Yolov5 garbage 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 is started, the camera captures the image and places the garbage label code block in the image. The robotic arm recognizes the category of the garbage label code block, and the lower claw grabs the garbage label code block. According to the category of the garbage label code, it is placed in the set position. After the placement is completed, it returns to the recognized posture.

2. Start and operate

2.1. Start command

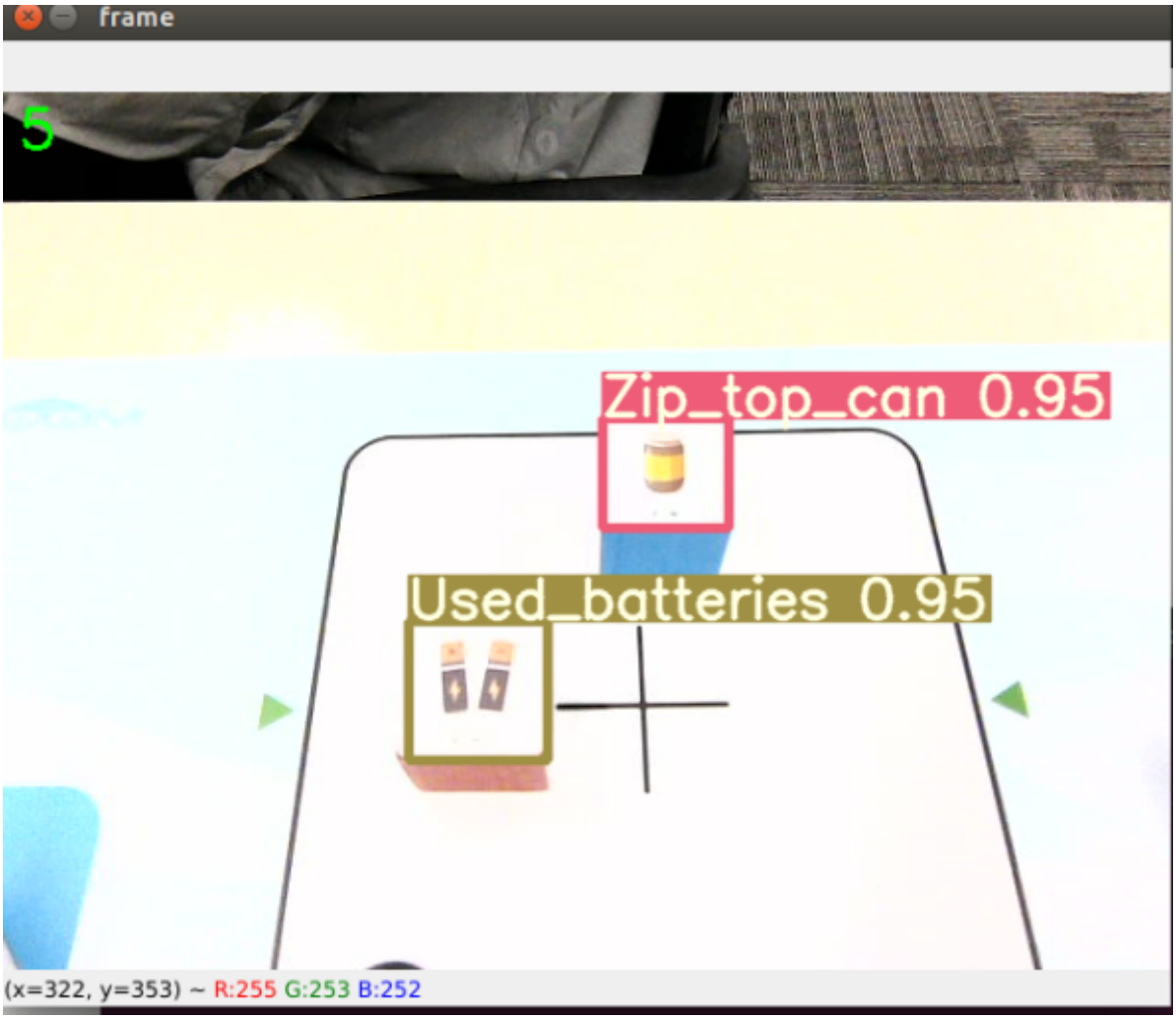
Enter the following command in the terminal to start,

```
#Start the camera
roslaunch orbbec_camera dabai_dcw2.launch
#Start the inverse solution
rosrun dofbot_pro_info kinemarics_dofbot_pro
#Start the underlying driver of the robotic arm
rosrun dofbot_pro_info arm_driver.py
#Start the image conversion program
rosrun dofbot_pro_yolov5 msgToimg.py
#Start the Yolov5 recognition program
python ~/dofbot_pro_ws/src/dofbot_pro_yolov5/scripts/yolov5.py
#Start the robotic arm garbage sorting program
rosrun dofbot_pro_yolov5 yolov5_sortation.py
```

