you're writing to a register when you write, or the values when you read.

● There are also a display contrast pin (Vo), power supply pins (+5V and Gnd) and LED Backlight (Bklt+ and BKlt-) pins that you can use to power the LCD, control the display contrast, and turn on or off the LED backlight respectively.

The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register. The wiringPiDev Library simplifies this for you, so you don't need to know the low-level instructions.

The Hitachi-compatible LCDs can be controlled in two modes: 4-bit or 8-bit. The 4-bit mode requires six I/O pins from the Raspberry Pi, while the 8-bit mode requires 10 pins. For displaying text on the screen, you can do most everything in 4-bit mode, so example shows how to control a 2x16 LCD in 4-bit mode.

A potentiometer, informally a pot, is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.

Key functions:

- int lcdInit (int rows, int cols, int bits, int rs, int strb, int d0, int d1, int d2, int d3, int d4, int d5, int d6, int d7)

This is the main initialisation function and must be called before you use any other LCD functions.

Rows and cols are the rows and columns on the display (e.g. 2, 16 or 4,20). Bits is the number of bits wide on the interface (4 or 8). The rs and strb represent the pin numbers of the displays RS pin and Strobe (E) pin. The parameters d0 through d7 are the pin numbers of the 8 data pins connected from the Pi to the display. Only the first 4 are used if you are running the display in 4-bit mode.

The return value is the 'handle' to be used for all subsequent calls to the lcd library when dealing with that LCD, or -1 to indicate a fault. (Usually incorrect parameters)

- lcdPosition (int handle, int x, int y)

Set the position of the cursor for subsequent text entry. x is the column and 0 is the left-most edge. y is the line and 0 is the top line.

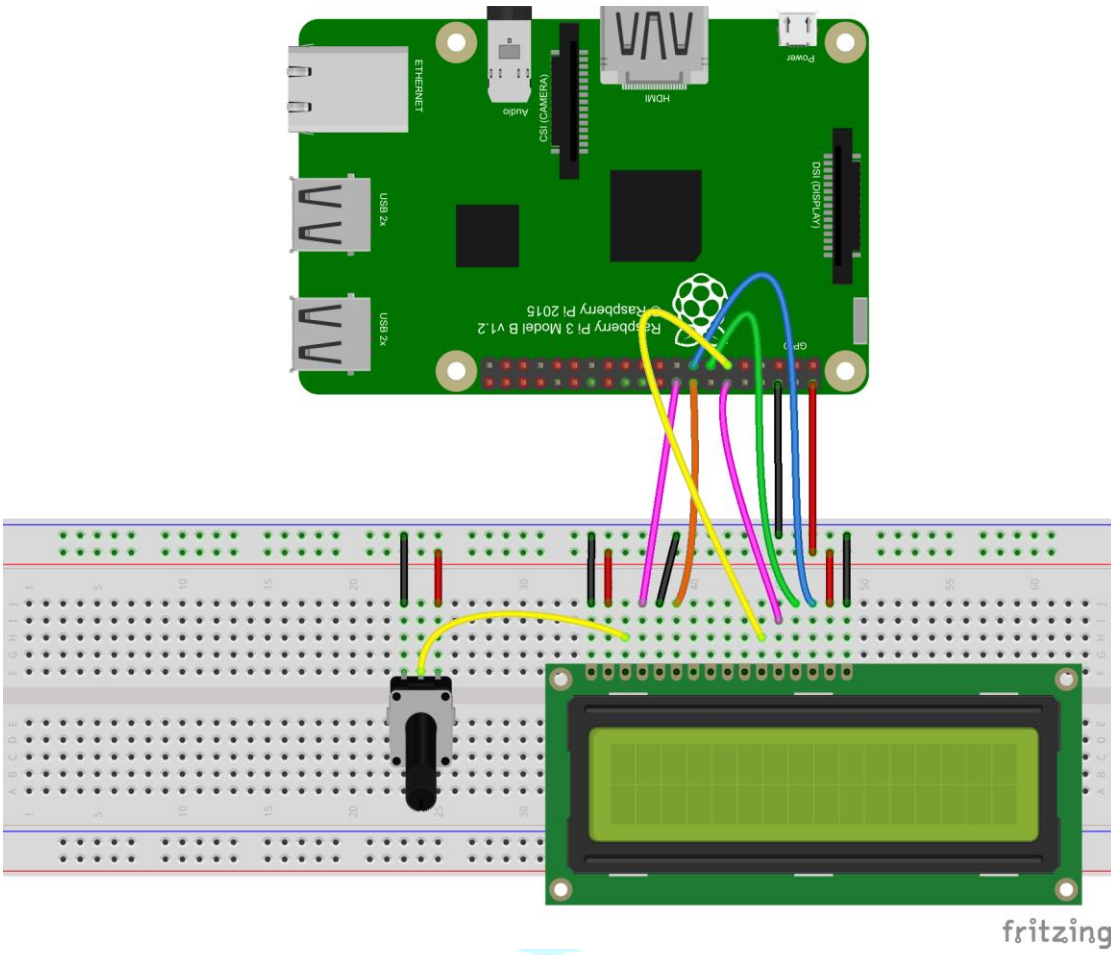
- lcdPuts (int handle, const char *string)
- lcdPrintf (int handle, const char *message, ...)
- lcdPutchar (int handle, unsigned char data)

These output a single ASCII character, a string or a formatted string using the usual printf formatting commands.

