Lesson 4 Line Following

1. Working Principle

In the process of recognition is to convert line clor through the Lab color space, and then frame the outline of the target after processing the image.

After the color of the line is recognized, MasterPi will follow the line.

The source code of the program is located in: /home/pi/MasterPi/Functions/VisualPatrol.py

```
roi = [ # [ROI, weight]
        (240, 280,  0, 640, 0.1),
        (340, 380,  0, 640, 0.3),
        (430, 460,  0, 640, 0.6)
       ]

roi_h1 = roi[0][0]
roi_h2 = roi[1][0] - roi[0][0]
roi_h3 = roi[2][0] - roi[1][0]

roi_h_list = [roi_h1, roi_h2, roi_h3]

size = (640, 480)
def run(img):
    global line_centerx
    global __target_color

    img_copy = img.copy()
    img_h, img_w = img.shape[:2]

    if not __isRunning or __target_color == ():
        return img

    frame_resize = cv2.resize(img_copy, size, interpolation=cv2.INTER_NEAREST)
    frame_gb = cv2.GaussianBlur(frame_resize, (3, 3), 3)
    centroid_x_sum = 0
    weight_sum = 0
    center_ = []
    n = 0

    for r in roi:
        roi_h = roi_h_list[n]
```

2. Operation Steps

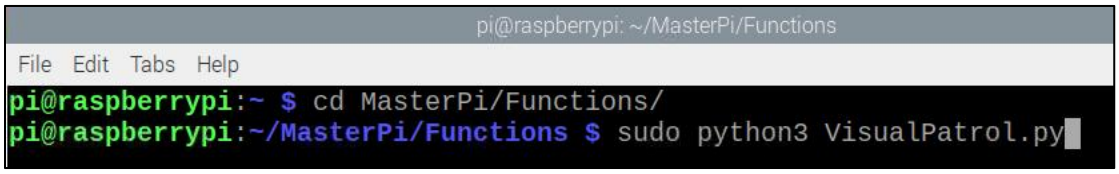
The entered command should be case sensitive. And the keywords can be complemented by Tab key.

1) Turn on MasterPi, then connect to Raspberry Pi system desktop through VNC.

2) Click  or press “Ctrl+Alt+T” to enter LX terminal.

3) Enter “cd MasterPi/Functions/” command, and then press “Enter” to come to the directory of games programmings.

4) Enter “sudo python3 VisualPatrol.py”, then press “Enter” to start the game.



5) If you want to exit the game programming, press “Ctrl+C” in LX terminal interface. If the exit fails, please try it few more times.

3. Project Outcome

The program defaults to recognize red line.

After the game starts, MasterPi will follow the red line.

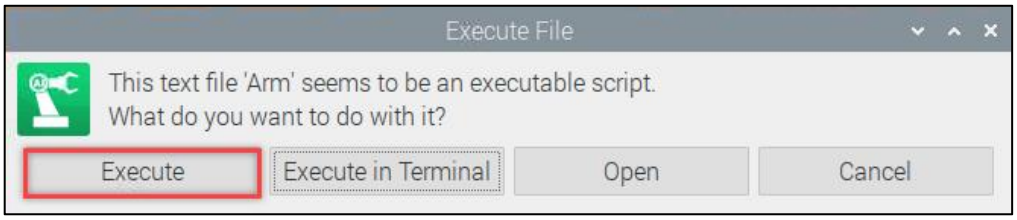
4. Function Extension

4.1 Color Threshold Adjustment

If the performance effect is not good enough when MasterPi follows the red line, you can adjust the color threshold to allow MasterPi to normally follow the red line. The steps are as follow:

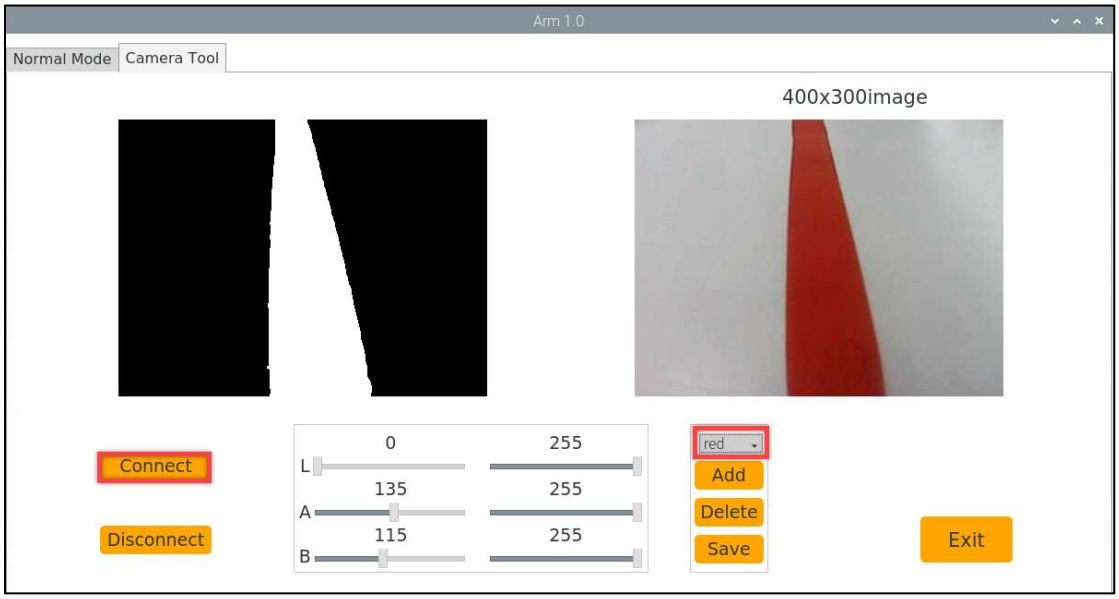
1) Double-click 

on system desktop, and then click “Execute” in the pop-up window.



2) After entering the interface, click “Camera Tool”.

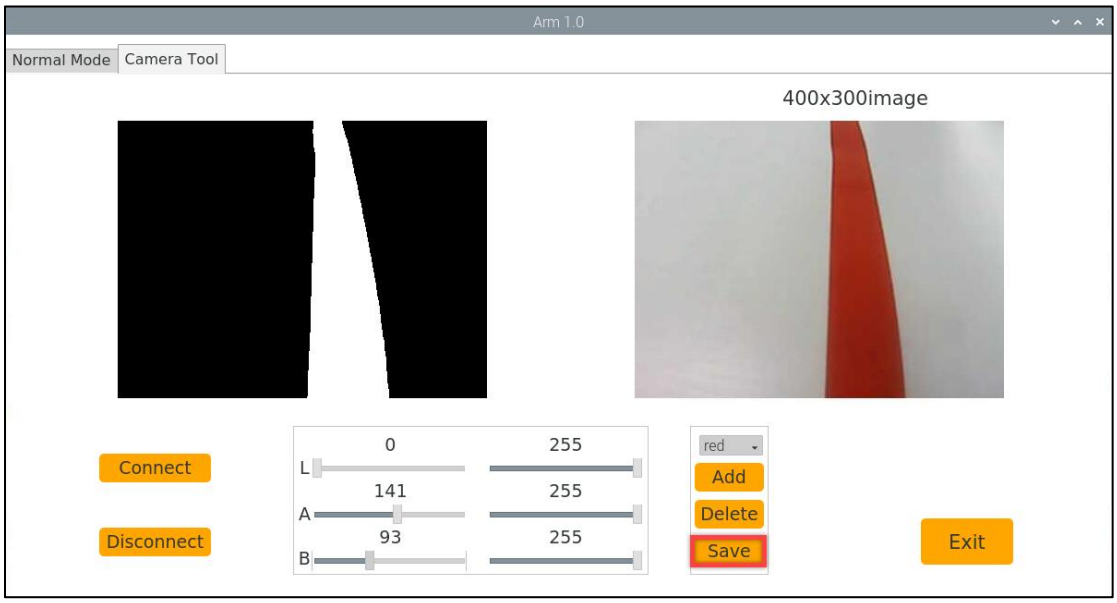
3) Then click “Connect” button. After connecting successfully, select “red” in color option bar.



