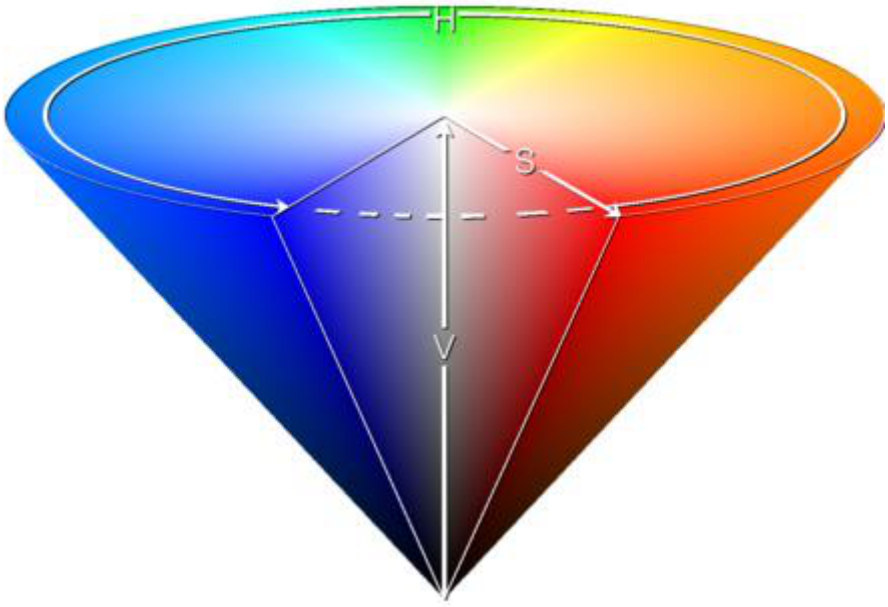
7. Color recognition

1. Introduction to HSV color space:

RGB color space is the most familiar color space, that is, the three primary color spaces. Any color can be mixed by the three colors. However, effective processing of images in color space is generally carried out in HSV space. HSV (Hue, Saturation, Brightness Value) is a color space created based on the intuitive characteristics of color, also known as the hexagonal pyramid model.

Why choose HSV space instead of RGB space? For images, identifying corresponding colors is feasible in RGB space, HSV space or other color spaces. The reason why HSV was chosen is because the hue represented by H can basically determine a certain color, and combined with the saturation and brightness information, it can be judged to be greater than a certain threshold. RGB is composed of three components, and the contribution proportion of each component needs to be judged. That is, the recognition range of HSV space is wider and more convenient.



HSV color space model

2. Conversion of three color spaces (gray BGR HSV):

There are more than 150 color space conversion methods in OpenCV, but there are only two that we often use, namely BGR->Gray and BGR->HSV. Note that Gray and HSV are not convertible to each other. Color space conversion: cv2.cvtColor(input_image, flag)

BGR->Gray: flag is cv2.COLOR_BGR2GRAY

BGR->HSV: flag is cv2.COLOR_BGR2HSV

The value range of HSV color space in OpenCV:

H [0, 179] S [0, 255] V [0, 255]

	黑	灰	白	红		橙	黄	绿	青	蓝	紫
hmin	0	0	0	0	156	11	26	35	78	100	125
hmax	180	180	180	10	180	25	34	77	99	124	155
smin	0	0	0	43		43	43	43	43	43	43
smax	255	43	30	255		255	255	255	255	255	255
vmin	0	46	221	46		46	46	46	46	46	46
vmax	46	220	255	255		255	255	255	255	255	255

Value range of commonly used colors

Based on the above interval, our goal is to identify whether it is the color interval we set, and replace this color with white first, replace it with black if it is not this color, and finally replace the white part with the original image.

```
#bgr8 to jpeg format

import enum

import cv2



def bgr8_to_jpeg(value, quality=75):

     return bytes(cv2.imencode('.jpg', value)[1])
```

```
#Camera component display

import traitlets

import ipywidgets.widgets as widgets

import time

# Thread function operation library

import threading

import inspect

import ctypes



origin_widget = widgets.Image(format='jpeg', width=320, height=240)

mask_widget = widgets.Image(format='jpeg',width=320, height=240)

result_widget = widgets.Image(format='jpeg',width=320, height=240)



# create a horizontal box container to place the image widget next to each other
```

```
image_container = widgets.HBox([origin_widget, mask_widget, result_widget])


display(image_container)
```

```
#Thread related functions

def _async_raise(tid, exctype):

     """raises the exception, performs cleanup if needed"""

     tid = ctypes.c_long(tid)

     if not inspect.isclass(exctype):

         exctype = type(exctype)

     res = ctypes.pythonapi.PyThreadState_SetAsyncExc(tid,
ctypes.py_object(exctype))

     if res == 0:

         raise ValueError("invalid thread id")

     elif res != 1:

         # """if it returns a number greater than one, you're in trouble,

         # and you should call it again with exc=NULL to revert the effect"""

         ctypes.pythonapi.PyThreadState_SetAsyncExc(tid, None)

def stop_thread(thread):

     _async_raise(thread.ident, SystemExit)
```

```
#Main process function

import cv2

import numpy as np

import ipywidgets.widgets as widgets




cap = cv2.VideoCapture(0)

cap.set(3, 640)

cap.set(4, 480)
```

