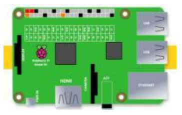
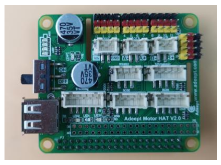
Lesson 7 How to Control WS2812 LED

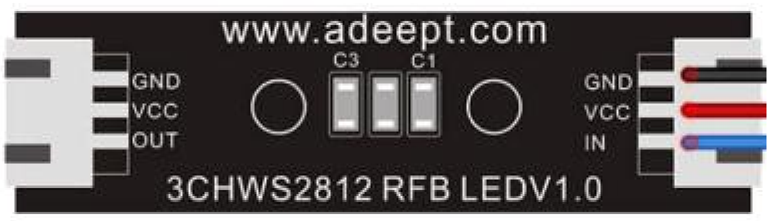
In this lesson, we will learn how to control WS2812 LED.

7.1 Components used in this course

Components	Quantity	Picture
Raspberry Pi	1	
Robot HAT	1	
3 pin wire	1	
WS2812 RGB LED	1	

7.2 Introduction of WS2812 RGB LED

WS2812 RGB module is a low-power RGB tri-color lamp with integrated current control chip. Its appearance is the same as a 5050LED lamp bead, and each element is a pixel. The pixel contains an intelligent digital interface data latch signal shaping amplifier driving circuit, and also contains a high-precision internal oscillator and a 12V high-voltage programmable constant current control part, which effectively guarantees that the color of the pixel light is highly consistent.



WS2812 LED is a very commonly used module on our robot products. There are three WS2812 LEDS on each module. Pay attention to the direction of the signal line when connecting. The signal line needs to be connected to the “IN” port of WS2812 LED after being led from the Raspberry Pi. When the next WS2812 LED needs to be connected, we connect a signal wire drawn from the "OUT" port of the previous WS2812 LED with the "IN" port of the next WS2812 LED.

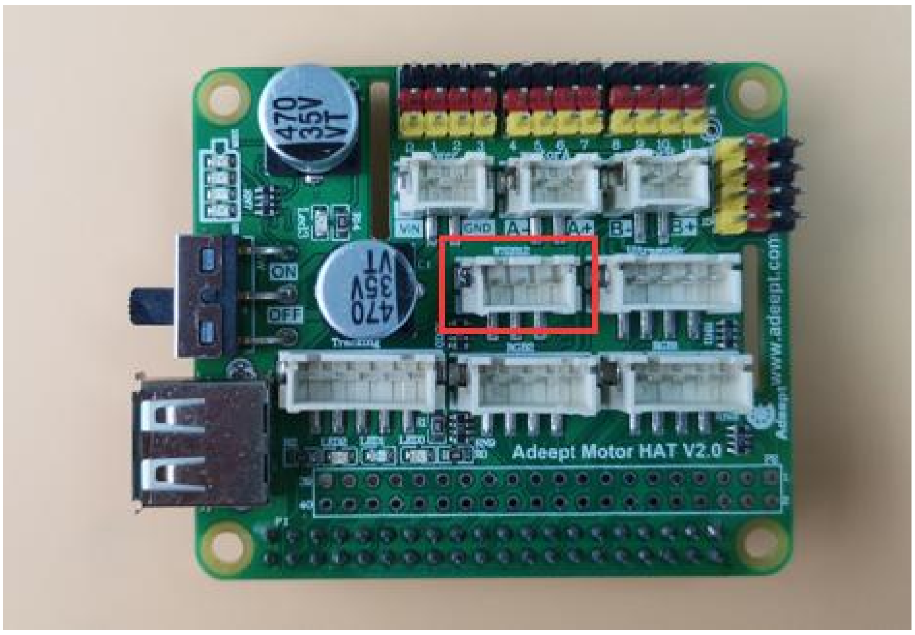
When using the Raspberry Pi to install the driver board RobotHAT, the WS2812 LED can be connected to the WS2812 interface on the RobotHAT using a 3pin cable.