4) If no real-time image transmitted by camera appears in the pop-up window, it means the camera fails to connect and need to check whether the camera cable is connected normally.

The right side of the interface below is real-time image transmitted by camera. The left side is the screen after processing . Point the camera at red line, and then drag the following six sliders until the red area becomes white and other areas become black.

5) Then click “Save” to save data.

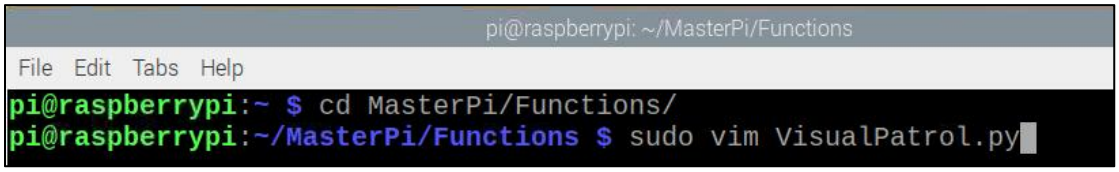


4.2 Modify Line Color

Black and red are two built-in recognition colors in program. This section defaults to follow red line. If want to modify the color of line to be followed, you can refer to the following steps.

1) Enter “cd MasterPi/Functions/” command and press “Enter” to come to the directory where the game programmings are located.

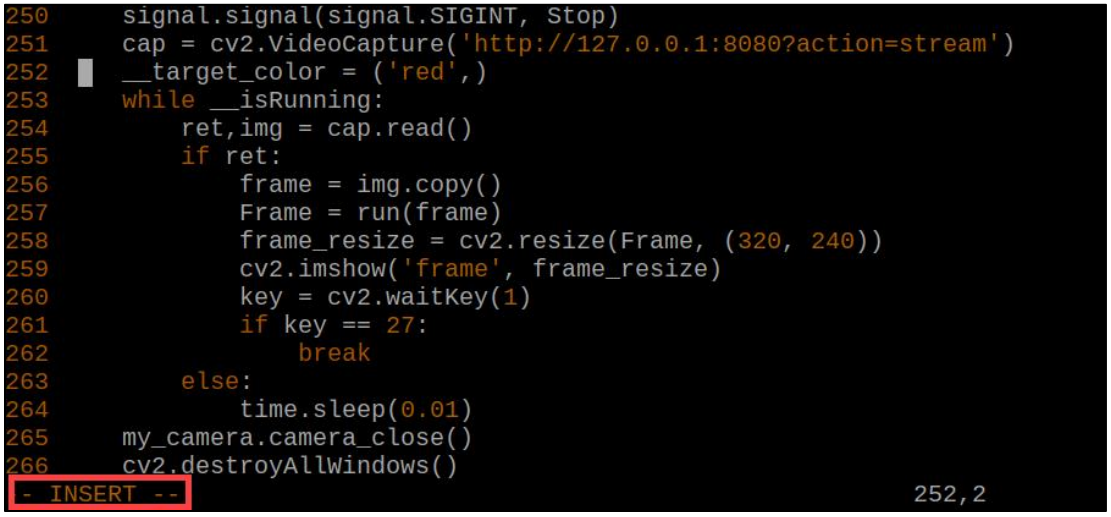
2) Step 2: Enter “sudo vim VisualPatrol.py” command, and then press “Enter” to open the program file.



3) Find the code shown in the following red box.

Note: After entering the position number of code, press “Shift+G” to jump to the corresponding position. (The position number of the code in figure is for reference only.)

4) Press “i” on the keyboard. Then enter the editing mode when the word “INSERT” appears.