At the moment, there is no clever scrolling of the screen, but long lines will wrap to the next line, if necessary.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/09_lcd1602/lcd1602_2.c)

Step 3: Compile

```
$ gcc lcd1602_2.c -o lcd1602_2 -lwiringPi -lwiringPiDev
```

Step 4: Run

```
$ sudo ./lcd1602_2
```

Python users:

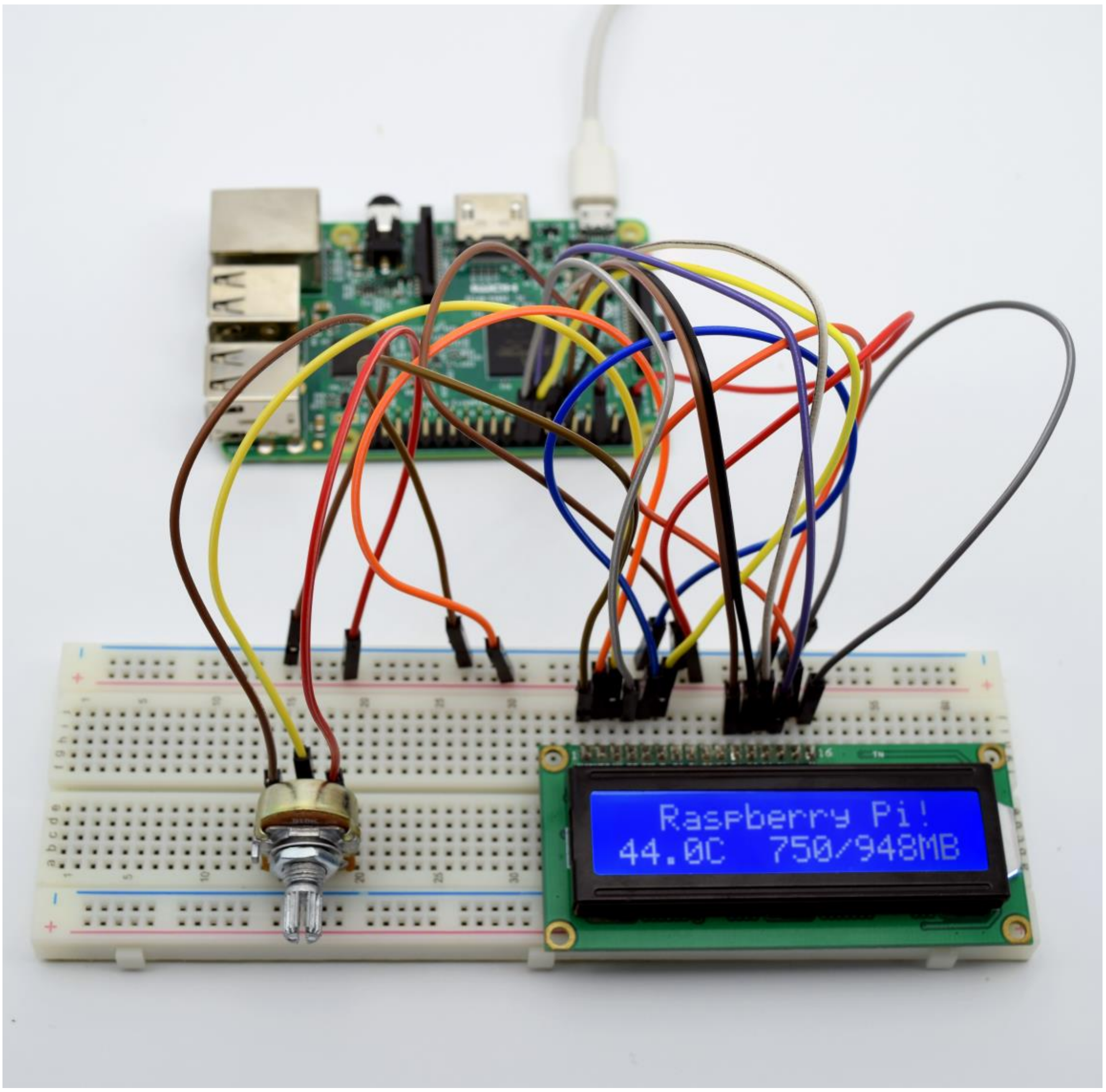
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/09_lcd1602.py)

Step 3: Run

```
$ sudo python 09_lcd1602.py
```

Now, you can see the string "Hello Geeks!" shown on the LCD1602 scrolling, and then the string "Adeept" and "www.adeept.com" displayed statically.



Summary

After learning the experiment, you should have already mastered the driver of the LCD1602. Now you can make something more interesting based on this lesson and the previous lessons learned.

Lesson 10 Photoresistor

Overview

In this lesson, we will learn how to measure the light intensity by photoresistor and display the measurement result on the screen.

Components

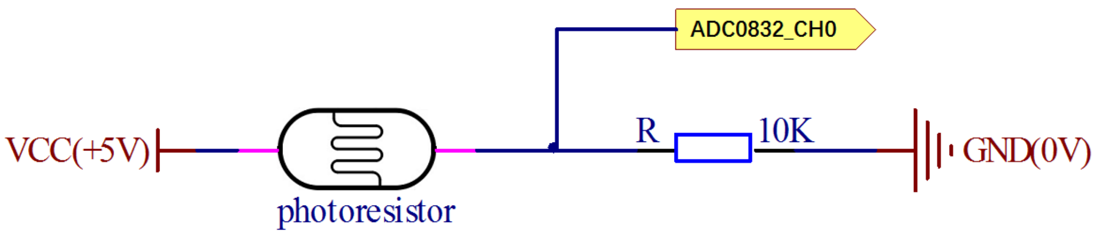
- 1* Raspberry Pi
- 1* ADC0832
- 1* Photoresistor
- 1* 10KΩ Resistor
- 1* Breadboard
- Several jumper wires

Principle

A photoresistor is a light-controlled variable resistor. The resistance of a photoresistor decreases with the increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits.