Due to the performance differences of the motherboard, the time for different motherboards to start loading the Yolov5 recognition program is different, so you need to wait patiently for a while.

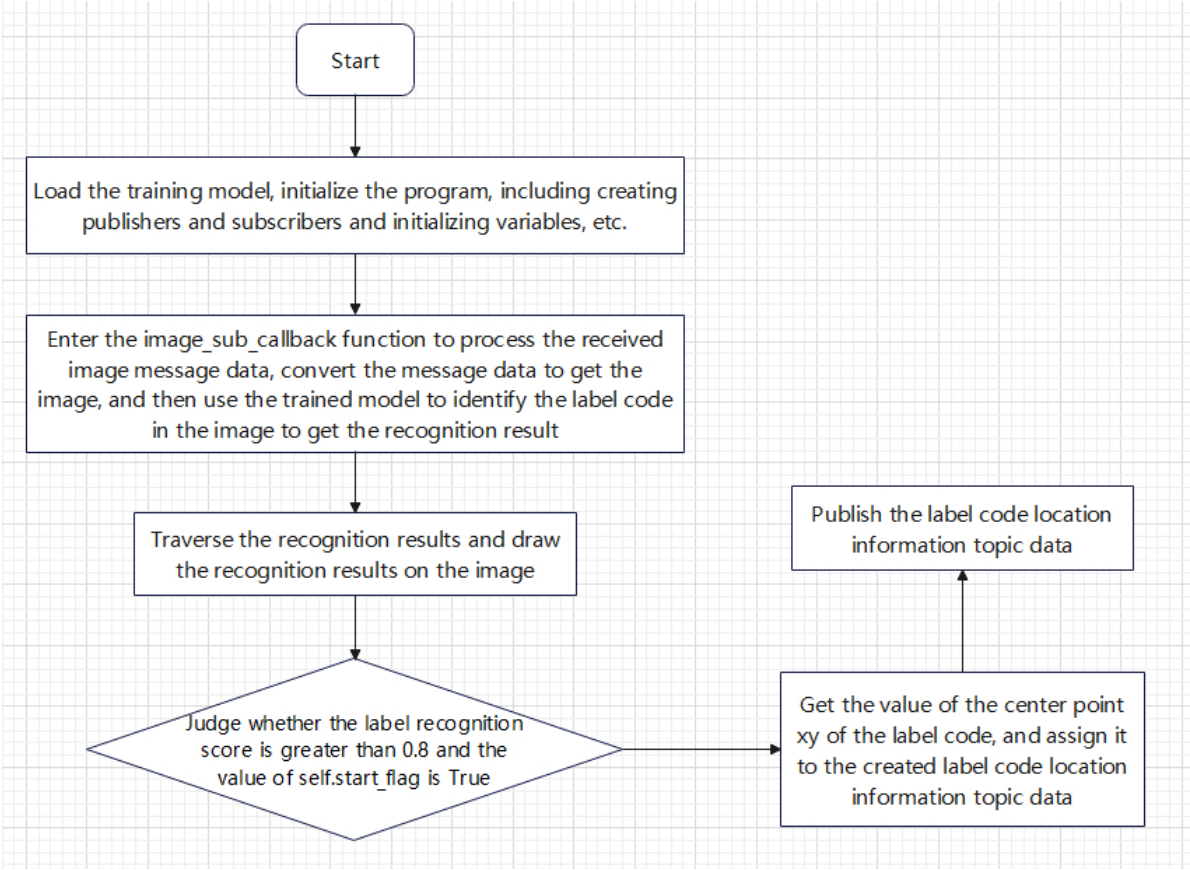
2.2, Operation process

After the program is started, place the wooden block with the garbage label code in the middle of the image. The wooden block needs to be straightened and the icon needs to be in the same direction as the robot arm (forward, Y axis direction). Press the space bar to start recognition. The robot arm will grasp the wooden block and place it in the corresponding position according to the type of garbage it recognizes.