5) Modify “red” in “__target_color = ('red',)” to “black” as shown in the figure below:

```
250     signal.signal(signal.SIGINT, Stop)
251     cap = cv2.VideoCapture('http://127.0.0.1:8080?action=stream')
252     __target_color = ('black',)
253     while __isRunning:
254         ret,img = cap.read()
255         if ret:
256             frame = img.copy()
257             Frame = run(frame)
258             frame_resize = cv2.resize(Frame, (320, 240))
259             cv2.imshow('frame', frame_resize)
260             key = cv2.waitKey(1)
261             if key == 27:
262                 break
263         else:
264             time.sleep(0.01)
265     my_camera.camera_close()
266     cv2.destroyAllWindows()
-- INSERT --                                                    253,23
```

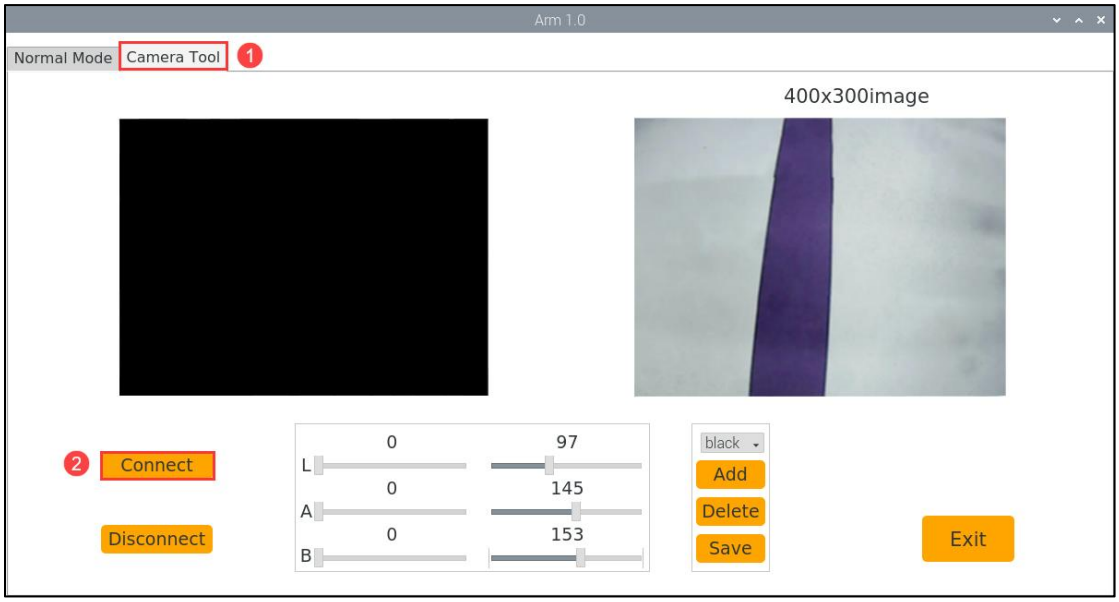
6) After modifying, press “Esc”. Then enter “:wq” and press “Enter” to save and exit.

```
251     cap = cv2.VideoCapture('http://127.0.0.1:8080?action=stream')
252     __target_color = ('black',)
253     while __isRunning:
254         ret,img = cap.read()
255         if ret:
256             frame = img.copy()
257             Frame = run(frame)
258             frame_resize = cv2.resize(Frame, (320, 240))
259             cv2.imshow('frame', frame_resize)
260             key = cv2.waitKey(1)
261             if key == 27:
262                 break
263         else:
264             time.sleep(0.01)
265     my_camera.camera_close()
266     cv2.destroyAllWindows()
:wq
```