A photoresistor is made of a high resistance semiconductor. In the dark, it can show a resistance as high as a few megohms (MΩ), while in the light, its resistance can be as low as a few hundred ohms. If the incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor will give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering the resistance. The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices. Moreover, unique photoresistors may react substantially differently to photons within certain wavelength bands.

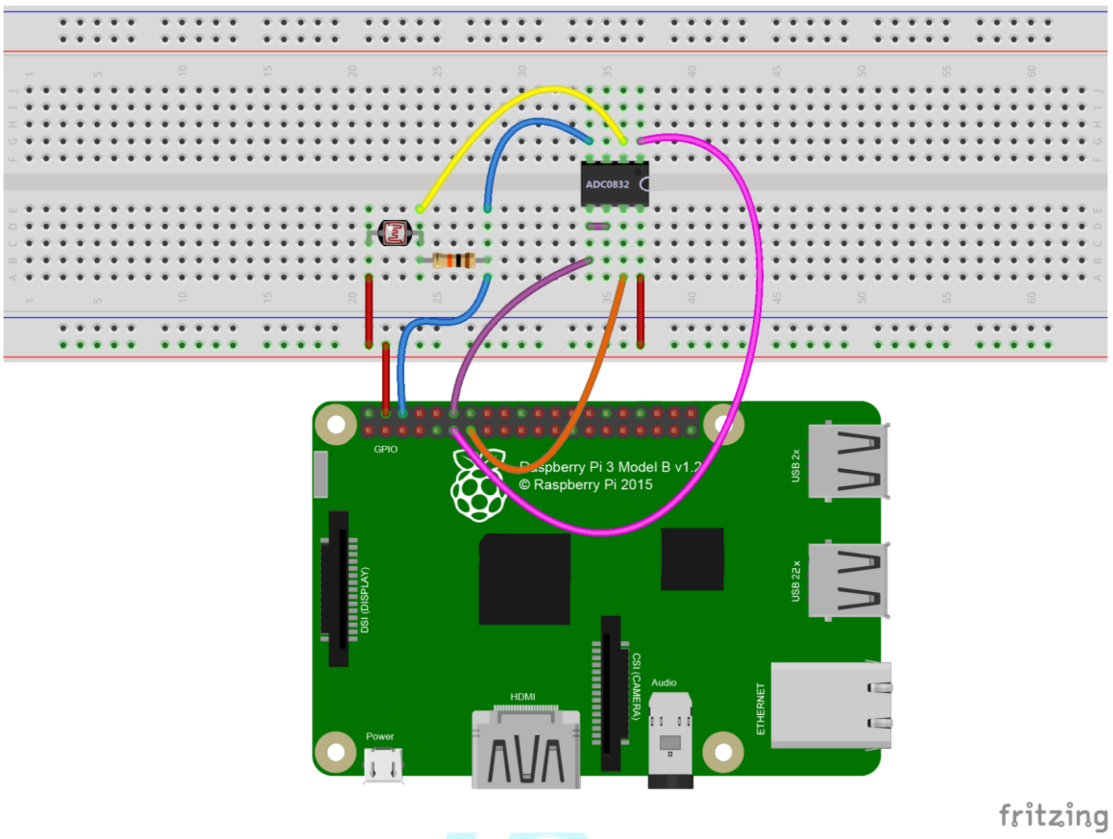
The schematic diagram of this experiment is as shown below:



With the increase of the light intensity, the resistance of the photoresistor will decrease. The voltage of the GPIO port in the above figure will become high.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/10_photoresistor/photoresistor.c)

Step 3: Compile

```
$ gcc photoresistor.c -o photoresistor -lwiringPi
```

Step 4: Run

```
$ sudo ./photoresistor
```

For Python users:

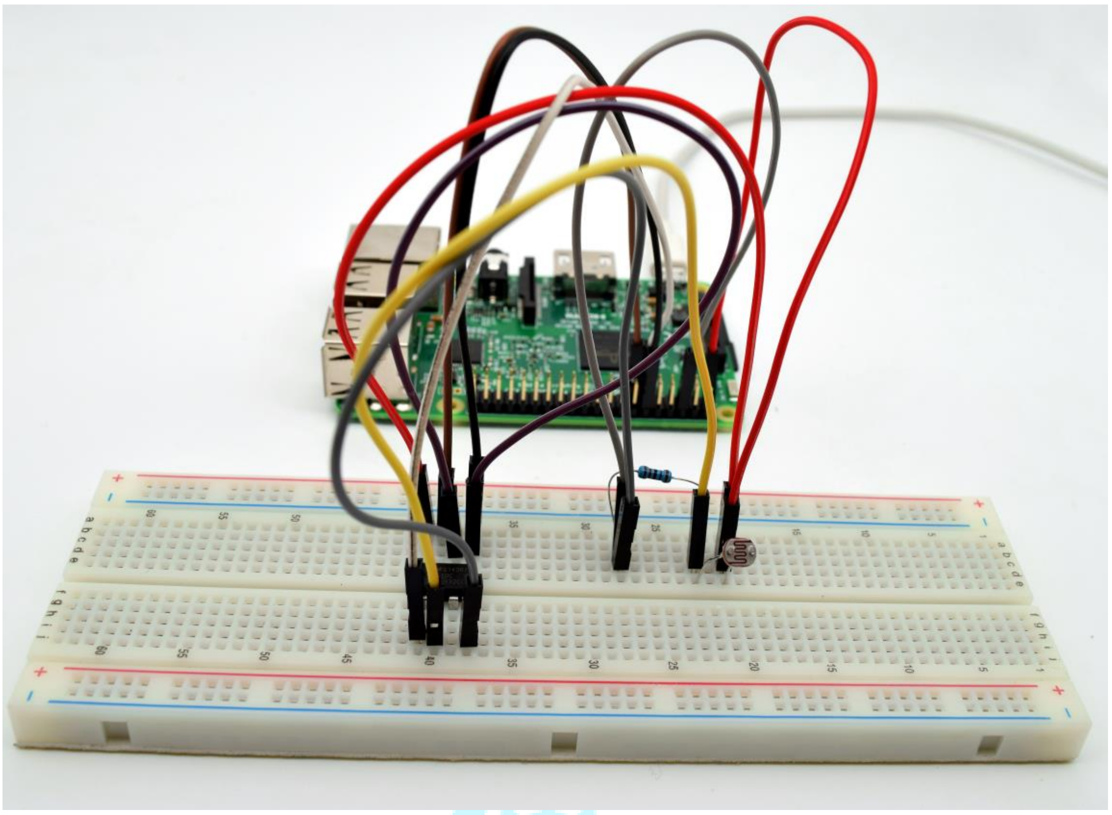
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/10_photoresistor.py)

