Color Stacking

Orin board users can directly open a web page and enter IP address:8888 to access jupyter-lab and run directly. Jetson-Nano board users need to first enter the docker container, then enter the following command in docker:

```
cd
jupyter-lab --allow-root
```

Then open a web page and enter IP address:9999 to access jupyter-lab and run the following program.

1. Function Description

The color stacking function is based on the color sorting function, modifying the grabbing and placement position to stack building blocks, with similar functional operations.

The color recognition function uses HSV color recognition. The HSV color calibration file is saved at ~/dofbot_ws/src/dofbot_color_identify/scripts/HSV_config.txt. If color recognition is not accurate enough, please recalibrate the building block color HSV values according to the [Visual Basic Course] -> [Color Calibration] course. After the calibration operation is completed, it will be automatically saved to the HSV_config file. Rerun the program without needing to modify the code.

Note: Before starting the program, please follow the [Assembly and Installation Tutorial] -> [Install Map] tutorial to correctly install the map before proceeding with operations.

The robotic arm position calibration file is saved at:

```
#Jetson-Nano users need to enter the docker container to view
~/dofbot_pro/dofbot_color_stacking/scripts/XYT_config.txt
```

Code path:

```
#Jetson-Nano users need to enter the docker container to view
~/dofbot_pro/dofbot_color_stacking/scripts/Color_Stacking.ipynb
```

2. Code Block Design

- Import header files

```
import cv2 as cv
import threading
from time import sleep
import ipywidgets as widgets
from IPython.display import display

from dofbot_utils.dofbot_config import *
from stacking_target import stacking_GetTarget
from dofbot_utils.fps import FPS
```

- Create instances, initialize parameters

```
target      = stacking_GetTarget()
calibration = Arm_Calibration()
num = 0
dp = []
xy = [90, 106]
msg   = {}
threshold = 120
debug_pos = False
model = "General"
color_list = {'1': 'red', '2': 'green', '3': 'blue', '4': 'yellow'}
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))}
# XYT参数路径  XYT Parameter path
HSV_path="/home/jetson/dofbot_pro/dofbot_color_identify/scripts/HSV_config.txt"
XYT_path="/home/jetson/dofbot_pro/dofbot_color_stacking/scripts/XYT_config.txt"
try: read_HSV(HSV_path,color_hsv)
except Exception: print("No HSV_config file!!!")
try: xy, threshold = read_XYT(XYT_path)
except Exception: print("No XYT_config file!!!")
```

```
import Arm_Lib
arm = Arm_Lib.Arm_Device()
joints_0 = [xy[0], xy[1], 0, 0, 90, 30]
arm.Arm_serial_servo_write6_array(joints_0, 1000)
fps = FPS()
```

- Create widgets

```
button_layout      = widgets.Layout(width='320px', height='60px',
align_self='center')
output = widgets.Output()
# 调整滑杆 Adjust the slider
joint1_slider      = widgets.IntSlider(description='joint1 :'    ,     value=xy[0]
    , min=70 , max=110, step=1, orientation='horizontal')
joint2_slider      = widgets.IntSlider(description='joint2 :'    ,     value=xy[1]
    , min=90, max=150, step=1, orientation='horizontal')
threshold_slider   = widgets.IntSlider(description='threshold :',
value=threshold , min=0  , max=255, step=1, orientation='horizontal')

# 进入标定模式  Enter calibration mode
```

```
calibration_model  = widgets.Button(description='calibration_model',
button_style='primary', layout=button_layout)
calibration_ok     = widgets.Button(description='calibration_ok',
button_style='success', layout=button_layout)
calibration_cancel = widgets.Button(description='calibration_cancel',
button_style='danger', layout=button_layout)
# 选择抓取颜色  Select grab color
color_list_one     = widgets.Dropdown(options=['red', 'green', 'blue', 'yellow',
'none'], value='red', disabled=False)
color_list_two     = widgets.Dropdown(options=['red', 'green', 'blue', 'yellow',
'none'], value='green', disabled=False)
color_list_three   = widgets.Dropdown(options=['red', 'green', 'blue', 'yellow',
'none'], value='blue', disabled=False)
color_list_four    = widgets.Dropdown(options=['red', 'green', 'blue', 'yellow',
'none'], value='yellow', disabled=False)
# 目标检测抓取 Target detection and capture
target_detection   = widgets.Button(description='target_detection',
button_style='info', layout=button_layout)
reset_color_list   = widgets.Button(description='reset_color_list',
button_style='info', layout=button_layout)
grap = widgets.Button(description='grap', button_style='success',
layout=button_layout)
# 退出  exit
exit_button = widgets.Button(description='Exit', button_style='danger',
layout=button_layout)
imgbox = widgets.Image(format='jpg', height=480, width=640,
layout=widgets.Layout(align_self='center'))
color_down = widgets.HBox([exit_button, reset_color_list],
layout=widgets.Layout(align_self='center'));
color_img = widgets.VBox([imgbox, color_down],
layout=widgets.Layout(align_self='center'));
color_identify = widgets.VBox(
    [joint1_slider, joint2_slider, threshold_slider, calibration_model,
calibration_ok, calibration_cancel,
     color_list_one, color_list_two, color_list_three, color_list_four,
target_detection, grap],
    layout=widgets.Layout(align_self='center'));
controls_box = widgets.HBox([color_img, color_identify],
layout=widgets.Layout(align_self='center'))
```