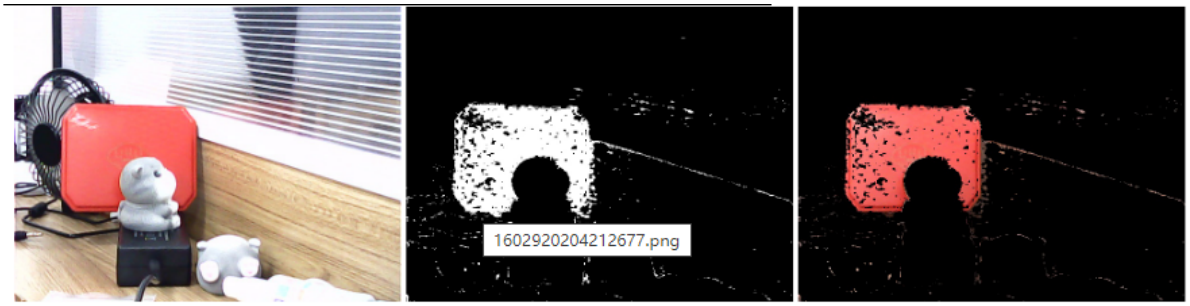
```
cap.set(5, 120) #Set frame rate

cap.set(cv2.CAP_PROP_FOURCC, cv2.VideoWriter.fourcc('M', 'J', 'P', 'G'))

# image.set(cv2.CAP_PROP_BRIGHTNESS, 40) #Set brightness -64 - 64 0.0

# image.set(cv2.CAP_PROP_CONTRAST, 50) #Set contrast -64 - 64 2.0

# image.set(cv2.CAP_PROP_EXPOSURE, 156) #Set exposure value 1.0 - 5000 156.0




#The red one is selected by default. If you want to identify other ones, please comment the red interval code below and release the other interval code segments below.

# red interval

color_lower = np.array([0, 43, 46])

color_upper = np.array([10, 255, 255])



# #Green interval

# color_lower = np.array([35, 43, 46])

# color_upper = np.array([77, 255, 255])



# #Blue interval

# color_lower=np.array([100, 43, 46])

# color_upper = np.array([124, 255, 255])



# #Yellow interval

# color_lower = np.array([26, 43, 46])

# color_upper = np.array([34, 255, 255])



# #Orange range

# color_lower = np.array([11, 43, 46])
```

```
# color_upper = np.array([25, 255, 255])




def Color_Recongnize():



     while(1):

          # get a frame and show Get the video frame and convert it to HSV format. Use cvtColor() to convert the BGR format to HSV format. The parameter is cv2.COLOR_BGR2HSV.

          ret, frame = cap.read()

          #cv2.imshow('Capture', frame)

          origin_widget.value = bgr8_to_jpeg(frame)



          # change to hsv model

          hsv = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)



          # get mask Use the inRange() function and the upper and lower bounds of the blue range in the HSV model to obtain the mask. The blue part of the original video in the mask will be made white and the other parts black.

          mask = cv2.inRange(hsv, color_lower, color_upper)

          #cv2.imshow('Mask', mask)

          mask_widget.value = bgr8_to_jpeg(mask)



          # detect blue Perform a bitwise AND operation on the mask on the original video frame, then the white in the mask will be replaced with the real image:

          res = cv2.bitwise_and(frame, frame, mask=mask)

          #cv2.imshow('Result', res)

          result_widget.value = bgr8_to_jpeg(res)



          # if cv2.waitKey(1) & 0xFF == ord('q'):
```

```
            #break
            time.sleep(0.01)
        cap.release()
        #cv2.destroyAllWindows()
```

```
#Start process
thread1 = threading.Thread(target=Color_Recongnize)
thread1.setDaemon(True)
thread1.start()
```

```
#End the process, this code needs to be executed only when it ends
stop_thread(thread1)
```



This is the effect of performing red recognition. If you want to recognize other colors, you can annotate the red range and open other color ranges.