Step 3: Run

```
$ sudo python 10_photoresistor.py
```

Now, when you try to cover the photoresistor, you will find that the value displayed on the screen decreasing. On the contrary, when you shine the photoresistor with strong light, the value displayed will increase.



Summary

By learning this lesson, you should have learned how to detect the ambient light intensity with the photoresistor. You can take full advantage of your own wisdom and make more original works based on your gains in this and previous experiments.

Lesson 11 Thermistor

Overview

In this lesson, we will learn how to use a thermistor to collect the temperature data by programming the Raspberry Pi and ADC0832.

Components

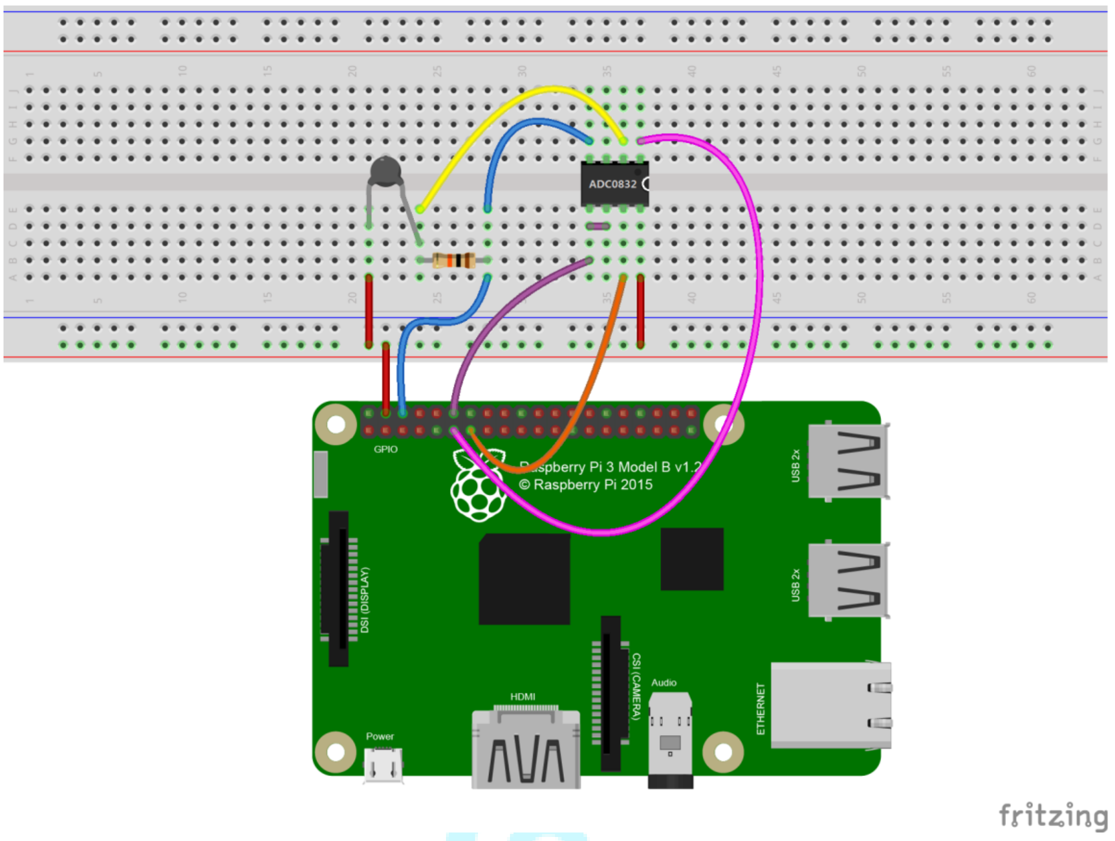
- 1* Raspberry Pi
- 1* ADC0832
- 1* Thermistor
- 1* 10KΩ Resistor
- 1* Breadboard
- Several jumper wires

Principle

A thermistor is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors. When the temperature increases, the thermistor resistance decreases; when the temperature decreases, the thermistor resistance increases. It can detect the ambient temperature changes in real time. In the experiment, we need an analog-digital converter ADC0832 to convert analog signal into digital signal.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/11_thermistor/thermistor.c)

Step 3: Compile

```
$ gcc thermistor.c -o thermistor -lwiringPi
```

Step 4: Run

```
$ sudo ./thermistor
```

For Python users:

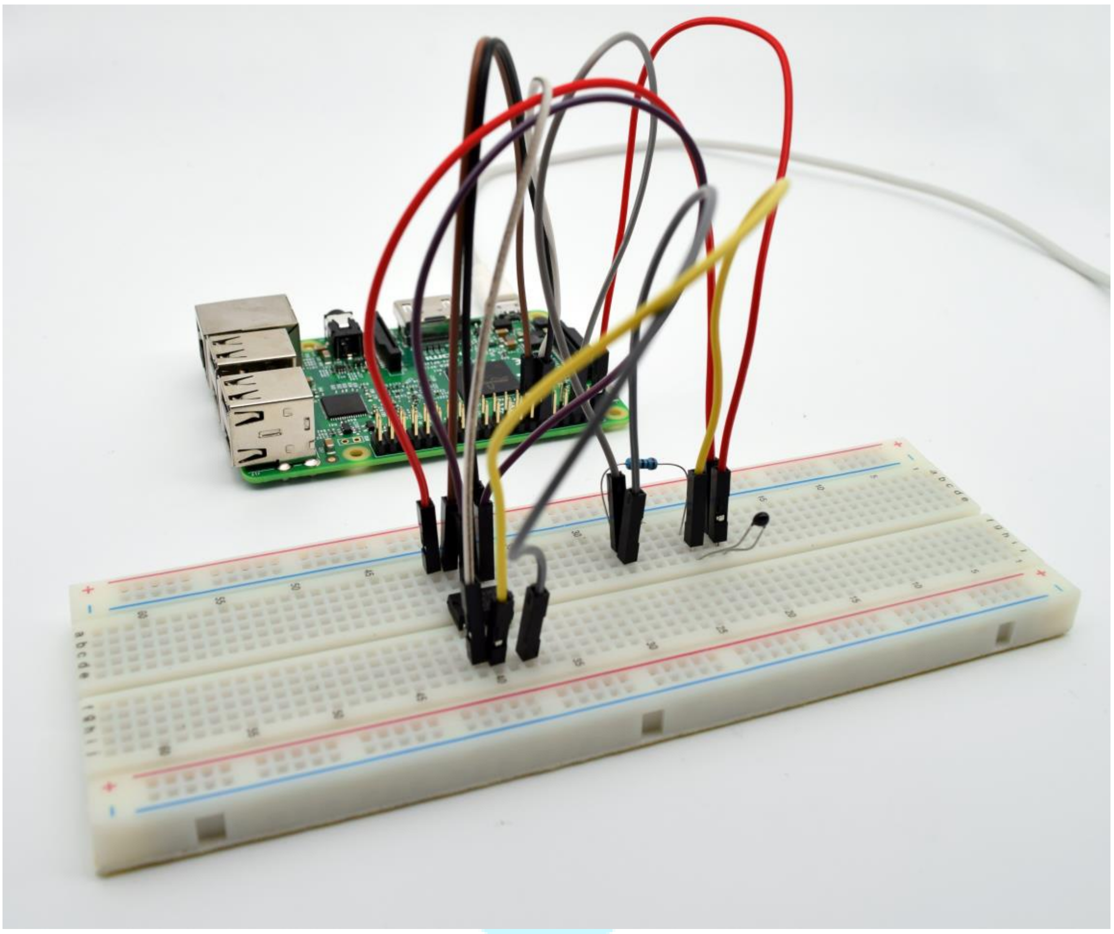
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/11_thermistor.py)

Step 3: Run

```
$ sudo python 11_thermistor.py
```

Now, touch the thermistor and you can see the current temperature value displayed on the screen, which changes accordingly.



Lesson 12 Controlling an LED Through LAN

Overview

In this lesson, we will introduce TCP and socket, and then how to program the Raspberry Pi to control an LED through the local area network (LAN).

Components

- 1* Raspberry Pi
- 1* LED
- 1* 220Ω Resistor
- 1* Breadboard
- Several jumper wires

Principle

1. TCP

The Transmission Control Protocol (TCP) is a core protocol of the Internet Protocol Suite. It originated in the initial network implementation in which it complemented the Internet Protocol (IP). Therefore, the entire suite is commonly referred to as TCP/IP. TCP provides reliable, ordered, and error-checked delivery of a stream of octets between applications running on hosts communicating over an IP network. TCP is the protocol that major Internet applications such as the World Wide Web, email, remote administration and file transfer rely on. Applications that do not require reliable data stream service may use the User Datagram Protocol (UDP), which provides a connectionless datagram service that emphasizes reduced latency over reliability.

2. Socket

A network socket is an endpoint of an inter-process communication across a computer network. Today, most communication between computers is based on the Internet Protocol; therefore most network sockets are Internet sockets.

A socket API is an application programming interface (API), usually provided by the operating system, that allows application programs to control and use network sockets. Internet socket APIs are usually based on the Berkeley sockets standard.

A socket address is the combination of an IP address and a port number, much like one end of a telephone connection is the combination of a phone number and a particular extension. Based on this address, internet sockets deliver incoming data packets to the appropriate application process or thread.