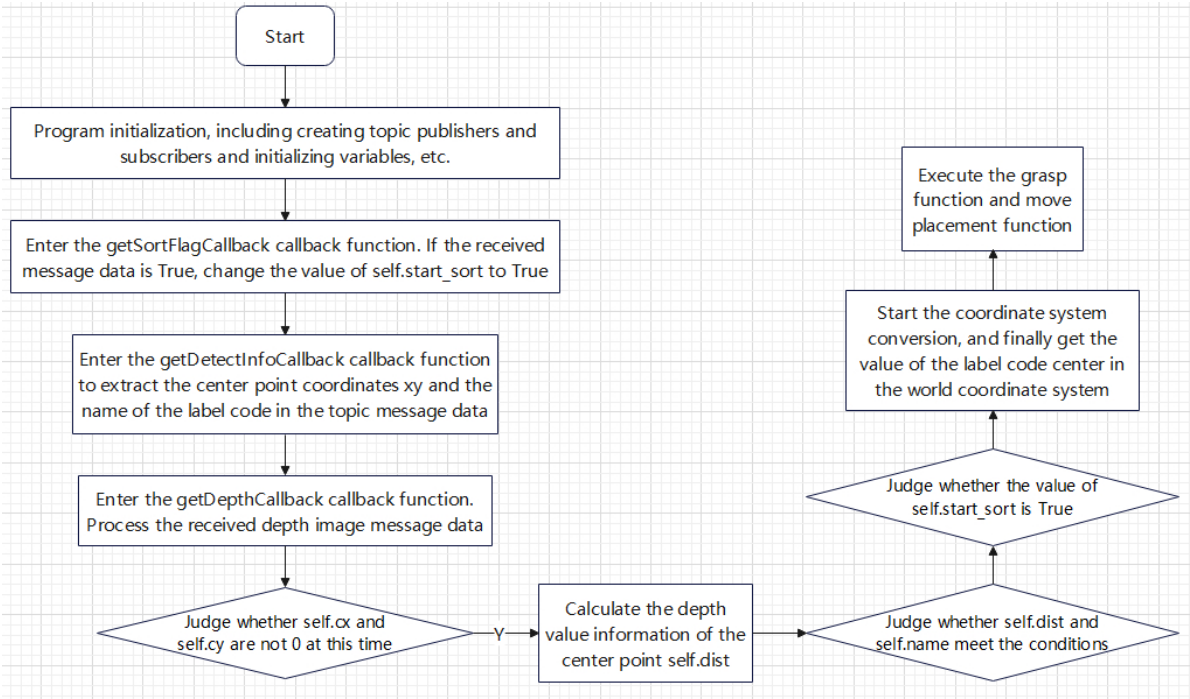


3. Program flow chart

yolov5.py



yolov5_sortation.py



4. Core code analysis

4.1. msgToimg.py

Code path: `/home/jetson/dofbot_pro_ws/src/dofbot_pro_yolov5/scripts/msgToimg.py`

Import necessary libraries,

```
import sys
import rospy
import numpy as np
import os
from sensor_msgs.msg import Image
from cv_bridge import CvBridge, CvBridgeError
from dofbot_pro_info.msg import Image_Msg
```

Initialize program parameters, create publishers and subscribers,

```
def __init__(self):
    #Create a bridge for color image topic message data to image data
    self.bridge = CvBridge()
    #Create a color image topic subscriber
    self.image_sub =
rospy.Subscriber("/camera/color/image_raw",Image,self.image_sub_callback)
    #Create an image data publisher
    self.image_pub = rospy.Publisher('/image_data', Image_Msg, queue_size=1)
    self.img = np.zeros((480, 640, 3), dtype=np.uint8) # Initial image
    self.yolov5_img = np.zeros((480, 640, 3), dtype=np.uint8) # Initial image
    self.img_flip = rospy.get_param("~img_flip", False)
    #Initialize the message object of the image data
    self.image = Image_Msg()
```

image_sub_callback callback function,

```
def image_sub_callback(self, data):
    #Receive a color image topic message and convert the message data into image
data
    self.img = self.bridge.imgmsg_to_cv2(data, "bgr8")
    #Get the length and width of the image
    size = self.img.shape
    #Assign values ••to the data in the image message object
    self.image.height = size[0] # 480
    self.image.width = size[1] # 640
    self.image.channels = size[2] # 3
    self.image.data = data.data # image_data
    #Publish an image topic
    self.image_pub.publish(self.image)
```

