Hand detection

1. Content Description

This course implements color image acquisition and hand joint detection using the mediapipe framework. This section requires entering commands in a terminal. The terminal you open depends on your board type. This lesson uses the Raspberry Pi as an example.

For Raspberry Pi and Jetson-Nano boards, you need to open a terminal on the host computer and enter the command to enter the Docker container. Once inside the Docker container, enter the commands mentioned in this lesson in the terminal. For instructions on entering the Docker container from the host computer, refer to **[01. Robot Configuration and Operation Guide] --[4.Enter Docker (For JETSON Nano and RPi 5)]**.

For RDKX5 and Orin boards, simply open a terminal and enter the commands mentioned in this lesson.

2. Program Startup

For Raspberry Pi and Jetson-Nano boards, you need to enter the Docker container first. For RDKX5 and Orin controllers, this is not necessary.

Enter the Docker container (see [Docker course] --- [4. Docker Startup Script] for steps).

All the following commands must be executed within the same Docker container **(see [Docker course] --- [3. Docker Submission and Multi-Terminal Access] for steps).**

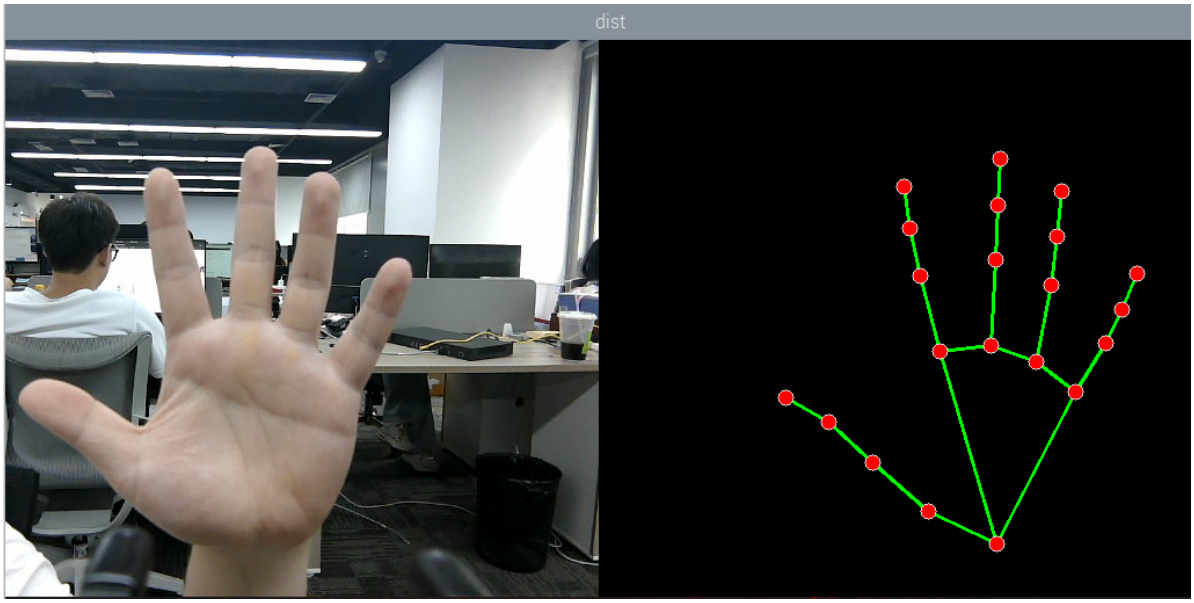
First, enter the following command in the terminal to start the camera.

```
#usb camera
ros2 launch usb_cam camera.launch.py
#nuwa camera
ros2 launch ascamera hp60c.launch.py
```

After successfully starting the camera, open another terminal and enter the following command to start the hand detection program.

```
ros2 run yahboomcar_mediapipe 01_HandDetector
```

After running the program, the following image appears. The detected hand joints are displayed on the right side of the image.