- Calibration callback

```
def calibration_model_Callback(value):
    global model
    model = 'Calibration'
    with output: print(model)
def calibration_OK_Callback(value):
    global model
    model = 'calibration_OK'
    with output: print(model)
def calibration_cancel_Callback(value):
    global model
    model = 'calibration_Cancel'
    with output: print(model)
calibration_model.on_click(calibration_model_Callback)
calibration_ok.on_click(calibration_OK_Callback)
calibration_cancel.on_click(calibration_cancel_Callback)
```

- Color selection sequence

```
# 选择颜色  Select color
def color_list_one_Callback(value):
    global model,color_list
    model="General"
    if not isinstance(value['new'],str):return
    if value['new'] == "none":
        if '1' in color_list:del color_list['1']
    elif value['new'] == "red":
        color_list['1'] = "red"
    elif value['new']== "green":
        color_list['1'] = "green"
    elif value['new'] == "blue":
        color_list['1'] = "blue"
    elif value['new'] == "yellow":
        color_list['1'] = "yellow"
    with output:
        print("color_list_three_Callback clicked.",color_list)
def color_list_two_Callback(value):
    global model,color_list
    model="General"
    if not isinstance(value['new'],str):return
    if value['new'] == "none":
        if '2' in color_list:del color_list['2']
    elif value['new'] == "red":
        color_list['2'] = "red"
    elif value['new'] == "green":
        color_list['2'] = "green"
    elif value['new'] == "blue":
        color_list['2'] = "blue"
    elif value['new'] == "yellow":
        color_list['2'] = "yellow"
    with output:
        print("color_list_three_Callback clicked.",color_list)
def color_list_three_Callback(value):
    global model,color_list
    model="General"
    if not isinstance(value['new'],str):return
    if value['new'] == "none":
        if '3' in color_list:del color_list['3']
    elif value['new'] == "red":
        color_list['3'] = "red"
    elif value['new'] == "green":
        color_list['3'] = "green"
    elif value['new'] == "blue":
        color_list['3'] = "blue"
    elif value['new'] == "yellow":
        color_list['3'] = "yellow"
    with output:
        print("color_list_three_Callback clicked.",color_list)
def color_list_four_Callback(value):
    global model,color_list
    model="General"
    if not isinstance(value['new'],str):return
    if value['new'] == "none":
        if '4' in color_list:del color_list['4']
    elif value['new'] == "red":
        color_list['4'] = "red"
    elif value['new'] == "green":
        color_list['4'] = "green"
    elif value['new'] == "blue":
        color_list['4'] = "blue"
    elif value['new'] == "yellow":
        color_list['4'] = "yellow"
    with output:
        print("color_list_four_Callback clicked.",color_list)
color_list_one.observe(color_list_one_Callback)
color_list_two.observe(color_list_two_Callback)
color_list_three.observe(color_list_three_Callback)
color_list_four.observe(color_list_four_Callback)
```

- Mode switching

```
def target_detection_Callback(value):
    global model, debug_pos
    model = 'Detection'
    debug_pos = True
    with output: print(model)
def reset_color_list_Callback(value):
    global model
    model = 'Reset_list'
    with output: print(model)
def grap_Callback(value):
    global model
    model = 'Grap'
    with output: print(model)
def exit_button_Callback(value):
    global model
    model = 'Exit'
    with output: print(model)
target_detection.on_click(target_detection_Callback)
reset_color_list.on_click(reset_color_list_Callback)
grap.on_click(grap_Callback)
exit_button.on_click(exit_button_Callback)
```