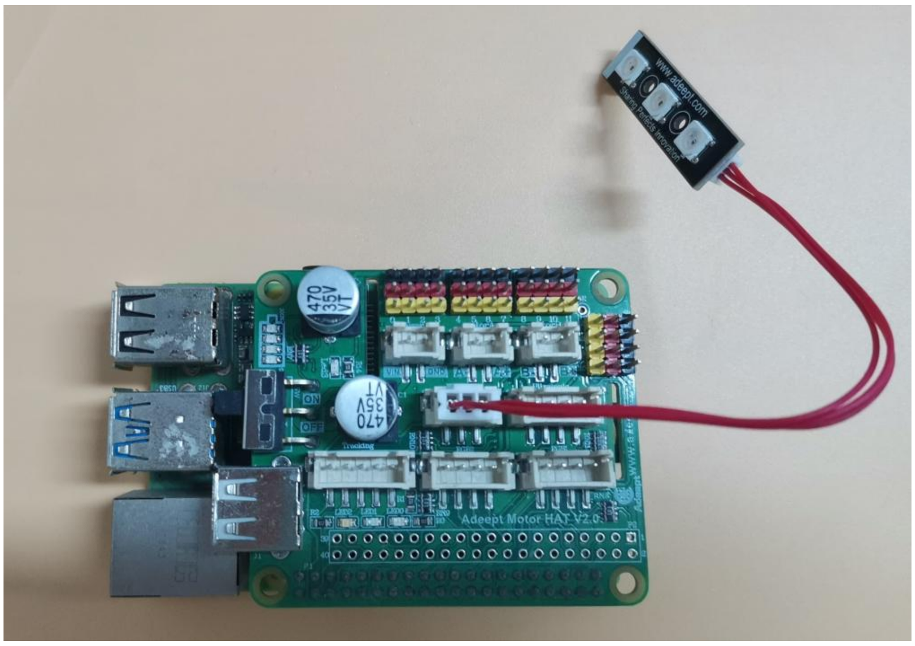
We use a third-party library [rpi_ws281x] to control the WS2812 LED. You can learn about it via https://github.com/richardghirst/rpi_ws281x.

If you connect the WS2812 LED to the WS2812 interface of Motor HAT, the signal line is equivalent to connecting to the GPIO 12 of the Raspberry Pi.

7.3 Wiring diagram (Circuit diagram)

When the WS2812 LED is in use, the IN port needs to be connected to the WS2812 port on the Motor HAT driver board, as shown in the figure below:

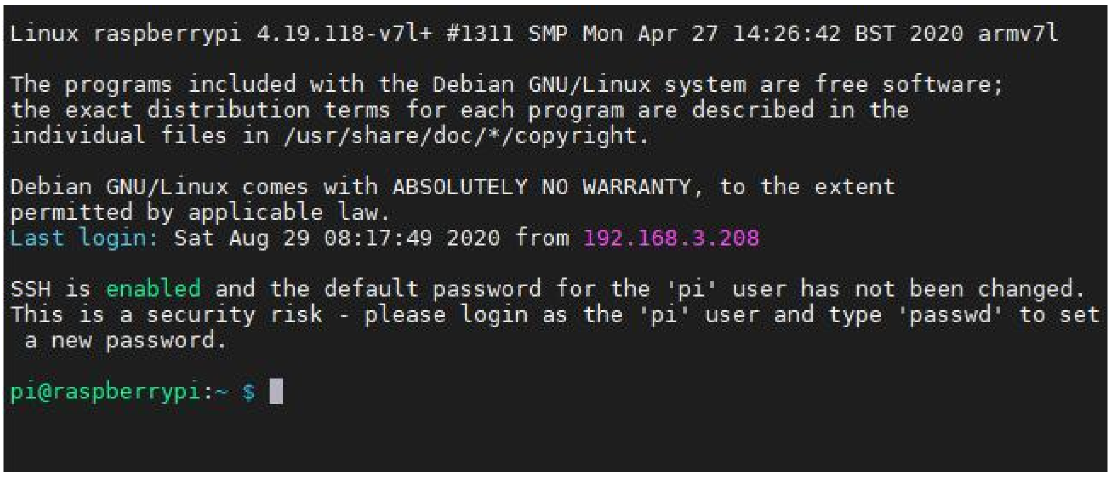

Adeept Motor HAT V2.0
www.adeept.com
ON
OFF



7.4 How to control WS2812 LED

Run the code

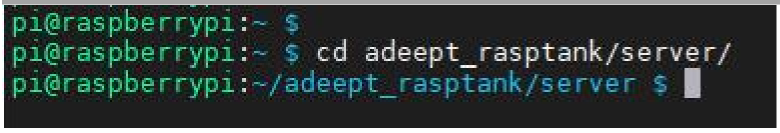
1. Remotely log in to the Raspberry Pi terminal.



```
Linux raspberrypi 4.19.118-v7l+ #1311 SMP Mon Apr 27 14:26:42 BST 2020 armv7l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sat Aug 29 08:17:49 2020 from 192.168.3.208

SSH is enabled and the default password for the 'pi' user has not been changed.
This is a security risk - please login as the 'pi' user and type 'passwd' to set
 a new password.

pi@raspberrypi:~ $
```

2. Enter the command and press Enter to enter the folder where the program is located:

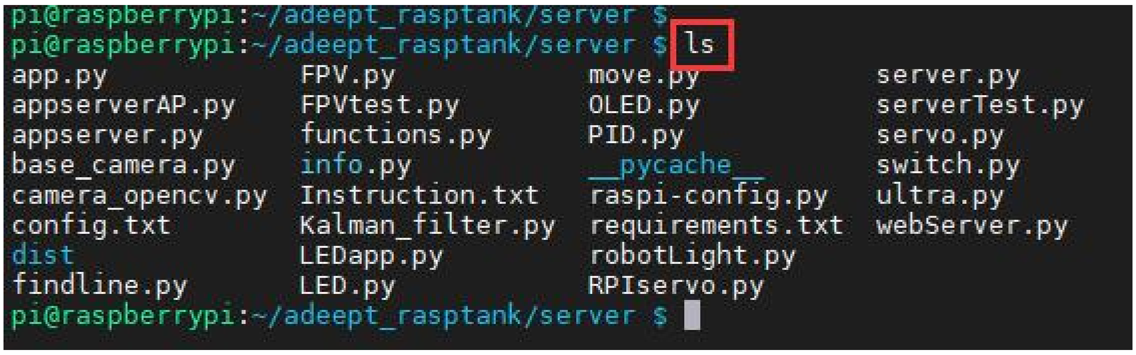
cd adeept_rasptank/server/



```
pi@raspberrypi:~ $
pi@raspberrypi:~ $ cd adeept_rasptank/server/
pi@raspberrypi:~/adeept_rasptank/server $
```

3. View the contents of the current directory file:

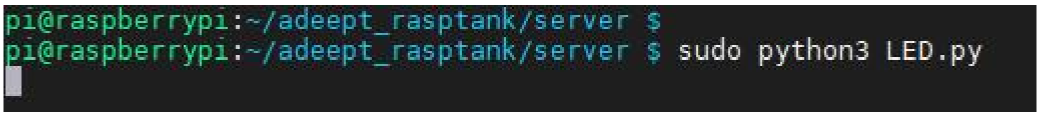
ls



```
pi@raspberrypi:~/adeept_rasptank/server $
pi@raspberrypi:~/adeept_rasptank/server $ ls
app.py            FPV.py            move.py            server.py
appserverAP.py    FPVtest.py        OLED.py            serverTest.py
appserver.py      functions.py      PID.py             servo.py
base_camera.py    info.py           __pycache__        switch.py
camera_opencv.py  Instruction.txt   raspi-config.py    ultra.py
config.txt        Kalman_filter.py  requirements.txt   webServer.py
dist              LEDapp.py         robotLight.py
findline.py       LED.py            RPIservo.py
pi@raspberrypi:~/adeept_rasptank/server $
```

4. Enter the command and press Enter to run the program:

sudo python3 LED.py



```
pi@raspberrypi:~/adeept_rasptank/server $
pi@raspberrypi:~/adeept_rasptank/server $ sudo python3 LED.py
```

5. After running the program successfully, you will observe that the WS2812 alternately flashing red, green and blue lights.

