Abnormal height sorting of color blocks

Before starting this function, you need to close the process of the big program and APP. If you need to start the big program and APP again later, start the terminal,

```
bash ~/dofbot_pro/APP_DOFBOT_PRO/start_app.sh
```

1. Function description

After the program is started, place color blocks of the same color, and the robot will perform color recognition according to the set HSV value. After pressing the space bar, the robot will lower its claws to grab the color blocks that exceed the height threshold; after placement, it returns to the recognition posture.

2. Start and operate

2.1. Start command

Enter the following command in the terminal to start,

```
#Start the camera:
ros2 launch orbbec_camera dabai_dcw2.launch.py
#Start the underlying control:
ros2 run dofbot_pro_driver arm_driver
#Start the inverse solution program:
ros2 run dofbot_pro_info kinemarics_dofbot
#Start the color recognition program:
ros2 run dofbot_pro_color AnomalyHeightRemoval
#Start the robot gripping program:
ros2 run dofbot_pro_driver grasp
```

2.2. Operation process

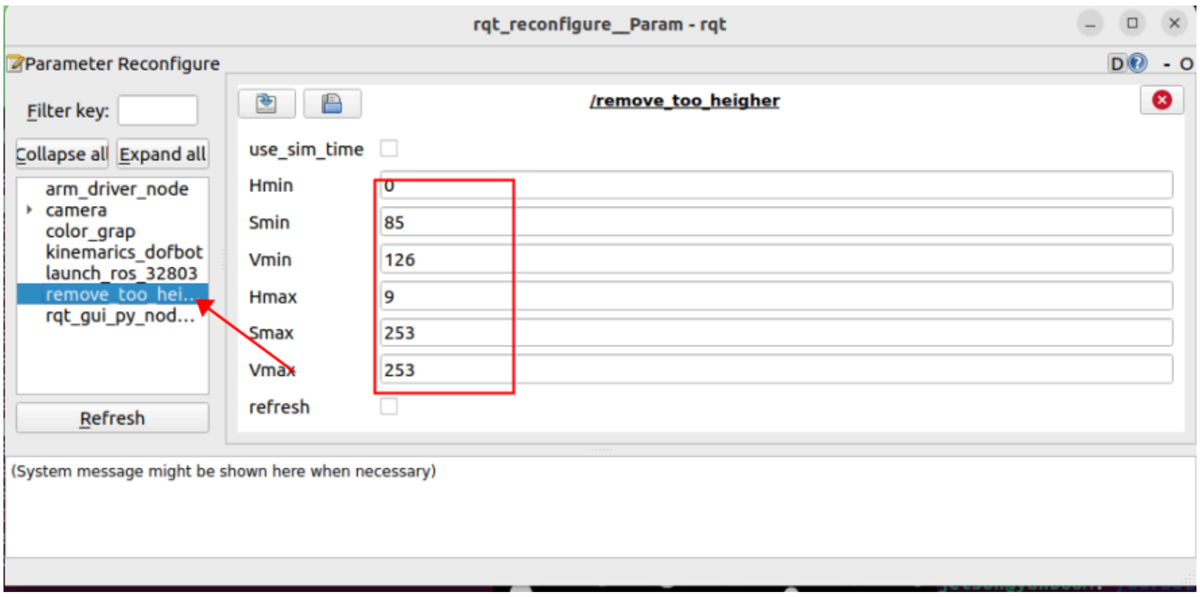
After the terminal is started, place blocks of different colors, the camera captures the image, and press the following buttons to process the image:

- [i] or [I]: Enter the color recognition mode, directly load the HSV value calibrated by the last program for recognition;
- 【r】or 【R】: reset program parameters, enter color selection mode, select a certain area of the color block with the mouse, obtain the HSV value of this area, release the mouse to enter color recognition mode
- Spacebar: start to grab highly abnormal color blocks

After entering color recognition mode, if the current HSV value still cannot filter out other colors, you can use the dynamic parameter adjuster to fine-tune 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


rqt_reconfigure__Param - rqt

Parameter Reconfigure

Filter key:

Collapse all Expand all

arm_driver_node
camera
color_grap
kinemarics_dofbot
launch_ros_32803
remove_too_hei...
rqt_gui_py_nod...