4.2、yolov5.py

Code path: `/home/jetson/dofbot_pro_ws/src/dofbot_pro_yolov5/scripts/yolov5.py`

Import necessary library files,

```
import cv2
import torch
import numpy as np
from numpy import random
from utils.plots import plot_one_box
from models.experimental import attempt_load
```

```
from utils.general import (non_max_suppression, scale_coords, xyxy2xywh)
from utils.torch_utils import select_device, time_synchronized
import time
import message_filters
#ros
import rospy
from sensor_msgs.msg import Image
from std_msgs.msg import Bool
from dofbot_pro_info.msg import *
```

Initialize program parameters, create publishers and subscribers,

```
def __init__(self):
    rospy.init_node('detect_node')
    self.pr_time = time.time()
    #Create a subscriber to subscribe to the image topic message
    self.image_sub =
rospy.Subscriber("/image_data",Image_Msg,self.image_sub_callback)
    #Customize the size of the initial image
    self.img = np.zeros((480, 640, 3), dtype=np.uint8) # Initial image
    #Initialize the recognition posture of the robotic arm
    self.init_joints = [90.0, 120, 0.0, 0.0, 90, 90]
    #Create a publisher to publish the topic "robotic arm target angle"
    self.pubPoint = rospy.Publisher("TargetAngle", ArmJoint, queue_size=1)
    #Create a publisher to publish the topic "Yolov5 detection information"
    self.pubDetect = rospy.Publisher("Yolov5DetectInfo", Yolov5Detect,
queue_size=1)
    #Create a publisher to publish the topic "sorting"
    self.pub_SortFlag = rospy.Publisher('sort_flag',Bool,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)
    #Initialize the flag to start sorting. If it is True, start sorting
    self.start_flag = False
```

The callback function for subscribing to the image topic,

```
def image_sub_callback(self,data):
    # Convert custom image messages into images
    image = np.ndarray(shape=(data.height, data.width, data.channels),
dtype=np.uint8, buffer=data.data)
    # Convert rgb to opencv bgr order
    self.img[:,:,0],self.img[:,:,1],self.img[:,:,2] =
image[:,:,2],image[:,:,1],image[:,:,0] # 将rgb 转化为opencv的bgr顺序
    img = self.img.copy()
    img = np.transpose(img, (2, 0, 1))
    img = torch.from_numpy(img).to(device)
    img = img.float()  # uint8 to fp16/32
    img /= 255.0  # 0 - 255 to 0.0 - 1.0
    if img.ndimension() == 3:
        img = img.unsqueeze(0)
    pred = model(img)[0]
    pred = non_max_suppression(pred, 0.4, 0.5)
    gn = torch.tensor(self.img.shape)[[1, 0, 1, 0]]
```

```
    key = cv2.waitKey(10)
    if pred != [None]:
        for i, det in enumerate(pred):  # detections per image
            det[:, :4] = scale_coords(img.shape[2:], det[:, :4],
self.img.shape).round()
            for *xyxy, conf, cls in reversed(det):
                xywh = (xyxy2xywh(torch.tensor(xyxy).view(1, 4)) /
gn).view(-1).tolist()  # normalized xywh
                label = '%s %.2f' % (names[int(cls)], conf)
                plot_one_box(xyxy, self.img, label=label,
color=colors[int(cls)], line_thickness=3)
                #Judge whether the score of label recognition is greater than 0.8
and the value of self.start_flag is True
                if conf.item()>0.8 and self.start_flag == True:
                    #self.pubDetect.publish(center)
                    #Extract the center point coordinates of the tag and assign
them to the created tag code location information topic message data
                    cx = (xyxy[0].item() + xyxy[2].item())/2
                    cy = (xyxy[1].item() + xyxy[3].item())/2
                    center = Yolov5Detect()
                    center.centerx = cx
                    center.centery = cy
                    center.result = names[int(cls)]
                    #Publish tag code machine code location information topic
message data
                    self.pubDetect.publish(center)
                    self.start_flag = False
    #Get the current timestamp
    cur_time = time.time()
    #Calculate frame rate
    fps = str(int(1/(cur_time - self.pr_time)))
    self.pr_time = cur_time
    cv2.putText(self.img, fps, (10, 30), cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 255,
0), 2)
    cv2.imshow("frame", self.img)
    #Judge whether the space bar is pressed or the value of self.start_flag is
true. If any of these conditions are met, a "start sorting" message is sent
    if key == 32 or self.start_flag == True:
        print("Send a start signal.")
        start_flag = Bool()
        start_flag.data = True
        self.pub_SortFlag.publish(start_flag)
```