6. When you want to terminate the running program, you can press the shortcut key "Ctrl + C" on the keyboard.

7.5 Main code program

For the complete code, please refer to the file LED.py.

```
import time
from rpi_ws281x import *
```

Import dependency.

```
class LED:
        def __init__(self):
                self.LED_COUNT      = 16 #  Set to the total number of LED lights on the robot product, which can be more than the total number of LED lights connected to the Raspberry Pi
                self.LED_PIN        = 12 # Set as the input pin number of the LED lamp group
                self.LED_FREQ_HZ    = 800000
                self.LED_DMA        = 10
                self.LED_BRIGHTNESS = 255
                self.LED_INVERT     = False
                self.LED_CHANNEL    = 0

     # Use the configuration items above to create a strip
                self.strip = Adafruit_NeoPixel(
        self.LED_COUNT,
        self.LED_PIN,
        self.LED_FREQ_HZ,
        self.LED_DMA,
        self.LED_INVERT,
        self.LED_BRIGHTNESS,
        self.LED_CHANNEL
        )
    self.strip.begin()

    def colorWipe(self, R, G, B): # This function is used to change the color of the LED
        color = Color(R, G, B)
        for i in range(self.strip.numPixels()): # Only one LED light color can be set at a time, so a cycle is required
            self.strip.setPixelColor(i, color)
            self.strip.show() # After calling the show method, the color will really change
```

Build LED control class.

```
if __name__ == '__main__':
    led= LED()
    try:
        while 1:
            led.colorWipe(255, 0, 0)  #All lights turn red
            time.sleep(1)
            led.colorWipe(0, 255, 0)  # All lights turn green
            time.sleep(1)
            led.colorWipe(0, 0, 255)  # All lights turn blue
            time.sleep(1)
    except:
        LED.colorWipe(0,0,0)  #Turn off all lights
```

The above code will control all the WS2812 lights to switch among the three colors, press CTRL+C to exit the program.

If you want to control the color of a single light, you can use the following code to achieve, where i is the serial number of the light, the serial number of the first light connected to the signal line from the driver board is 0, and the serial number of the second light is 1. , And so on, R, G, B are the brightness corresponding to the three color channels:

```
LED.strip.setPixelColor(i, Color(R, G, B))

LED.strip.show()
```

Note: You must use the Color() method to pack the RGB value, and then pass it to setPixelColor().

7.6 Q&A

- If an error message appears after running the program: *RuntimeError: ws2811_init failed with code* ***-5****.(mmap() failed)*

  Please use "sudo" to run the program.

- If an error message appears after running the program: *RuntimeError: ws2811_init failed with code -3 (****Hardware revision is not supported****)*

1. Run in the Raspberry Pi command line:

```
cd ../..
```

```
sudo pip3 install rpi_ws281x --upgrade
```

2. Then run the product program:

```
sudo python3 adeept_rasptank/server/LED.py
```

Test whether it can be used. If you can run the program normally, please skip all the steps below. if an error occurs, if an error occurs， please continue with the following operations.

RuntimeError: ws2811_init failed with code -3 (Hardware revision is not supported)

3. Delete the rpi_ws281x library file:

```
sudo pip3 uninstall rpi_ws281x
```

4. Download the libraries needed to manually install the dependent libraries:

```
sudo apt-get update
```

```
sudo apt-get install gcc make build-essential python-dev scons swig
```

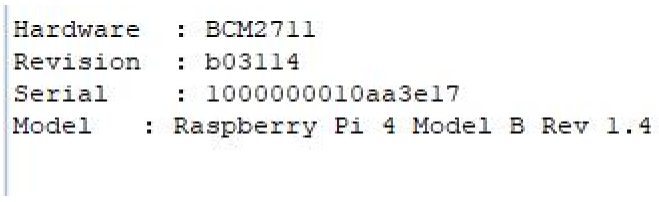
5. Download the ws2812 source code:

```
git clone https://github.com/jgarff/rpi_ws281x.git
```

6. View the CPU information of the Raspberry Pi.

```
sudo nano //proc/cpuinfo
```

Find the last few lines in the file



```
Hardware   : BCM2711
Revision   : b03114
Serial     : 1000000010aa3e17
Model    : Raspberry Pi 4 Model B Rev 1.4
```

Information to remember: (used for the file to be modified next)

Revision： b03114

Model : Raspberry Pi 4 Model B Rev 1.4

Exit via "Ctrl + X".