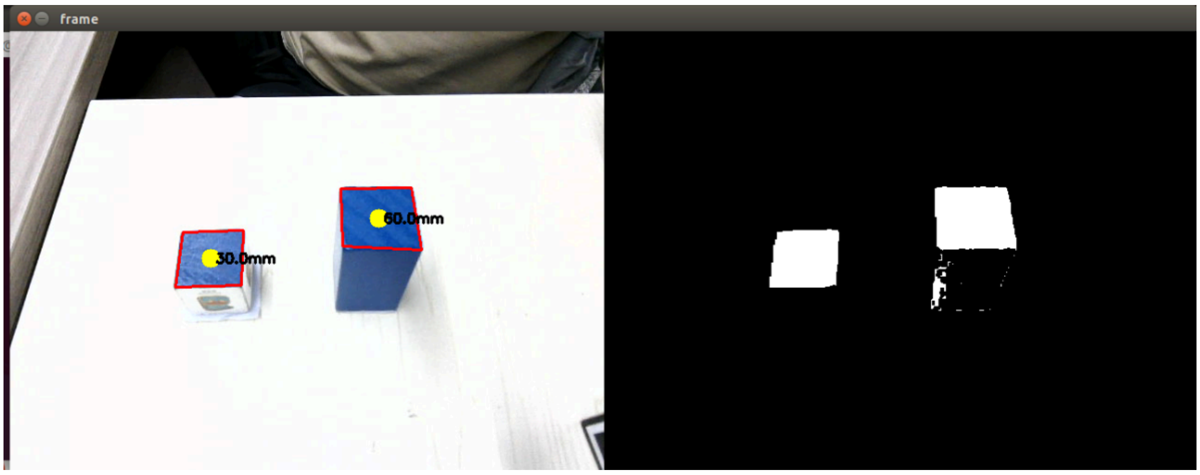
Refresh

/remove_too_heigher

use_sim_time ☐
Hmin 0
Smin 85
Vmin 126
Hmax 9
Smax 253
Vmax 253
refresh ☐

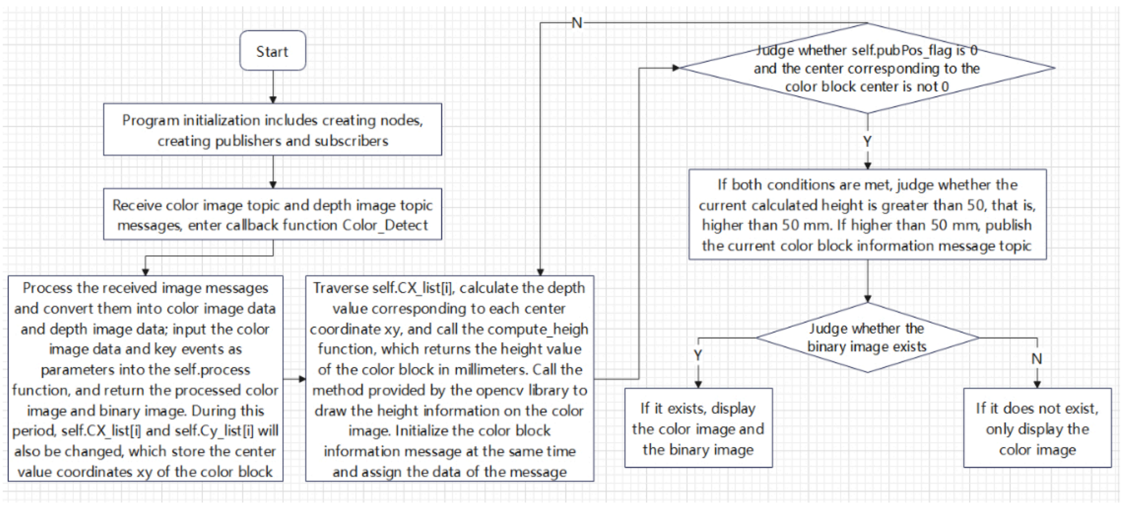
(System message might be shown here when necessary)

As shown in the figure below, when the image on the left (binarization) only shows the only recognized color, click the color image box and press the spacebar. The robotic arm will lower its claws to grab highly abnormal color blocks.



3. Program flow chart

AnomalyHeightRemoval.py


Start
Program initialization includes creating nodes, creating publishers and subscribers
Receive color image topic and depth image topic messages, enter callback function Color_Detect
Process the received image messages and convert them into color image data and depth image data; input the color image data and key events as parameters into the self.process function, and return the processed color image and binary image. During this period, self.CX_list[i] and self.Cy_list[i] will also be changed, which store the center value coordinates xy of the color block
Traverse self.CX_list[i], calculate the depth value corresponding to each center coordinate xy, and call the compute_heigh function, which returns the height value of the color block in millimeters. Call the method provided by the opencv library to draw the height information on the color image. Initialize the color block information message at the same time and assign the data of the message
N
Judge whether self.pubPos_flag is 0 and the center corresponding to the color block center is not 0
Y
If both conditions are met, judge whether the current calculated height is greater than 50, that is, higher than 50 mm. If higher than 50 mm, publish the current color block information message topic
Judge whether the binary image exists
Y
N
If it exists, display the color image and the binary image
If it does not exist, only display the color image

4. Core code analysis

4.1. AnomalyHeightRemoval.py

Code path:

```
/home/jetson/dofbot_pro_ws/src/dofbot_pro_color/dofbot_pro_color/AnomalyHeightRem
oval.py
```

Import necessary libraries,

```
import cv2
import rclpy
from rclpy.node import Node
import numpy as np
from message_filters import ApproximateTimeSynchronizer, Subscriber
from sensor_msgs.msg import Image
from std_msgs.msg import Float32, Bool
from cv_bridge import CvBridge
import cv2 as cv

import time
import math
import os
encoding = ['16UC1', '32FC1']
import tf_transformations as tf
import transforms3d as tfs

from dofbot_pro_color.height_measurement import *
from dofbot_pro_interface.msg import *
```

