Facial Landmark Detection

1. Content Description

This course implements color image acquisition and facial 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).**

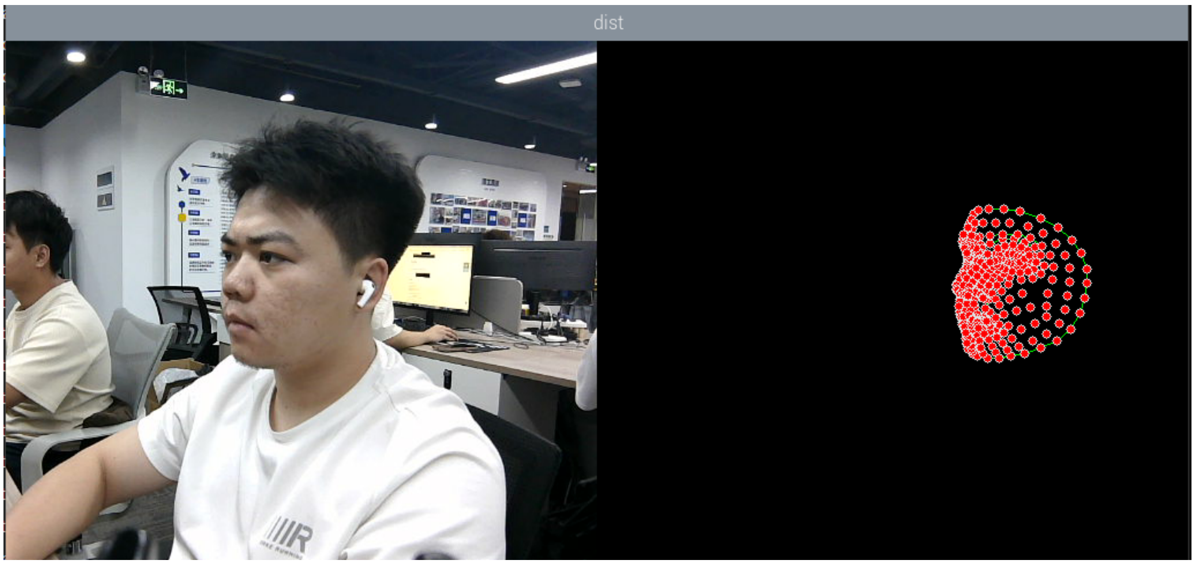
First, enter the following command in the terminal to start the camera.

```
#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 face detection program.

```
ros2 run yahboomcar_mediapipe 04_FaceMesh
```

After running the program, the image below shows the detected facial points 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/04_FaceMesheMesh.py`

- Orin board

  The program code path is `/home/jetson/yahboomcar_ros2_ws/yahboomcar_ws/src/yahboomcar_mediapipe/yahboomcar_mediapipe/04_FaceMesh.py`

- RDK X5

  The program code path is `/home/sunrise/yahboomcar_ros2_ws/yahboomcar_ws/src/yahboomcar_mediapipe/yahboomcar_mediapipe/04_FaceMesh.py`

Import the library files used,

```
import time
import rclpy
from rclpy.node import Node
import cv2 as cv
import numpy as np
import mediapipe as mp
from geometry_msgs.msg import Point
from yahboomcar_msgs.msg import PointArray
from sensor_msgs.msg import Image
from cv_bridge import CvBridge, CvBridgeError
import os
```

Initialize data and define publishers and subscribers,

```
def __init__(self, staticMode=False, maxFaces=2, minDetectionCon=0.5,
minTrackingCon=0.5):
    super().__init__('face_mesh_detector')
    self.mpDraw = mp.solutions.drawing_utils
    #Use the class in the mediapipe library to define a face object
    self.mpFaceMesh = mp.solutions.face_mesh
    self.faceMesh = self.mpFaceMesh.FaceMesh(
    static_image_mode=staticMode,
    max_num_faces=maxFaces,
    min_detection_confidence=minDetectionCon,
    min_tracking_confidence=minTrackingCon )
    #Define the properties of the joint connection line, which will be used in
the subsequent joint point connection function
    self.lmDrawSpec = mp.solutions.drawing_utils.DrawingSpec(color=(0, 0, 255),
thickness=-1, circle_radius=3)
    self.drawSpec = self.mpDraw.DrawingSpec(color=(0, 255, 0), thickness=1,
circle_radius=1)
    self.bridge = CvBridge()
    #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 get_RGBImageCallBack(self,msg):
    #Use CvBridge to convert color image message data into image data
    frame = self.bridge.imgmsg_to_cv2(msg, desired_encoding='bgr8')
    #Pass the obtained image into the defined pubFaceMeshPoint function,
draw=False means not to draw joint points on the original color image
    frame, img = self.pubFaceMeshPoint(frame, draw=True)
    #Merge two images
    dist = self.frame_combine(frame, img)
    key = cv2.waitKey(1)
    cv.imshow('dist', dist)
```

pubFaceMeshPoint function,

```
def pubFaceMeshPoint(self, frame, draw=True):
    #Create a new image based on the incoming image size. 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
    imgRGB = cv.cvtColor(frame, cv.COLOR_BGR2RGB)
    #Call the process function in the mediapipe library for image processing.
During init, the self.faceMesh object is created and initialized.
    self.results = self.faceMesh.process(imgRGB)
    #Judge whether self.results.multi_face_landmarks exists, that is, whether the
face is recognized
    if self.results.multi_face_landmarks:
        for i in range(len(self.results.multi_face_landmarks)):
            if draw: self.mpDraw.draw_landmarks(frame,
self.results.multi_face_landmarks[i], self.mpFaceMesh.FACEMESH_CONTOURS,
self.lmDrawSpec, self.drawSpec)
```

```
            #Connect each joint point on the blank image created previously
            self.mpDraw.draw_landmarks(img,
self.results.multi_face_landmarks[i], self.mpFaceMesh.FACEMESH_CONTOURS,
self.lmDrawSpec, self.drawSpec)
    return frame, img
```

The frame_combine image merging function was mentioned in the first lesson of this chapter. Please refer to [07.Mediapipe Visual Course] - [1. Hand Detection] for an analysis of this function.