The above information can know the version number of the Raspberry Pi CPU: b03114

7. Modify the downloaded rpi_ws281x file.

```
sudo nano rpi_ws281x/rpihw.c
```

Add the following information, **the red part needs to be modified to your Raspberry Pi CPU**

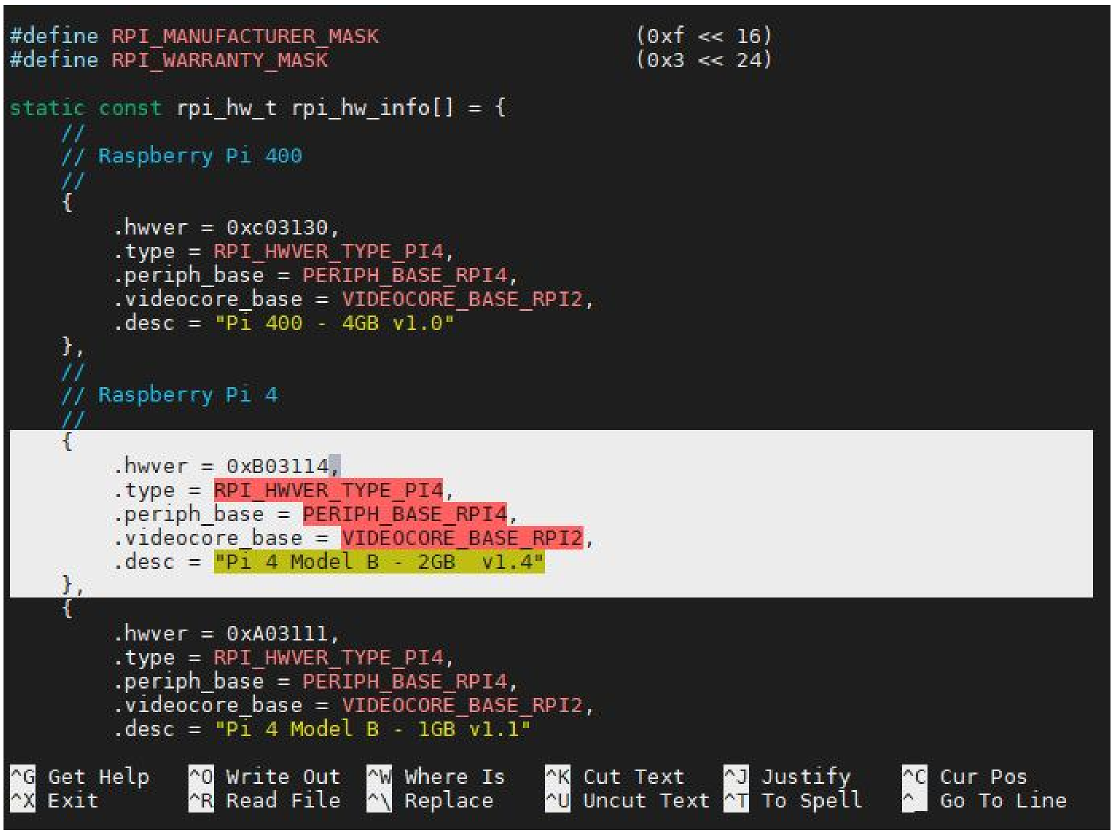
information.

```
    {

        .hwver = 0x+Revision,

        .type = RPI_HWVER_TYPE_PI4,

        .periph_base = PERIPH_BASE_RPI4,

        .videocore_base = VIDEOCORE_BASE_RPI2,

        .desc = "Pi 4 Model B - 2GB    v1.4"

   },
```

CPU information "Model: Raspberry Pi 4 Model B Rev 1.4" so write v1.4 in .desc

If your "Model: Raspberry Pi 4 Model B Rev 1.2" write v1.2 in .desc.