Initialize program parameters, create publishers and subscribers,

```
def __init__(self):
    super().__init__('remove_too_heigher')
    self.declare_param()
    #Robot arm recognizes the posture of the color block
    self.init_joints = [90.0, 120, 0.0, 0.0, 90, 90]
    #Create a publisher for publishing color block information
    self.pub_ColorInfo = self.create_publisher(AprilTagInfo, "PosInfo", 1)
    self.pubPoint = self.create_publisher(ArmJoint, "TargetAngle", 1)
    #Create a subscriber to subscribe to gesture recognition results
    self.grasp_status_sub = self.create_subscription(Bool, 'grasp_done',
self.GraspStatusCallback, 1)
    #Create two subscribers to subscribe to the color image topic and the depth
image topic
    self.depth_image_sub = Subscriber(self, Image, "/camera/color/image_raw",
qos_profile=1)
    self.rgb_image_sub = Subscriber(self, Image, "/camera/depth/image_raw",
qos_profile=1)
    #Time synchronization of color and depth image subscription messages
    self.TimeSynchronizer = ApproximateTimeSynchronizer([self.depth_image_sub,
self.rgb_image_sub],queue_size=10,slop=0.5)
    self.TimeSynchronizer.registerCallback(self.Color_Detect)
```

```python
    #Save the xy coordinates of the center of the color block
    self.y = 0 #320
    self.x = 0 #240
    #Create a bridge for color and depth image topic message data to image data
    self.rgb_bridge = CvBridge()
    self.depth_bridge = CvBridge()
    #Store the list of x and y values ••of the center value of the identified color block
    self.CX_list = []
    self.CY_list = []
    #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'
    #Initialize the state value
    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 selected by the mouse
    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)
    exit_code = os.system('rosservice call /camera/set_color_exposure 50')
    #The center xy coordinates of the currently identified color block and the radius of the minimum circumscribed circle of the color block
    self.cx = 0
    self.cy = 0
    self.circle_r = 0
    #The flag for publishing color block information, True means that the color block information can be published
    self.pubPos_flag = False
    #Initialize the height value of the color block
    self.heigh = 0.0
    #Current position and posture of the end of the robot
    self.CurEndPos = [-0.006,0.116261662208,0.0911289015753,-1.04719,-0.0,0.0]
    #Camera built-in parameters
    self.camera_info_K = [477.57421875, 0.0, 319.3820495605469, 0.0,
477.55718994140625, 238.64108276367188, 0.0, 0.0, 1.0]
    #Rotation transformation matrix of the end of the robot and the camera,
describing the relative position and posture between the two
    self.EndToCamMat =
np.array([[1.00000000e+00,0.00000000e+00,0.00000000e+00,0.00000000e+00],
     [0.00000000e+00,7.96326711e-04,9.99999683e-01,-9.90000000e-02],
     [0.00000000e+00,-9.99999683e-01,7.96326711e-04,4.90000000e-02],
[0.00000000e+00,0.00000000e+00,0.00000000e+00,1.00000000e+00]])
```

Mainly look at the image processing function Color_Detect,

```
def Color_Detect(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 the
keyboard event action
    result_frame, binary = self.process(result_image,action)
    print("self.CX_list: ",self.CX_list)
    print("self.CY_list: ",self.CY_list)
    # Traverse self.CX_list
    for i in range(len(self.CX_list)):
        cx = self.CX_list[i]
        cy = self.CY_list[i]
       #Calculate the depth value corresponding to the center coordinate
       dist = depth_image_info[cy,cx]/1000
       #Put the obtained color block center value coordinates and the depth
information corresponding to the center point into the compute_heigh function,
calculate the color block height value and perform a method on it, and change the
unit from meter to millimeter
       heigh = round(self.compute_heigh(cx,cy,dist),2) *1000
       heigh_msg = str(heigh) + 'mm'
       #Call opencv's putText function to draw the height information on the
color image
       cv.putText(result_frame, heigh_msg, (cx+5, cy+5), cv.FONT_HERSHEY_SIMPLEX,
0.5, (0, 0, 0), 2)
       #Create a color block information message and assign a value
       pos = AprilTagInfo()
       pos.x = cx
       pos.y = cy
       pos.z = dist
       #Judge whether self.pubPos_flag is 0 and the center corresponding to the
center of the color block is not 0
        if self.pubPos_flag == True and pos.z!=0:
            if i==len(self.CX_list) :
                self.pubPos_flag = False
            #If the calculated value is greater than 50, that is, the height is
higher than 5 cm, then publish the message of the topic of color block
information
            if heigh>50:
                self.pub_ColorInfo.publish(pos)
                self.pubPos_flag = False
    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 so, 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:
            rgb_img, binary, self.CX_list,self.CY_list =
self.color.ShapeRecognition(rgb_img, self.hsv_range)
            #The flag for determining dynamic parameter updates. 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].