4、color tracking

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4.1 Introduction to gameplay

This course mainly uses the robot's camera to obtain the camera picture, select a color, and then put the object of the selected color into the camera picture, frame the color object with a circle in the picture in real time, move the color object, and the circle will track the color object. Note that the robot will not move during this process, only the camera pan/tilt will track the color object.

4.2 Core content analysis

Color_HSV defines the HSV value of a color. Since the color of an object has color differences and light effects, if the recognition of a certain color is inaccurate, you can adjust the course based on the color HSV value. After adjusting for the best effect, record the data and update the HSV value of the corresponding color. .

```
Color_HSV = {
    'Red': ([0, 43, 46], [10, 255, 255]),
    'Green': ([35, 43, 46], [77, 255, 255]),
    'Blue': ([100, 43, 46], [124, 255, 255]),
    'Yellow': ([26, 43, 46], [34, 255, 255])
}
```

Red objects are tracked by default.

```
color_lower = np.array(Color_HSV["Red"][0])
color_upper = np.array(Color_HSV["Red"][1])
```

Each time a key is pressed, the color_lower and color_upper of the color HSV values are updated.

```
def on_button_clicked(b):
    global color_lower, color_upper, g_stop_program
    ALL_Uncheck()
    b.icon = 'check'
    with output:
        print("Button clicked:", b.description)
    if b.description == Name_widgets['Close_Camera'][g_ENABLE_CHINESE]:
        # 停止线程，释放摄像头  Stop the thread and release the camera
        Button_Start.icon = 'uncheck'
        g_stop_program = True
        b.icon = 'uncheck'
    elif b.description == Name_widgets['Red'][g_ENABLE_CHINESE]:
        color_lower = np.array(np.array(Color_HSV["Red"][0]))
        color_upper = np.array(np.array(Color_HSV["Red"][1]))
    elif b.description == Name_widgets['Green'][g_ENABLE_CHINESE]:
        color_lower = np.array(np.array(Color_HSV["Green"][0]))
        color_upper = np.array(np.array(Color_HSV["Green"][1]))
    elif b.description == Name_widgets['Blue'][g_ENABLE_CHINESE]:
        color_lower = np.array(np.array(Color_HSV["Blue"][0]))
        color_upper = np.array(np.array(Color_HSV["Blue"][1]))
    elif b.description == Name_widgets['Yellow'][g_ENABLE_CHINESE]:
        color_lower = np.array(np.array(Color_HSV["Yellow"][0]))
        color_upper = np.array(np.array(Color_HSV["Yellow"][1]))
```

Control the robot's camera pan/tilt function, which uses the PID algorithm to calculate the angle at which the servo needs to rotate.

```
def robot_control(x, y, radius):
    global g_last_x, g_last_y
    # print("raw:", x, y)
    if -20 < x < 20:
        x = 0
    if -20 < y < 20:
        y = 0
    value_x = int(PID_X.incremental(x))
    value_y = int(PID_Y.incremental(y))
    value_x = limit_value(value_x + g_last_x, 0, 180)
    value_y = limit_value(value_y + g_last_y, 0, 115)
    g_last_x = value_x
    g_last_y = value_y
    # print("angle:", value_x, value_y)
    g_bot.Gimbal_1_2(value_x, value_y)
```

The PID algorithm uses an incremental PID algorithm, and the PID parameters can be adjusted according to the actual effect to optimize the tracking effect.

```
def incremental(self, current_value, limit=0):
        self.err = self.setPoint - current_value
        result = self.last_result + self.Kp * (self.err - self.err_next) +
self.Ki * self.err + self.Kd * (self.err - 2 * self.err_next + self.err_last)
        self.err_last = self.err_next
        self.err_next = self.err
        if limit > 0:
            if result > limit:
                result = limit
            if result < -limit:
                result = -limit
        self.last_result = result
        return result
```

The program function of processing the camera screen will read the camera image, then analyze the HSV value, obtain the position information of the color object, draw it with a circular frame, and finally display it through the image control.