For example: (the white part is newly added)



```
#define RPI_MANUFACTURER_MASK                         (0xf << 16)
#define RPI_WARRANTY_MASK                             (0x3 << 24)

static const rpi_hw_t rpi_hw_info[] = {
    //
    // Raspberry Pi 400
    //
    {
        .hwver = 0xc03130,
        .type = RPI_HWVER_TYPE_PI4,
        .periph_base = PERIPH_BASE_RPI4,
        .videocore_base = VIDEOCORE_BASE_RPI2,
        .desc = "Pi 400 - 4GB v1.0"
    },
    //
    // Raspberry Pi 4
    //
    {
        .hwver = 0xB03114,
        .type = RPI_HWVER_TYPE_PI4,
        .periph_base = PERIPH_BASE_RPI4,
        .videocore_base = VIDEOCORE_BASE_RPI2,
        .desc = "Pi 4 Model B - 2GB  v1.4"
    },
    {
        .hwver = 0xA03111,
        .type = RPI_HWVER_TYPE_PI4,
        .periph_base = PERIPH_BASE_RPI4,
        .videocore_base = VIDEOCORE_BASE_RPI2,
        .desc = "Pi 4 Model B - 1GB v1.1"
^G Get Help    ^O Write Out   ^W Where Is    ^K Cut Text    ^J Justify     ^C Cur Pos
^X Exit        ^R Read File   ^\ Replace     ^U Uncut Text  ^T To Spell    ^_ Go To Line
```

Save and exit with "Ctrl + X", "Y", "Enter". (文件中已有的树莓派 CPU 版本号是官方已经兼容的)

8. Compile the downloaded code.

```
cd rpi_ws281x/
```

```
sudo scons
```

9. Install rpi_ws281x dependency library.

```
cd python
```

```
sudo python3 setup.py build
```

```
sudo python3 setup.py install
```

10. Update dependent libraries.

```
sudo pip3 install rpi-ws281x --upgrade
```

11. Run the program code:

```
cd ../..
```

```
sudo python3 adeept_rasptank/server/LED.py
```

If the above method is not compatible with your Raspberry Pi version (for example: c03114), you need to wait for the compatibility update of ws281x dependent libraries, so this module is temporarily not available. This module needs to be shielded in order not to affect other functions of the robot.