4.3、yolov5_sortation.py

Code path:
`/home/jetson/dofbot_pro_ws/src/dofbot_pro_yolov5/scripts/yolov5_sortation.py`

Import necessary libraries,

```
import rospy
import numpy as np
from sensor_msgs.msg import Image
from std_msgs.msg import Float32,Bool,Int8
from cv_bridge import CvBridge
```

```
import cv2 as cv
import time
import math
from dofbot_pro_info.msg import *
from dofbot_pro_info.srv import *
import transforms3d as tfs
import tf.transformations as tf
import threading
import yaml
encoding = ['16UC1', '32FC1']
```

Open the offset parameter table,

```
offset_file = rospkg.RosPack().get_path("dofbot_pro_info") +
"/param/offset_value.yaml"
with open(offset_file, 'r') as file:
    offset_config = yaml.safe_load(file)
print(offset_config)
print("----------------------------")
print("x_offset: ",offset_config.get('x_offset'))
print("y_offset: ",offset_config.get('y_offset'))
print("z_offset: ",offset_config.get('z_offset'))
```

Initialize program parameters, create publishers, subscribers, etc.

```
def __init__(self):
    nodeName = 'yolov5_grap'
    rospy.init_node(nodeName)
    #Create a publisher to publish the target angle of the robot arm
    self.pubPoint = rospy.Publisher("TargetAngle", ArmJoint, queue_size=1)
    #Create a publisher to publish the topic of gripping completion
    self.pubGraspStatus = rospy.Publisher("grasp_done", Bool, queue_size=1)
    #Create a publisher to publish the voice ID code
    self.pub_playID = rospy.Publisher("player_id", Int8, queue_size=1)
    #Create a subscriber to subscribe to the results of Yolov5 identification
label code
    self.subDetect = rospy.Subscriber("Yolov5DetectInfo", Yolov5Detect,
self.getDetectInfoCallback)
    #Create a subscriber to subscribe to the depth image data topic
    self.depth_image_sub =
rospy.Subscriber('/camera/depth/image_raw',Image,self.getDepthCallback)
    #Create a subscriber to subscribe to the "start sorting" flag
    self.sub_SortFlag =
rospy.Subscriber('sort_flag',Bool,self.getSortFlagCallback)
    #Create a client that calls the inverse solution service
    self.client = rospy.ServiceProxy("get_kinemarics", kinemarics)
    #Initialize the grip flag. When the value is True, it means that gripping is
possible
    self.grasp_flag = True
    self.init_joints = [90.0, 120, 0.0, 0.0, 90, 90]
    self.down_joint = [130.0, 55.0, 34.0, 16.0, 90.0,125]
    self.set_joint = [90.0, 120, 0.0, 0.0, 90, 90]
    self.gripper_joint = 90
    self.depth_bridge = CvBridge()
```

```
    self.start_sort = False
    self.CurEndPos = [0.0, 0.0, 0.0, 0.0, 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 relative position of the camera and
the end of the robotic arm
    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]])
    #Get the current position and posture information of the end of the robot
    self.get_current_end_pos()
    #Current label center coordinate value
    self.cx = 320
    self.cy = 240
    #Garbage label name
    self.name = None
    #Read the content of the offset parameter table and assign it to the offset
parameter
    self.x_offset = offset_config.get('x_offset')
    self.y_offset = offset_config.get('y_offset')
    self.z_offset = offset_config.get('z_offset')

    self.play_id = Int8()
    #List of four types of garbage
    self.recyclable_waste=['Newspaper','Zip_top_can','Book','Old_school_bag']
    self.toxic_waste=
['Syringe','Expired_cosmetics','Used_batteries','Expired_tablets']
    self.wet_waste=['Fish_bone','Egg_shell','Apple_core','Watermelon_rind']
    self.dry_waste=
['Toilet_paper','Peach_pit','Cigarette_butts','Disposable_chopsticks']
    print("Current_End_Pose: ",self.CurEndPos)
    print("Init Done")
```