- Main program

```
def camera():
    global color_hsv,model,dp,msg,color_list, debug_pos
    # 打开摄像头 Open camera
    capture = cv.VideoCapture(0, cv.CAP_V4L2)
    capture.set(cv.CAP_PROP_FRAME_WIDTH, 640)
    capture.set(cv.CAP_PROP_FRAME_HEIGHT, 480)
    index=1
    # Be executed in loop when the camera is opened normally
    while capture.isOpened():
        try:
            _, img = capture.read()
            fps.update_fps()
            xy=[joint1_slider.value,joint2_slider.value]
            if model == 'Calibration':
                _, img =
calibration.calibration_map(img,xy,threshold_slider.value)
            if model == 'calibration_OK':
                try: write_XYT(XYT_path,xy, threshold_slider.value)
                except Exception: print("File XYT_config Error !!!")
                dp, img =
calibration.calibration_map(img,xy,threshold_slider.value)
                model="General"
            if len(dp) != 0: img = calibration.Perspective_transform(dp, img)
            if model == 'calibration_Cancel':
                dp = []
                msg= {}
                model="General"
            if len(dp)!= 0 and len(color_list)!= 0 and model == 'Detection':
                img, msg = target.select_color(img, color_hsv,color_list)
                # print("---",color_hsv['green'])
                if debug_pos:
                    debug_pos = False
                    print("detect msg:", msg)
            if model=="Reset_list":
                msg={}
                color_list = {}
                color_list_one.value = 'none'
                color_list_two.value = 'none'
                color_list_three.value = 'none'
                color_list_four.value = 'none'
                model="General"
            if len(msg)!= 0 and model == 'Grap':
                print("grasp msg:", msg)
                threading.Thread(target=target.target_run, args=
(msg,xy)).start()
                msg={}
                model="Detection"
            if model == 'Exit':
                capture.release()
                break
            index+=1
            fps.show_fps(img)
            imgbox.value = cv.imencode('.jpg', img)[1].tobytes()
        except Exception as e:
            print("program end")
            print(e)
            capture.release()
```

- Startup

```
display(controls_box,output)
threading.Thread(target=camera, ).start()
```

3. Start the Program

Start ROS Node Service

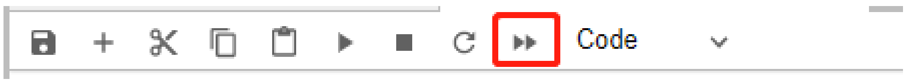
Open the system terminal and enter the following command. If it's already running, there's no need to start it again.

```
ros2 run dofbot_pro_info kinemarics_dofbot
```

Start the Program

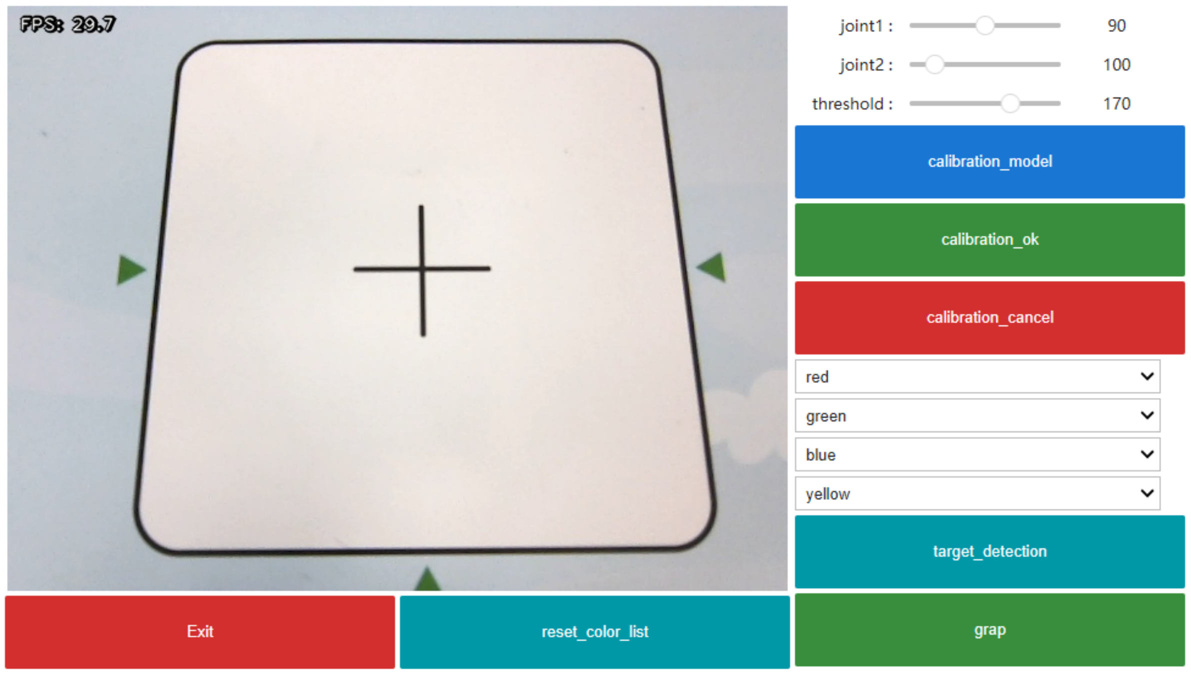
Open the jupyterlab webpage and find the corresponding .ipynb program file.