Modify the **adept_rasptank/server/robotLight.py** file to the following content.

```
#!/usr/bin/env python3
# Description : Control lights
import time
import RPi.GPIO as GPIO
import sys
# from rpi_ws281x import *
import threading

class RobotLight(threading.Thread):
    def __init__(self, *args, **kwargs):
        self.LED_COUNT      = 16      # Number of LED pixels.
        self.LED_PIN        = 12      # GPIO pin connected to the pixels (18 uses PWM!).
        self.LED_FREQ_HZ    = 800000  # LED signal frequency in hertz (usually 800khz)
        self.LED_DMA        = 10      # DMA channel to use for generating signal (try 10)
        self.LED_BRIGHTNESS = 255    # Set to 0 for darkest and 255 for brightest
         self.LED_INVERT   = False    # True to invert the signal (when using NPN transistor leve
 shift)
        self.LED_CHANNEL    = 0     # set to '1' for GPIOs 13, 19, 41, 45 or 53
        self.colorBreathR = 0
        self.colorBreathG = 0
        self.colorBreathB = 0
        self.breathSteps = 10

        self.lightMode = 'none'     #'none' 'police' 'breath'

        GPIO.setwarnings(False)
        GPIO.setmode(GPIO.BCM)
        GPIO.setup(5, GPIO.OUT)
        GPIO.setup(6, GPIO.OUT)
        GPIO.setup(13, GPIO.OUT)

        # Create NeoPixel object with appropriate configuration.
        # self.strip = Adafruit_NeoPixel(self.LED_COUNT, self.LED_PIN, self.LED_FREQ_HZ, self.L
ED_DMA, self.LED_INVERT, self.LED_BRIGHTNESS, self.LED_CHANNEL)
        # Intialize the library (must be called once before other functions).
        # self.strip.begin()

        super(RobotLight, self).__init__(*args, **kwargs)
        self.__flag = threading.Event()
        self.__flag.clear()

    # Define functions which animate LEDs in various ways.
    def setColor(self, R, G, B):
        # """Wipe color across display a pixel at a time."""
        # color = Color(int(R),int(G),int(B))
        # for i in range(self.strip.numPixels()):
        #   self.strip.setPixelColor(i, color)
        #   self.strip.show()
            pass

    def setSomeColor(self, R, G, B, ID):
        # color = Color(int(R),int(G),int(B))
        # #print(int(R),'  ',int(G),'  ',int(B))
        # for i in ID:
        #   self.strip.setPixelColor(i, color)
        #   self.strip.show()
            pass

    def pause(self):
        # self.lightMode = 'none'
        # self.setColor(0,0,0)
        # self.__flag.clear()
        pass

    def resume(self):
        # self.__flag.set()
        pass

    def police(self):
        # self.lightMode = 'police'
        # self.resume()
        pass

    def policeProcessing(self):
        # while self.lightMode == 'police':
        #   for i in range(0,3):
        #       self.setSomeColor(0,0,255,[0,1,2,3,4,5,6,7,8,9,10,11])
        #       time.sleep(0.05)
        #       self.setSomeColor(0,0,0,[0,1,2,3,4,5,6,7,8,9,10,11])
        #       time.sleep(0.05)
        #   if self.lightMode != 'police':
        #       break
        #   time.sleep(0.1)
        #   for i in range(0,3):
        #       self.setSomeColor(255,0,0,[0,1,2,3,4,5,6,7,8,9,10,11])
        #       time.sleep(0.05)
        #       self.setSomeColor(0,0,0,[0,1,2,3,4,5,6,7,8,9,10,11])
        #       time.sleep(0.05)
        #   time.sleep(0.1)
        pass

    def breath(self, R_input, G_input, B_input):
        # self.lightMode = 'breath'
        # self.colorBreathR = R_input
        # self.colorBreathG = G_input
        # self.colorBreathB = B_input
        # self.resume()
        pass

    def breathProcessing(self):
        # while self.lightMode == 'breath':
        #   for i in range(0,self.breathSteps):
        #       if self.lightMode != 'breath':
        #           break
        #       self.setColor(self.colorBreathR*i/self.breathSteps, self.colorBreathG*i/self.br
eathSteps, self.colorBreathB*i/self.breathSteps)
        #       time.sleep(0.03)
        #   for i in range(0,self.breathSteps):
        #       if self.lightMode != 'breath':
        #           break
        #       self.setColor(self.colorBreathR-(self.colorBreathR*i/self.breathSteps), self.co
lorBreathG-(self.colorBreathG*i/self.breathSteps), self.colorBreathB-(self.colorBreathB*i/self.
breathSteps))
        #       time.sleep(0.03)
        pass

    def frontLight(self, switch):
        # if switch == 'on':
        #   GPIO.output(6, GPIO.HIGH)
        #   GPIO.output(13, GPIO.HIGH)
        # elif switch == 'off':
        #   GPIO.output(5,GPIO.LOW)
        #   GPIO.output(13,GPIO.LOW)
        pass

    def switch(self, port, status):
        # if port == 1:
        #   if status == 1:
        #       GPIO.output(5, GPIO.HIGH)
        #   elif status == 0:
        #       GPIO.output(5,GPIO.LOW)
        #   else:
        #       pass
        # elif port == 2:
        #   if status == 1:
        #       GPIO.output(6, GPIO.HIGH)
        #   elif status == 0:
        #       GPIO.output(6,GPIO.LOW)
        #   else:
        #       pass
        # elif port == 3:
        #   if status == 1:
```

```
        #       GPIO.output(13, GPIO.HIGH)
        #   elif status == 0:
        #       GPIO.output(13,GPIO.LOW)
        #   else:
        #       pass
        # else:
        #   print('Wrong Command: Example--switch(3, 1)->to switch on port3')
        pass

    def set_all_switch_off(self):
        # self.switch(1,0)
        # self.switch(2,0)
        # self.switch(3,0)
        pass

    def headLight(self, switch):
        # if switch == 'on':
        #   GPIO.output(5, GPIO.HIGH)
        # elif switch == 'off':
        #   GPIO.output(5,GPIO.LOW)
        pass

    def lightChange(self):
        # if self.lightMode == 'none':
        #   self.pause()
        # elif self.lightMode == 'police':
        #   self.policeProcessing()
        # elif self.lightMode == 'breath':
        #   self.breathProcessing()
        pass

    def run(self):
        # while 1:
        #   self.__flag.wait()
        #   self.lightChange()
            pass

if __name__ == '__main__':
    # RL=RobotLight()
    # RL.start()
    # RL.breath(70,70,255)
    # time.sleep(15)
```

```
        # RL.pause()
        # RL.frontLight('off')
        # time.sleep(2)
        # RL.police()
        pass
```

If you want to use this module, modify **adeept_rasptank/server/robotLight.py** to:

https://github.com/adeept/adeept_rasptank/blob/master/server/robotLight.py