Several Internet socket types are available:

1. Datagram sockets, also known as connectionless sockets, which use User Datagram Protocol (UDP).

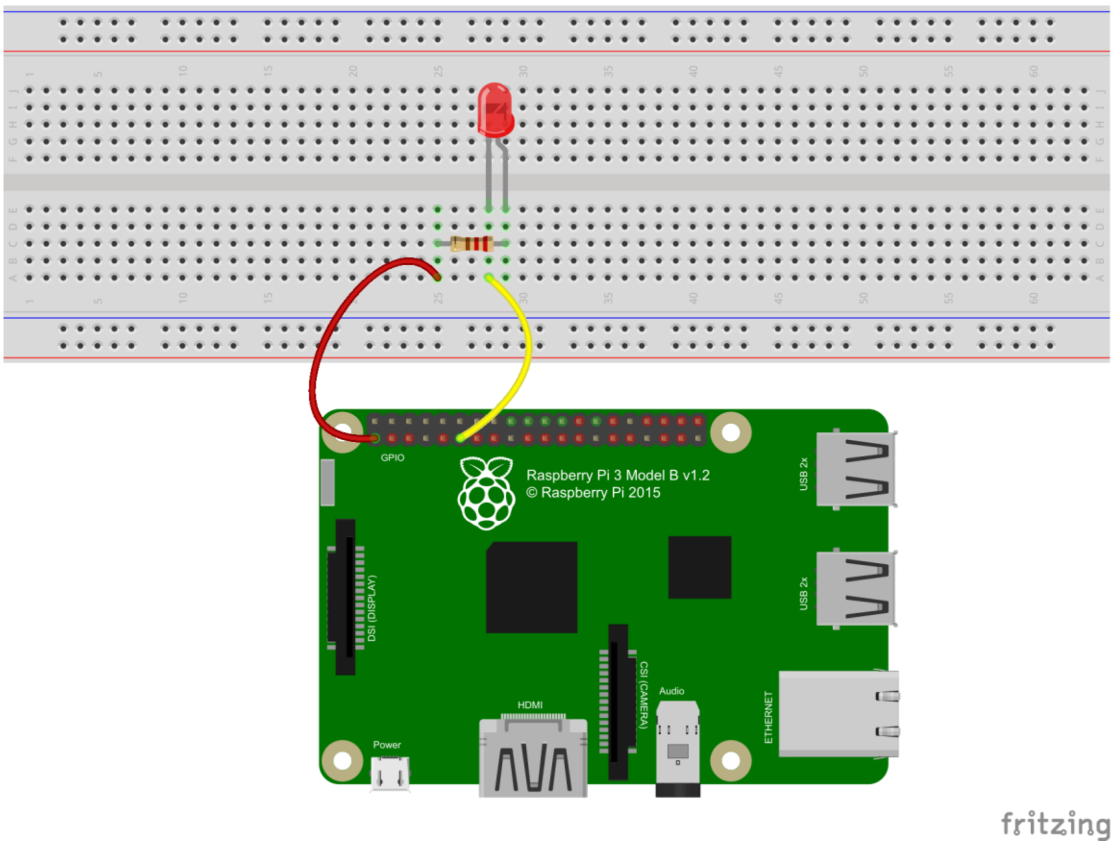
2. Stream sockets, also known as connection-oriented sockets, which use Transmission Control Protocol (TCP) or Stream Control Transmission Protocol (SCTP).

3. Raw sockets (or Raw IP sockets), typically available in routers and other network equipment. Here the transport layer is bypassed, and the packet headers are made accessible to the application.

In this experiment, our program is based on stream socket, and the program is divided into two parts, the client and the server. The server routine is run on the Raspberry Pi, and the client routine is run on the PC. So you can send command to the server through the client, and then control the LED connected to the Raspberry Pi.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the server code with vim or nano on the Raspberry Pi.

(Code path: /home/Starter_Kit_C_Code_for_RPi/12_TCPCtrlLed/ledServer.c)

Step 3: Compile(On Raspberry Pi)

```
$ gcc ledServer.c -o ledServer -lwiringPi
```

Step 4: Edit and save the client code with vim or nano on the PC.

(Code path: /home/Starter_Kit_C_Code_for_RPi/12_TCPCtrlLed/ledClient.c)

Step 5: Compile (On Linux PC)

```
$ gcc ledClient.c -o ledClient
```

Step 6: Run

```
$ sudo ./ledServer
```
(On Raspberry Pi)

```
$ ./ledClient 192.168.1.188
```
(On PC, modify the IP Address to your Raspberry Pi's IP Address)

Now, input "ON" in the terminal and then press Enter. The LED connected to the Raspberry Pi will light up; input "OFF" and the LED goes out.

For Python users:

Step 2: Edit and save the server code with vim or nano on the Raspberry Pi.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/12_TCPCtrlLed/ledServer.py)

Step 3: Edit and save the client code with vim or nano on the PC.

