Block different shape sorting

Before starting this function, you need to close the process of the big program and APP. Enter the following program in the terminal to close the process of the big program and APP.

```
sh ~/app_Arm/kill_YahboomArm.sh
sh ~/app_Arm/stop_app.sh
```

If you need to start the big program and APP again later, start the terminal.

```
sudo systemctl start yahboom_arm.service
sudo systemctl start yahboom_app.service
```

1. Function description

After the program runs, place the same color block. After the camera captures the image, it recognizes the color according to the HSV value and recognizes the shape of the color block. Press the space bar, the robot arm will grab the color block of the target shape and place it at the set position; after the placement is completed, it returns to the initial recognition posture of the color block.

2. Start and operate

(1) Start command

Enter the following command in the terminal to start,

```
#Start the depth camera
roslaunch orbbec_camera dabai_dcw2.launch
#Start the underlying driver control of the robotic arm
rosrun dofbot_pro_info arm_driver.py
#Start the robotic arm inverse solution program
rosrun dofbot_pro_info kinemarics_dofbot_pro
#Start the robotic arm grasping program
rosrun dofbot_pro_info grasp.py
#Start the color block shape recognition program
rosrun dofbot_pro_color shape_recognize.py
```

(2) Operation process

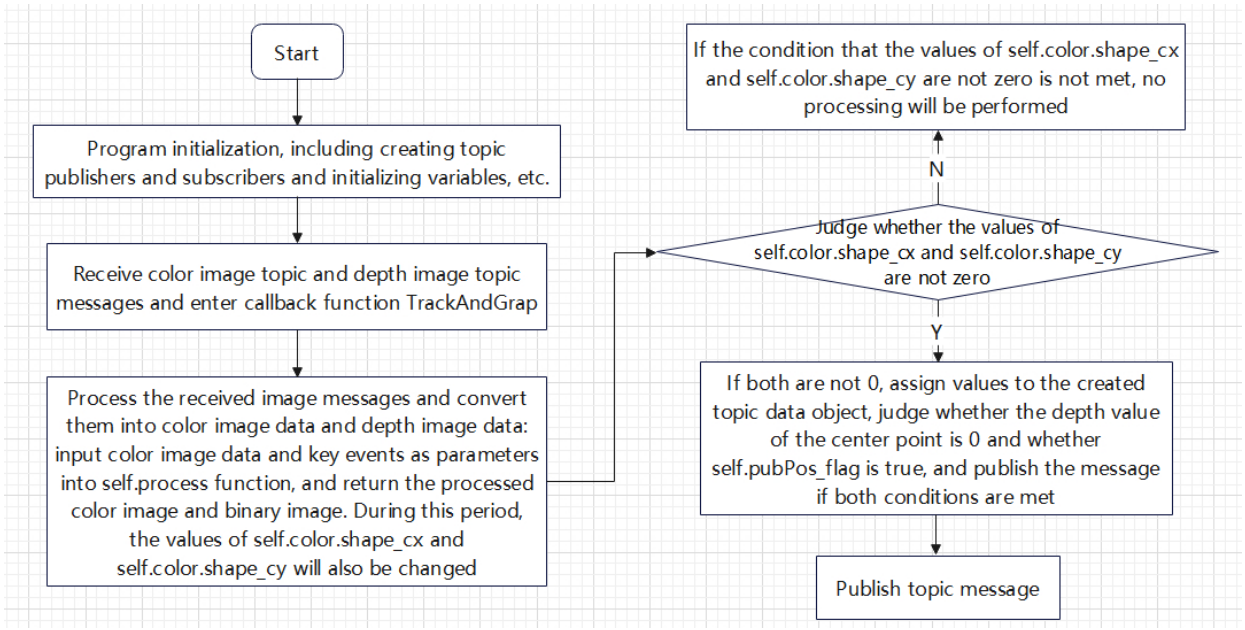
After the terminal is started, place a color block of the same color. The camera captures the image. Press [r] or [R] to enter the color selection mode. Use the mouse to select a certain area of the color block, obtain the HSV value of this area, and release the mouse to enter the color recognition mode. After entering the color recognition mode, if the current HSV value still cannot filter out other colors, you can use the dynamic parameter adjuster to fine-tune the HSV. Enter the following command in the terminal to start the dynamic parameter adjuster.

```
rosrun rqt_reconfigure rqt_reconfigure
```

You can modify the HSV value through the slider. When the image on the left (binarized) only shows the only recognized color, click the color image box and press the space bar. The robot arm will lower its claws to grab the color block of the set target shape. The default target shape is a square.