Then click the run all command.

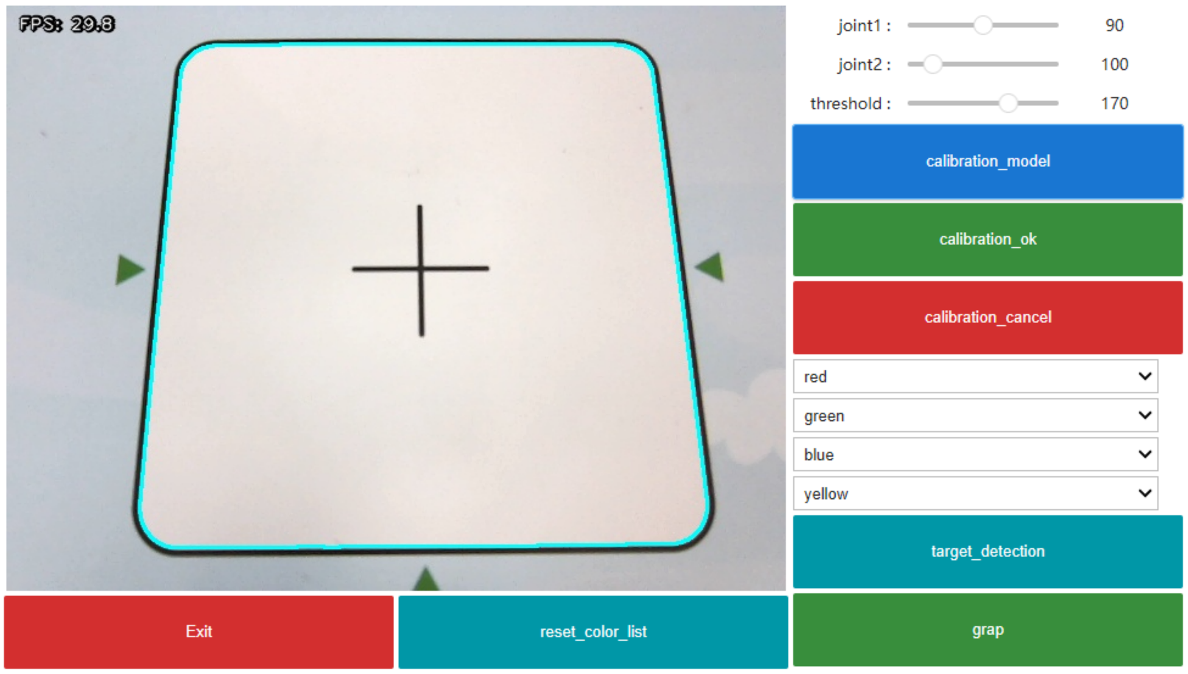


4. Operation and Effects

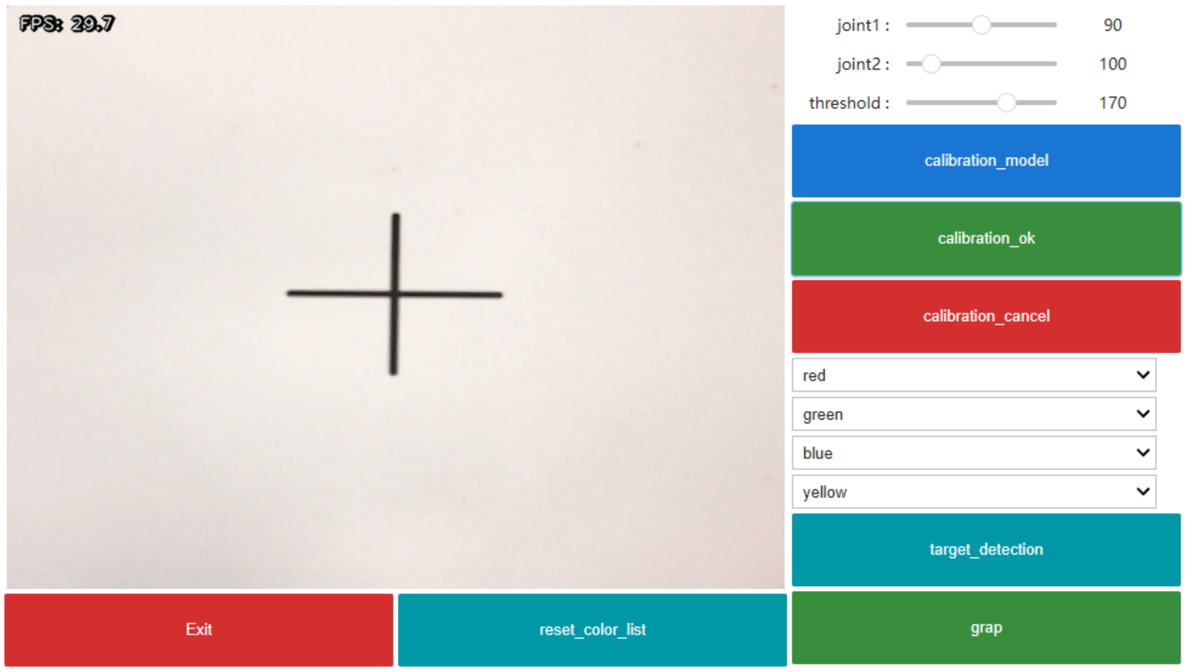
After the program runs, the jupyterlab webpage will display controls, with the camera display on the left and related button functions on the right.



Click [calibration_model] to enter calibration mode. Adjust the robotic arm joint sliders and threshold slider above to make the displayed blue line overlap with the black line of the recognition area.