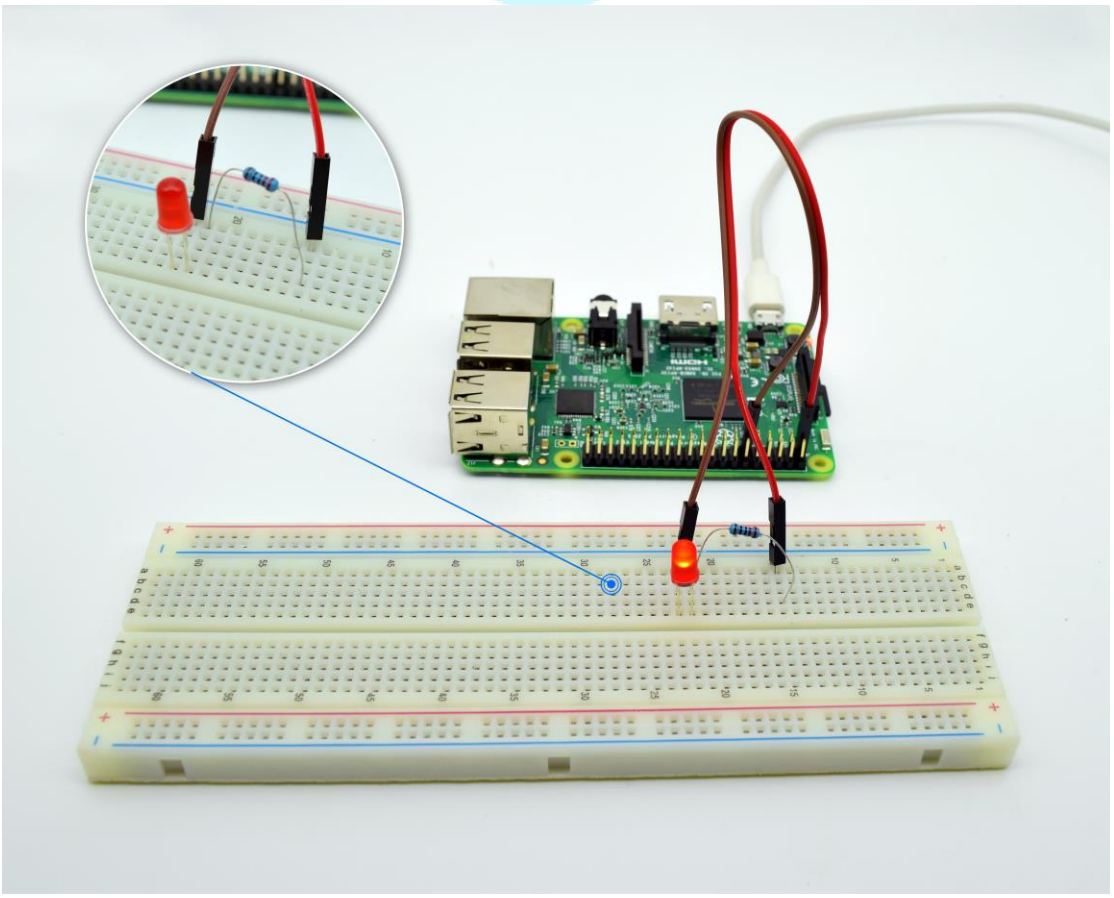
(Code path: /home/Starter_Kit_Python_Code_for_RPi/12_TCPCtrlLed/ledClient.py)

Step 4: Run

```
$ sudo python ledServer.py
```
(On Raspberry Pi)

```
$ python ledClient.py
```
(On PC)

Now, input "ON" in the terminal and then press Enter. The LED connected to the Raspberry Pi will light up; input "OFF" and the LED goes out.



Summary

By learning this lesson, you should have mastered the basic principles of inter-computer communication. This lesson can help you open the door to learn the Internet of Things (IoT).

Lesson 13 DC Motor

Overview

In this comprehensive experiment, we will learn how to control the state of a DC motor with Raspberry Pi. The state of DC motors includes its forward, reverse, acceleration, deceleration and stop.

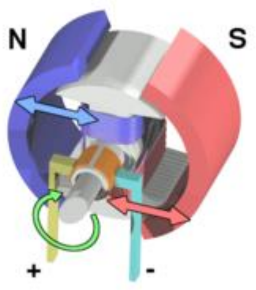
Components

- 1* Raspberry Pi
- 1* L9110 DC Motor Driver
- 1* DC motor
- 4* Button
- 1* LED
- 1* 220Ω Resistor
- 1* Capacitor (104, 0.1uF)
- 1* Breadboard
- Several jumper wires

Principle

1. DC motor

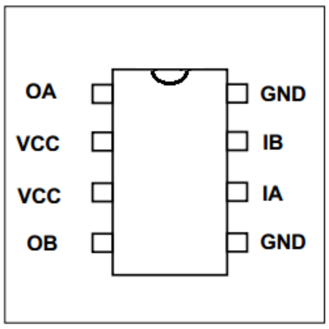
A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.



DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances.

2. L9110

L9110 is a driver chip which is used to control and drive motor. The chip has two TTL/CMOS compatible input terminals, and possesses the property of anti-interference: it has high current driving capability, two output terminals that can directly drive DC motor, each output port can provide 750~800mA dynamic current, and its peak current can reach 1.5~2.0A; L9110 is widely applied to various motor drives, such as toy cars, stepper motor, power switches and other electric circuits.



OA, OB: These are used to connect the DC motor.

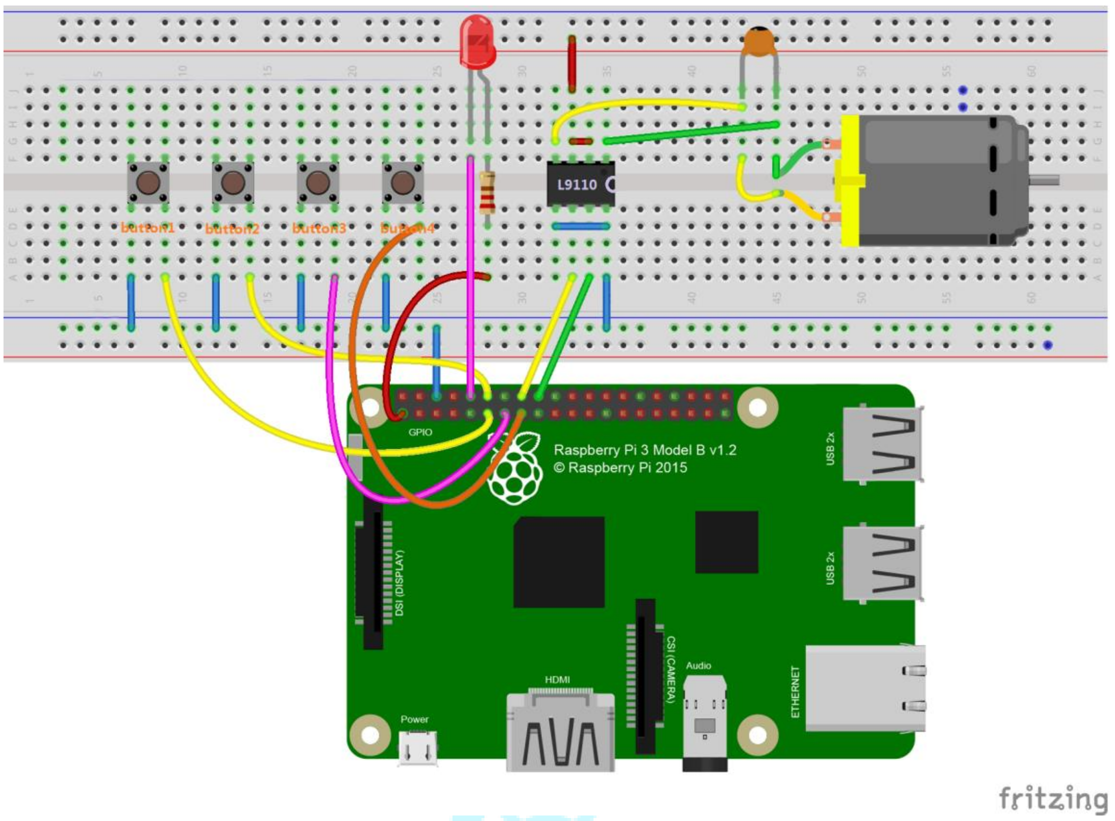
VCC: Power supply (+5V)