3. Program flow chart

shape_recognize.py



4. Core code analysis

4.1. shape_recognize.py

Code path: `/home/jetson/dofbot_pro_ws/src/dofbot_pro_color/scripts/shape_recognize.py`

astra_common code library path:
`/home/jetson/dofbot_pro_ws/src/dofbot_pro_color/scripts/astra_common.py`

Import necessary libraries,

```
import rospy
import numpy as np
from sensor_msgs.msg import Image
import message_filters
from std_msgs.msg import Float32,Bool
import os
from cv_bridge import CvBridge
import cv2 as cv
encoding = ['16UC1', '32FC1']
import time
#color recognition
from astra_common import *
#from shape_recognize import *
from dynamic_reconfigure.server import Server
from dynamic_reconfigure.client import Client
import rospkg
from dofbot_pro_color.cfg import ColorHSVConfig
import math
from dofbot_pro_info.msg import *
```

Initialize program parameters, create publishers, subscribers, etc.

```
def __init__(self):
    nodeName = 'shape_detect'
    rospy.init_node(nodeName)
    self.window_name = "depth_image"
    #Robotic arm recognizes the posture of the color block
    self.init_joints = [90.0, 120, 0.0, 0.0, 90, 90]
    #Create a publisher to publish color block information
    self.pub_ColorInfo = rospy.Publisher("PosInfo", AprilTagInfo, queue_size=1)
    #Create a publisher that publishes the target angle of the robotic arm
    self.pubPoint = rospy.Publisher("TargetAngle", ArmJoint, queue_size=1)
    #Create a subscriber to subscribe to gesture recognition results
    self.grasp_status_sub = rospy.Subscriber('grasp_done', Bool,
self.GraspStatusCallback, queue_size=1)
    #Create two subscribers to subscribe to the color image topic and the depth
image topic
    self.depth_image_sub =
message_filters.Subscriber('/camera/depth/image_raw',Image)
```

```
    self.rgb_image_sub = message_filters.Subscriber('/camera/color/image_raw',Image)
    #Time synchronization of color and depth image subscription messages
    self.TimeSynchronizer =
message_filters.ApproximateTimeSynchronizer([self.rgb_image_sub,self.depth_image_sub
],10,0.5)
    #Callback function TrackAndGrap for processing synchronization messages. The
callback function is connected to the subscribed message so that it can be
automatically called when a new message is received
    self.TimeSynchronizer.registerCallback(self.TrackAndGrap)
    #Create a bridge for converting color and depth image topic message data to
image data
    self.rgb_bridge = CvBridge()
    self.depth_bridge = CvBridge()

    #color
    #Initialize the region coordinates
    self.Roi_init = ()
    #Initialize the HSV value
    self.hsv_range = ()
    #Initialize the information of the recognized color block, which represents the
center x coordinate, center y coordinate and the minimum circumscribed circle radius
r of the color block
    self.circle = (0, 0, 0)
    #Flag for dynamic parameter adjustment, if True, dynamic parameter adjustment is
performed
    self.dyn_update = True
    #Flag for mouse selection
    self.select_flags = False
    self.gTracker_state = False
    self.windows_name = 'frame'
    self.Track_state = 'init'
    #Create a color detection object
    self.color = color_detect()
    #Initialize the row and column coordinates of the region coordinates
    self.cols, self.rows = 0, 0
    #Initialize the xy coordinates of the mouse selection
    self.Mouse_XY = (0, 0)
    #The path of the default HSV threshold file, which stores the last saved HSV
value
    self.hsv_text = rospkg.RosPack().get_path("dofbot_pro_color") +
"/scripts/colorHSV.text"
    #Load the color HSV configuration file and configure the dynamic parameter
regulator
    Server(ColorHSVConfig, self.dynamic_reconfigure_callback)
    self.dyn_client = Client(nodeName, timeout=60)
    #Publish the flag of machine code information. When it is True, it will publish
the /PosInfo topic data
    self.pubPos_flag = False
    exit_code = os.system('rosservice call /camera/set_color_exposure 50')
    #Set the target shape. The default is a cube. You can choose a cuboid or a
cylinder
```

```
    self.color.target_shape = rospy.get_param("~Shape", "Square") # "Rectangle"
,"Cylinder"
    print("Target shape: ",self.color.target_shape)
```