4.3 Add Recognized Color

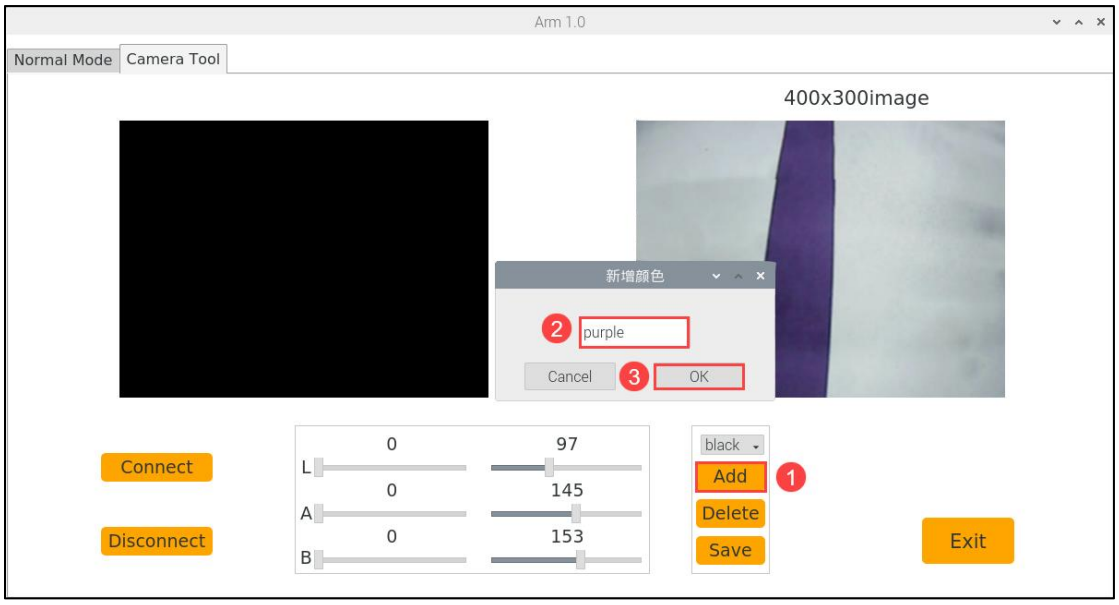
In addition to the built-in recognized colors, you can add other recognized colors in the programming. Take purple as example:

1) Click “Camera Tool” first, and then click “Connect”.

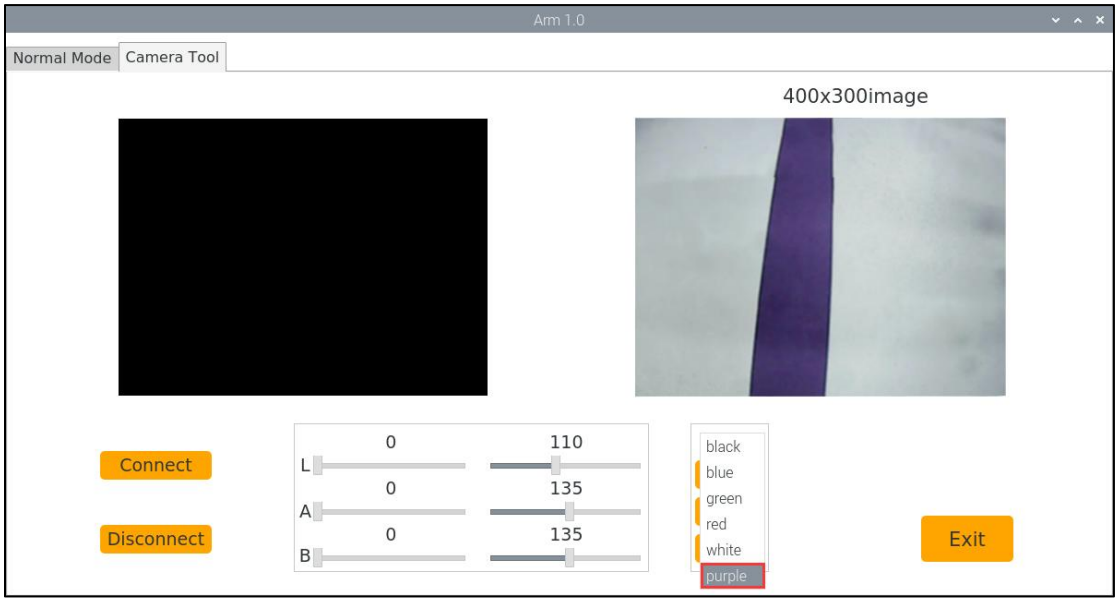


2) After connecting, click “Add”. Then name the added color “purple” and click “OK”.