GND: The cathode of the power supply (Ground).

IA, IB: The input terminal of drive signal.

Procedures

Step 1: Build the circuit



For C language users:

Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_C_Code_for_RPi/13_motor/motor.c)

Step 3: Compile

```
$ gcc motor.c -o motor –lwiringPi -lpthread
```

Step 4: Run

```
$ sudo ./motor
```

For Python users:

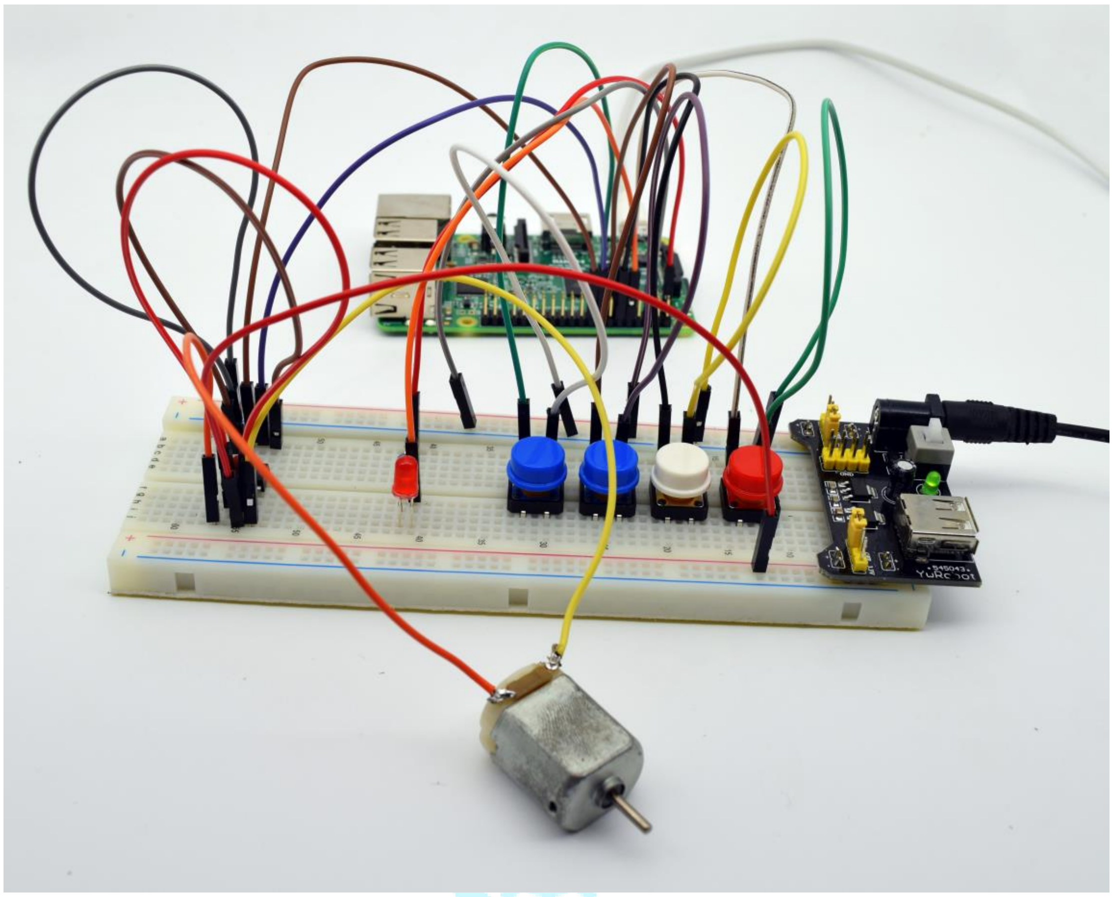
Step 2: Edit and save the code with vim or nano.

(Code path: /home/Starter_Kit_Python_Code_for_RPi/13_motor.py)

Step 3: Run

```
$ sudo python 13_motor.py
```

Press button 1 to stop or run the DC motor; press button 2 to make the DC motor move forward or reverse; press button 3 to accelerate the DC motor; press button 4 to decelerate the DC motor. When the motor is running, the LED will light up. Otherwise, the LED will stay off.



Summary

After learning, you must have grasped the basic theory and programming of the DC motor. You can not only make it move forward and reverse, but also regulate its speed. Besides, you can do some interesting applications with what you've got in this lesson and the knowledge acquired previously.

Adeept

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