Mainly look at the image processing function TrackAndGrap,

```
def TrackAndGrap(self,color_frame,depth_frame):
    #rgb_image
    #Receive a color image topic message and convert the message data into image
data
    rgb_image = self.rgb_bridge.imgmsg_to_cv2(color_frame,'bgr8')
    result_image = np.copy(rgb_image)
    #depth_image
    #Receive a depth image topic message and convert the message data into image
data
    depth_image = self.depth_bridge.imgmsg_to_cv2(depth_frame, encoding[1])
    frame = cv.resize(depth_image, (640, 480))
    depth_image_info = frame.astype(np.float32)
    action = cv.waitKey(10) & 0xFF
    result_image = cv.resize(result_image, (640, 480))
    # Pass the obtained color image as a parameter to process, and also pass it to
the keyboard event action
    result_frame, binary = self.process(result_image,action)
    # Check if self.color.shape_cx and self.color.shape_cy are not 0, indicating
that there is a color block that meets the conditions
    if self.color.shape_cx!=0 and self.color.shape_cy!=0:
        pos = AprilTagInfo()
        pos.x = self.color.shape_cx
        pos.y = self.color.shape_cy
        print(self.color.shape_cx,self.color.shape_cy)
        pos.z = depth_image_info[self.color.shape_cy,self.color.shape_cx]/1000
        print("depth: ",pos.z)
        #Judge whether the value of self.pubPos_flag is True and whether the depth
value of the color block is not 0. If both conditions are met, the message can be
published
        if self.pubPos_flag == True and pos.z!=0:
            self.pubPos_flag = False
            self.pub_ColorInfo.publish(pos)
    # Check if the binary image exists. If it does, display the color and binary
images. Otherwise, only display the color image.
    if len(binary) != 0: cv.imshow(self.windows_name, ManyImgs(1, ([result_frame,
binary])))
    else:
        cv.imshow(self.windows_name, result_frame)
```

Image processing function self.process,

```
def process(self, rgb_img, action):
    rgb_img = cv.resize(rgb_img, (640, 480))
    binary = []
```

```
    #Judge key events. When the space bar is pressed, change the information release
status. Self.pubPos_flag is True, indicating that the information topic can be
released.
    if action == 32: self.pubPos_flag = True
    #Judge key events. When i or I is pressed, change the status to identification
mode.
    elif action == ord('i') or action == ord('I'): self.Track_state = "identify"
    #Judge key events. When r or R is pressed, reset all parameters and enter color
selection mode.
    elif action == ord('r') or action == ord('R'): self.Reset()
    #Judge the status value. If it is init, it means the initial status value. At
this time, you can use the mouse to select the area.
    if self.Track_state == 'init':
        cv.namedWindow(self.windows_name, cv.WINDOW_AUTOSIZE)
        #Select the color of an area in the specified window
        cv.setMouseCallback(self.windows_name, self.onMouse, 0)
        #Judge the color selection flag, true means that the color can be selected
        if self.select_flags == True:
            cv.line(rgb_img, self.cols, self.rows, (255, 0, 0), 2)
            cv.rectangle(rgb_img, self.cols, self.rows, (0, 255, 0), 2)
            # Check if the selected area exists
            if self.Roi_init[0] != self.Roi_init[2] and self.Roi_init[1] !=
self.Roi_init[3]:
                #Call the Roi_hsv function in the created color detection object
self.color, and return the processed color image and HSV value
                rgb_img, self.hsv_range = self.color.Roi_hsv(rgb_img, self.Roi_init)
                self.gTracker_state = True
                self.dyn_update = True
            else: self.Track_state = 'init'
    #Judge the status value. If it is "identify", it means that color recognition
can be performed.
    elif self.Track_state == "identify":
        # Check if there is an HSV threshold file. If it exists, read the value in
it and assign it to hsv_range
        if os.path.exists(self.hsv_text): self.hsv_range = read_HSV(self.hsv_text)
        # If it does not exist, change the state to init to select the color
        else: self.Track_state = 'init'
    if self.Track_state != 'init':
        #Judge the length of the self.hsv_range value, that is, whether the value
exists. When the length is not 0, enter the color detection function
        if len(self.hsv_range) != 0:
            #Call the ShapeRecognition function in the created color detection
object self.color, pass in the color image and self.hsv_range, which is the hsv
threshold, and return the processed color image, the binary image, and the
information of the graphics that meet the hsv threshold, including the center point
coordinates and the radius of its minimum circumscribed circle
            rgb_img, binary, self.circle = self.color.ShapeRecognition(rgb_img,
self.hsv_range)
            #Judge the flag of dynamic parameter update. True means that the
hsv_text file can be updated and the value on the parameter server can be modified
            if self.dyn_update == True:
                write_HSV(self.hsv_text, self.hsv_range)
```

```
                params = {'Hmin': self.hsv_range[0][0], 'Hmax': self.hsv_range[1]
[0],
                          'Smin': self.hsv_range[0][1], 'Smax': self.hsv_range[1]
[1],
                          'Vmin': self.hsv_range[0][2], 'Vmax': self.hsv_range[1]
[2]}
                self.dyn_client.update_configuration(params)
                self.dyn_update = False
    return rgb_img, binary
```

4.2. grasp.py

Please refer to the content of [grasp.py] in section 4.2 of the tutorial [Three-dimensional space sorting and gripping\1. Machine code ID sorting].