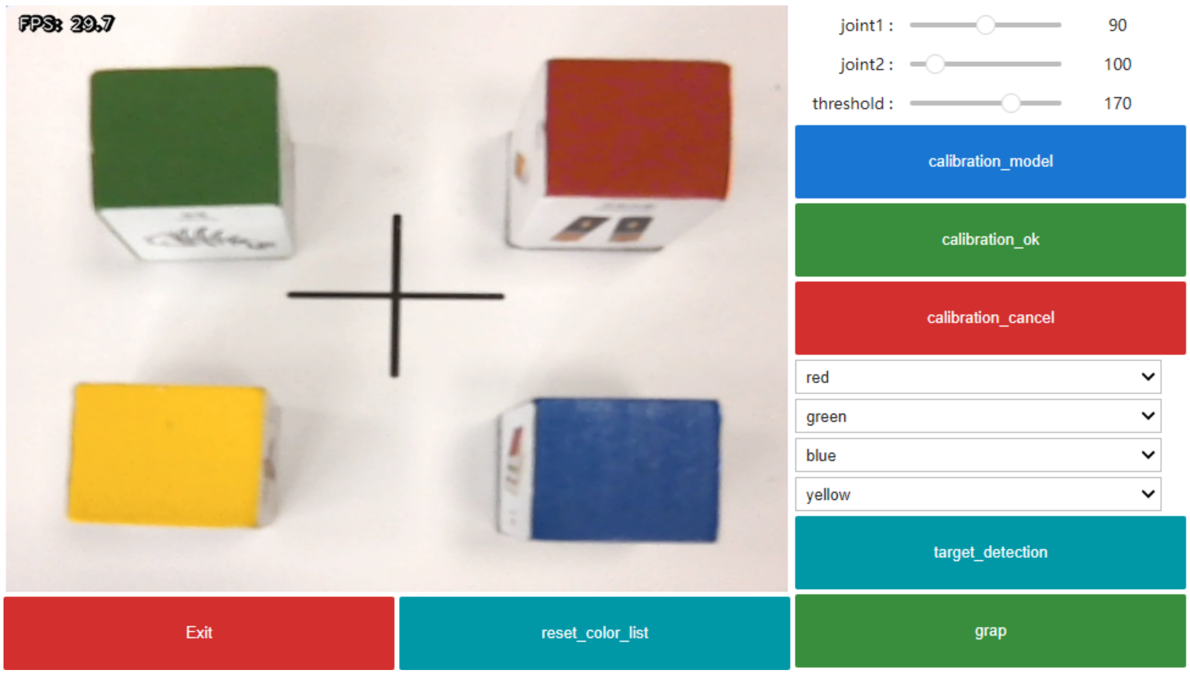


Then click [calibration_ok] for calibration OK. At this time, the camera view switches to the recognition area perspective.

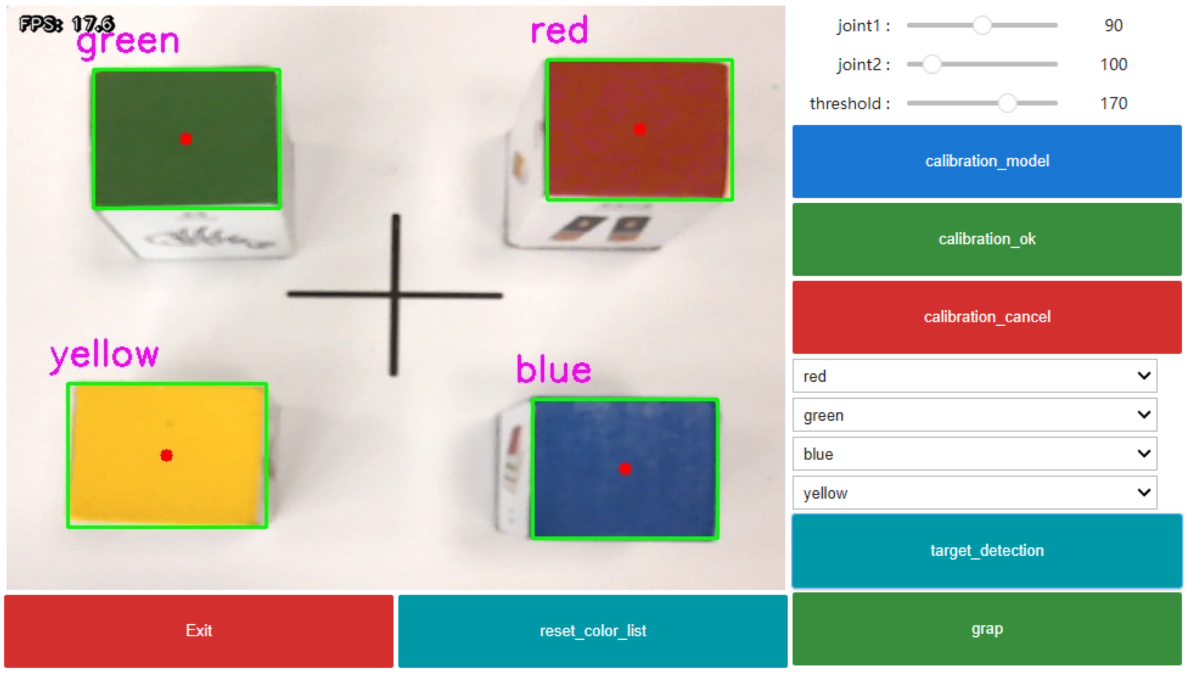


Place the building blocks in the recognition area with the colored side facing up, positioned properly within the recognition area, and try to keep the bottom edge parallel to the bottom edge of the recognition area. Then select the color sequence on the right. The default selection is red, green, blue, yellow. You can also click [reset_color_list] to reset all color options and then make selections.

Note: Due to the height of the building blocks, try to place them in the central area when placing, otherwise the color recognition of the building blocks may be incomplete and cause errors.



Then click [target_detection] to start color recognition. If color recognition is not accurate, please calibrate the colors first and then rerun the program.



Then click the [grap] button to start sorting. The system will stack the recognized colors in sequence in the green area.

If you need to exit the program, please click the [Exit] button.