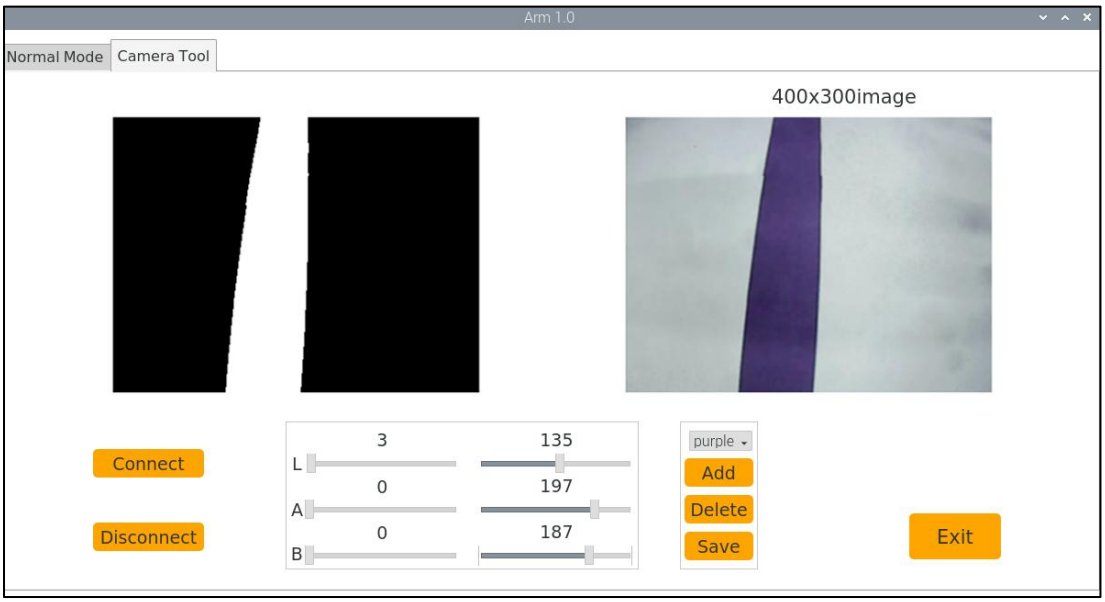
Note: Take “purple” as example. You can add other colors according to your need.



3) After adding the new color, click the color option bar and then select “purple”.



4) Refer to the operation steps in “4.1 Color Threshold Adjustment” to adjust purple threshold until the purple area to be recognized becomes white and other areas become black. Then click “Save”.



5) According to the operation steps in “4.2 Modify line color” to open the program file. Then enter the editing mode and find the code in red box below.

6) Modify “red” in “_target_color = (‘black’)” to “purple” as the figure shown below:

```
250     signal.signal(signal.SIGINT, Stop)
251     cap = cv2.VideoCapture('http://127.0.0.1:8080?action=stream')
252     __target_color = ('purple',)
253     while __isRunning:
254         ret,img = cap.read()
255         if ret:
256             frame = img.copy()
257             Frame = run(frame)
258             frame_resize = cv2.resize(Frame, (320, 240))
259             cv2.imshow('frame', frame_resize)
260             key = cv2.waitKey(1)
261             if key == 27:
262                 break
263         else:
264             time.sleep(0.01)
265     my_camera.camera_close()
266     cv2.destroyAllWindows()
-- INSERT --                                                    253,23
```

7) After the modification is complete, press “Esc”. Then enter “:wq” and press “Enter” to save and exit.

```
253     while __isRunning:
254         ret,img = cap.read()
255         if ret:
256             frame = img.copy()
257             Frame = run(frame)
258             frame_resize = cv2.resize(Frame, (320, 240))
259             cv2.imshow('frame', frame_resize)
260             key = cv2.waitKey(1)
261             if key == 27:
262                 break
263         else:
:wq
```

8) Refer to the operation steps in “2. Operation Steps” to start the game. Then, MasterPi will follow the purple line.