For CSI camera:

```
#bgr8 to jpeg format
import enum
import cv2


def bgr8_to_jpeg(value, quality=75):
    return bytes(cv2.imencode('.jpg', value)[1])
```

```
 #Thread-dependent functions
def _async_raise(tid, exctype):
    """raises the exception, performs cleanup if needed"""
    tid = ctypes.c_long(tid)
```

```
    if not inspect.isclass(exctype):

        exctype = type(exctype)

    res = ctypes.pythonapi.PyThreadState_SetAsyncExc(tid,
ctypes.py_object(exctype))

    if res == 0:

        raise ValueError("invalid thread id")

    elif res != 1:

        # """if it returns a number greater than one, you're in trouble,

        # and you should call it again with exc=NULL to revert the effect"""

        ctypes.pythonapi.PyThreadState_SetAsyncExc(tid, None)



def stop_thread(thread):

    _async_raise(thread.ident, SystemExit)
```

```
#Main process function

import cv2 as cv

import numpy as np

import ipywidgets.widgets as widgets

import libcamera

from picamera2 import Picamera2



cv.startWindowThread()

picam2 = Picamera2()
config = picam2.create_preview_configuration(main={"format": 'RGB888', "size":
(640, 480)})
config["transform"] = libcamera.Transform(hflip=0, vflip=1)
picam2.configure(config)
picam2.start()

# image.set(cv2.CAP_PROP_BRIGHTNESS, 40) #set brightness -64 - 64  0.0

# image.set(cv2.CAP_PROP_CONTRAST, 50)   #set contrast -64 - 64  2.0

# image.set(cv2.CAP_PROP_EXPOSURE, 156)  #Setting exposure value 1.0 - 5000
156.0
```

```
#The default selection is red. If you want to identify others, please comment the following red interval code, and let go of other interval code segments

# Red range

color_lower = np.array([0, 43, 46])

color_upper = np.array([10, 255, 255])



# #Green range

# color_lower = np.array([35, 43, 46])

# color_upper = np.array([77, 255, 255])



# #Blue range

# color_lower=np.array([100, 43, 46])

# color_upper = np.array([124, 255, 255])



# #yellow range

# color_lower = np.array([26, 43, 46])

# color_upper = np.array([34, 255, 255])



# #orange range

# color_lower = np.array([11, 43, 46])

# color_upper = np.array([25, 255, 255])





def Color_Recongnize():



    while(1):
```

```
        # get a frame and show. Take the video frame and convert it to HSV
format, using cvtColor() to convert the BGR format to HSV format with
cv2.COLOR_BGR2HSV.

        frame = picam2.capture_array()

        #cv2.imshow('Capture', frame)

        origin_widget.value = bgr8_to_jpeg(frame)



        # change to hsv model

        hsv = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)



        # get mask    We use the inRange() function and the upper and lower
bounds of the blue range from the HSV model.In this mask, the blue part of the
original video is colored white and the other parts are colored black.

        mask = cv2.inRange(hsv, color_lower, color_upper)

        #cv2.imshow('Mask', mask)

        mask_widget.value = bgr8_to_jpeg(mask)



        # detect blue     Applying a bitwise and to the original video frame will
replace the white in the mask with the real image:

        res = cv2.bitwise_and(frame, frame, mask=mask)

        #cv2.imshow('Result', res)

        result_widget.value = bgr8_to_jpeg(res)



        #     if cv2.waitKey(1) & 0xFF == ord('q'):

        #         break

        time.sleep(0.01)




    cap.release()

    #cv2.destroyAllWindows()
```

```
#Camera component display

import traitlets

import ipywidgets.widgets as widgets

import time

# Thread function manipulation library

import threading

import inspect

import ctypes



origin_widget = widgets.Image(format='jpeg', width=320, height=240)

mask_widget = widgets.Image(format='jpeg',width=320, height=240)

result_widget = widgets.Image(format='jpeg',width=320, height=240)



# create a horizontal box container to place the image widget next to eachother

image_container = widgets.HBox([origin_widget, mask_widget, result_widget])

display(image_container)   #Display camera assembly
```

```
#Starting processes

thread1 = threading.Thread(target=Color_Recongnize)

thread1.setDaemon(True)

thread1.start()
```

```
#Terminates the process, and this code needs to be executed only when it does

stop_thread(thread1)
```