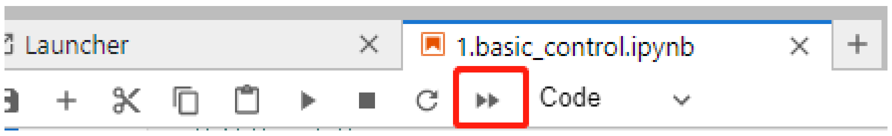
```
def task_processing():
    global color_lower, color_upper, g_stop_program
    global g_start_function
    t_start = time.time()
    m_fps = 0
    while g_camera.isOpened():
        if g_stop_program:
            break
        ret, frame = g_camera.read()

        PID_slider_value()
        # 根据HSV值处理图像 The image is processed according to the HSV value
        hsv = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)
        mask = cv2.inRange(hsv, color_lower, color_upper)

        cnts = cv2.findContours(mask.copy(), cv2.RETR_EXTERNAL,
cv2.CHAIN_APPROX_SIMPLE)[-2]
        if len(cnts) > 0:
            cnt = max (cnts, key = cv2.contourArea)
            (color_x, color_y), color_radius = cv2.minEnclosingCircle(cnt)
            if color_radius > 10:
                # 将检测到的颜色用圆形线圈标记出来 Mark the detected colors with
circular coils
                cv2.circle(frame, (int(color_x), int(color_y)),
int(color_radius), (255,0,255), 2)
                if g_start_function:
                    robot_control(int(color_x-320), int(color_y-240),
int(color_radius))
        m_fps = m_fps + 1
        fps = m_fps / (time.time() - t_start)
        if (time.time() - t_start) >= 2:
            m_fps = fps
            t_start = time.time() - 1
        cv2.putText(frame, "FPS " + str(int(fps)), (10,20),
cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0,255,255), 1)

        # 图像传输给显示组件 The image is transmitted to the display component
        image_widget.value = bgr8_to_jpeg(frame)
        time.sleep(.01)
    g_camera.release()
```

4.3 operation

Open the jupyterLab client and find the code path:

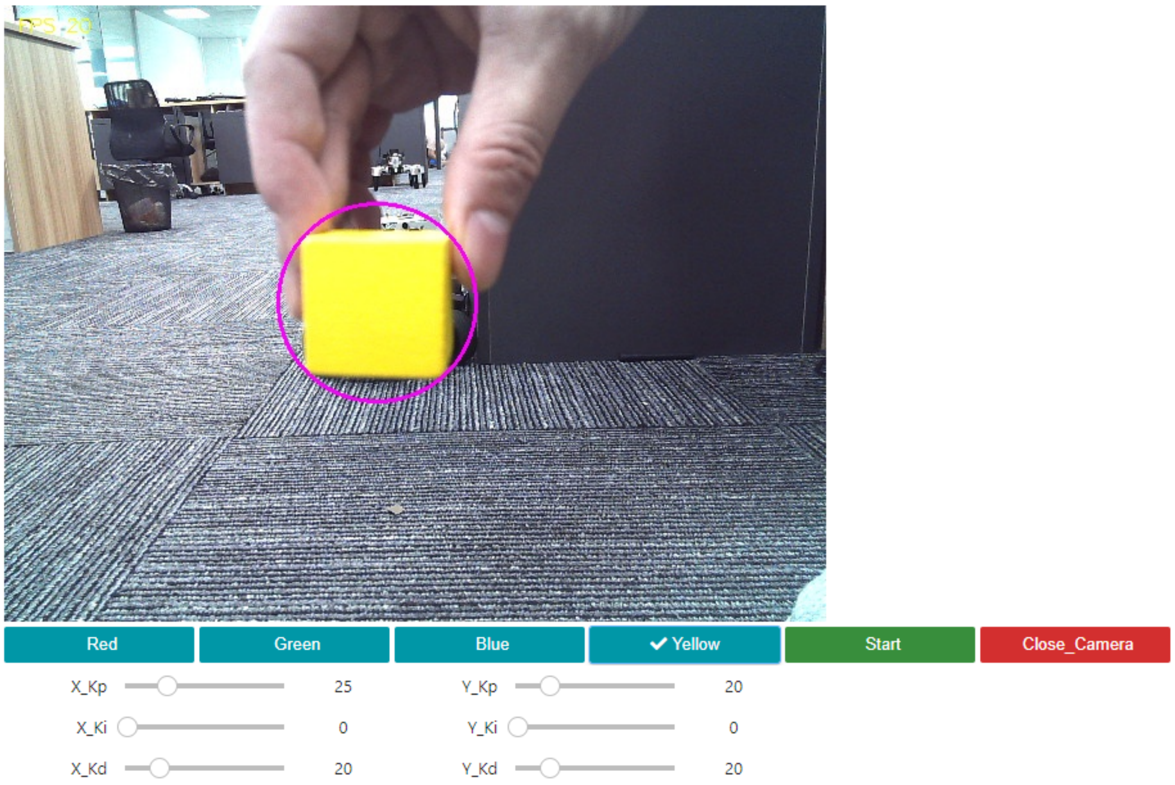
```
muto/Samples/AI_Samples/02_color_tracking/color_tracking.ipynb
```

Click to run all cells, and then scroll to the bottom to see the generated controls.



Select the color that needs to be tracked. For example, if you select yellow here, the camera will track the yellow object. If you move the color block, the camera will follow the object and try to keep the object in the middle of the screen. Note that the color you choose should be clearly different from the background color, otherwise it may cause interference.

If the camera pan/tilt tracking effect is not ideal, you can adjust the PID parameters below to optimize the tracking effect. X represents the left and right direction, and Y represents the up and down direction.



X_Kp 25 Y_Kp 20
X_Ki 0 Y_Ki 0
X_Kd 20 Y_Kd 20

Finally click the Close_Camera button to close the camera.