The callback function getDetectInfoCallback of the identified spam tag result,

```
def getDetectInfoCallback(self,msg):
    #Assign label center coordinate value and label name
    self.cx = int(msg.centerx)
    self.cy = int(msg.centery)
    self.name = msg.result
```

The callback function getDepthCallback of the depth image topic,

```
def getDepthCallback(self,msg):
    #Process the received deep image topic message
    depth_image = self.depth_bridge.imgmsg_to_cv2(msg, encoding[1])
    frame = cv.resize(depth_image, (640, 480))
    depth_image_info = frame.astype(np.float32)
```

```
    #Judge whether the values ••of self.cy and self.cx are both not 0
    if self.cy!=0 and self.cx!=0:
        #Get the depth value of the center point
        self.dist = depth_image_info[self.cy,self.cx]/1000
        print("self.dist",self.dist)
        print("get the cx,cy",self.cx,self.cy)
        print("get the detect result",self.name)
        #Judge whether the depth value of the center point is not 0 and the
value of self.name is not none
        if self.dist!=0 and self.name!=None:
            #Judge whether self.start_sort is True
            if self.start_sort == True:
                #Start coordinate system conversion, and finally output the
position of the center point in the world coordinate system
                camera_location =
self.pixel_to_camera_depth((self.cx,self.cy),self.dist)
                PoseEndMat = np.matmul(self.EndToCamMat,
self.xyz_euler_to_mat(camera_location, (0, 0, 0)))
                #PoseEndMat = np.matmul(self.xyz_euler_to_mat(camera_location,
(0, 0, 0)),self.EndToCamMat)
                EndPointMat = self.get_end_point_mat()
                WorldPose = np.matmul(EndPointMat, PoseEndMat)
                #WorldPose = np.matmul(PoseEndMat,EndPointMat)
                pose_T, pose_R = self.mat_to_xyz_euler(WorldPose)
                #Add the offset parameter to compensate for the deviation caused
by the difference in servo values
                pose_T[0] = pose_T[0] + self.x_offset
                pose_T[1] = pose_T[1] + self.y_offset
                pose_T[2] = pose_T[2] + self.z_offset
                #Start the clamping thread, the parameter passed in is the
position of the label just calculated in the world coordinate system
                grasp = threading.Thread(target=self.grasp, args=(pose_T,))
                grasp.start()
                grasp.join()
```

The callback function getSortFlagCallback that starts sorting topics.

```
def getSortFlagCallback(self,msg):
    #Judge whether the received value is True, if so, modify the value of
self.start_sort to True
    if msg.data == True:
        self.start_sort = True
```

Grasp function grasp,

```
def grasp(self,pose_T):
    print("--------------------------------------------------")
    print("pose_T: ",pose_T)
    #Call the ik algorithm in the inverse solution service to calculate the
values ••of the six servos
    request = kinemaricsRequest()
    #The target x value at the end of the robot arm, in m
    request.tar_x = pose_T[0]
    #The target y value at the end of the robot arm, in m
```

```
    request.tar_y = pose_T[1]
    #The target z value at the end of the robot arm, in m, 0.2 is the scaling
factor, make slight adjustments based on actual conditions
    request.tar_z = pose_T[2] +
(math.sqrt(request.tar_y**2+request.tar_x**2)-0.181)*0.2
    #Specify the service content as ik
    request.kin_name = "ik"
    #The target Roll value at the end of the robot arm, in radians, this value is
the current roll value at the end of the robot arm
    request.Roll = self.CurEndPos[3]
    print("calcutelate_request: ",request)
    try:
        response = self.client.call(request)
        joints = [0.0, 0.0, 0.0, 0.0, 0.0,0.0]
        #Assign the joint1-joint6 values ••returned by the call service to
joints
        joints[0] = response.joint1
        joints[1] = response.joint2
        joints[2] = response.joint3
        if response.joint4>90:
            joints[3] = 90
        else:
            joints[3] = response.joint4
        joints[4] = 90
        joints[5] = 30
        print("compute_joints: ",joints)
        self.pubTargetArm(joints)
        time.sleep(2.5)
        #After grabbing, call the move function, determine which garbage list it
belongs to based on the value of self.name, and place it in the set position
        self.move()
    except Exception:
       rospy.loginfo("run error")
```