3. Core Code Analysis

Program Code Path:

- Raspberry Pi 5 and Jetson Nano Board

  The program code is running in Docker. The path in Docker is `/root/yahboomcar_ros2_ws/yahboomcar_ws/src/yahboomcar_mediapipe/yahboomcar_mediapipe/01_HandDetector.py`

- Orin board

  The program code path is `/home/jetson/yahboomcar_ros2_ws/yahboomcar_ws/src/yahboomcar_mediapipe/yahboomcar_mediapipe/01_HandDetector.py`

- RDK X5

  The program code path is `/home/sunrise/yahboomcar_ros2_ws/yahboomcar_ws/src/yahboomcar_mediapipe/yahboomcar_mediapipe/01_HandDetector.py`

Import the required library files.

```
import rclpy
from rclpy.node import Node
import mediapipe as mp
import cv2 as cv
import numpy as np
import time
import os
from cv_bridge import CvBridge
from sensor_msgs.msg import Image
from arm_msgs.msg import ArmJoints
import cv2
```

Initialize data and define publishers and subscribers,

```
def __init__(self):
    super().__init__('hand_detector')
    self.mpHand = mp.solutions.hands
```

```
    self.mpDraw = mp.solutions.drawing_utils
    self.hands = self.mpHand.Hands(
        static_image_mode=False,
        max_num_hands=2,
        min_detection_confidence=0.5,
        min_tracking_confidence=0.5
    )
    self.bridge = CvBridge()
    self.publisher_ = self.create_publisher(PointArray, '/mediapipe/points', 10)
    self.lmDrawSpec = mp.solutions.drawing_utils.DrawingSpec(color=(0, 0, 255),
thickness=-1, circle_radius=6)
    self.drawSpec = mp.solutions.drawing_utils.DrawingSpec(color=(0, 255, 0),
thickness=2, circle_radius=2)
    # Define subscribers for the color image topic
    camera_type = os.getenv('CAMERA_TYPE', 'usb')
    topic_name = '/ascamera_hp60c/camera_publisher/rgb0/image' if camera_type ==
'nuwa' else '/usb_cam/image_raw'
    self.subscription = self.create_subscription(
    Image,
    topic_name,
    self.image_callback,
    10)
```

Color image callback function,

```
def image_callback(self, msg):
    # Use CvBridge to convert color image message data into image data
    frame = self.bridge.imgmsg_to_cv2(msg, desired_encoding='bgr8')
    # Put the obtained image into the defined pubHandsPoint function, draw=False
means not to draw the joint points on the original color image
    frame, img = self.pubHandsPoint(frame, draw=True)
    combined = self.frame_combine(frame, img)
    cv.imshow('HandDetector', combined)
```

pubHandsPoint function,

```
def pubHandsPoint(self, frame, draw=True):
    #Create a new image based on the size of the image passed in. The image data
type is uint8
    img = np.zeros(frame.shape, np.uint8)
    #Convert the color space of the incoming image from BGR to RGB to facilitate
subsequent image processing
    img_RGB = cv.cvtColor(frame, cv.COLOR_BGR2RGB)
    #Call the process function in the mediapipe library to process the image.
During init, the self.hands object is created and initialized.
    self.results = self.hands.process(img_RGB)
    #Determine whether self.results.multi_hand_landmarks exists, that is, whether
the palm is recognized
    if self.results.multi_hand_landmarks:
        #Traverse the palm list and get the information of each point
        for i in range(len(self.results.multi_hand_landmarks)):
            if draw: self.mpDraw.draw_landmarks(frame,
self.results.multi_hand_landmarks[i], self.mpHand.HAND_CONNECTIONS,
self.lmDrawSpec, self.drawSpec)
            #On the blank image created previously, connect each joint point
```

```
            self.mpDraw.draw_landmarks(img,
self.results.multi_hand_landmarks[i], self.mpHand.HAND_CONNECTIONS,
self.lmDrawSpec, self.drawSpec)
    return frame, img
```

frame_combine merge image function,

```
def frame_combine(slef,frame, src):
    #Determine whether the image is a 3-channel, that is, RGB image
    if len(frame.shape) == 3:
        #Get the size of two images and stitch them together
        frameH, frameW = frame.shape[:2]
        srcH, srcW = src.shape[:2]
        dst = np.zeros((max(frameH, srcH), frameW + srcW, 3), np.uint8)
        dst[:, :frameW] = frame[:, :]
        dst[:, frameW:] = src[:, :]
    else:
        src = cv.cvtColor(src, cv.COLOR_BGR2GRAY)
        frameH, frameW = frame.shape[:2]
        imgH, imgW = src.shape[:2]
        dst = np.zeros((frameH, frameW + imgW), np.uint8)
        dst[:, :frameW] = frame[:, :]
        dst[:, frameW:] = src[:, :]
    return dst
```