9. Finger control

1、synopsis

MediaPipe is a data stream processing machine learning application development framework developed and open-source by Google. It is a graph based data processing pipeline that enables the construction of various forms of data sources, such as video, frequency, sensor data, and any time series data. MediaPipe is cross platform and can run on embedded platforms (such as Raspberry Pi), mobile devices (iOS and Android), workstations, and servers, while supporting mobile GPU acceleration. MediaPipe provides cross platform, customizable ML solutions for real-time and streaming media. The core framework of MediaPipe is implemented in C++and provides support for languages such as Java and Objective C. The main concepts of MediaPipe include Packets, Streams, Calculators, Graphs, and Subgraphs.

The characteristics of MediaPipe：

- End to end acceleration: Built in fast ML inference and processing that can accelerate even on regular hardware。
- Build once, deploy anytime, anywhere: Unified solution suitable for Android, iOS, desktop/cloud, web, and IoT。
- Instant solution: A cutting-edge ML solution that showcases all features of the framework。
- Free and open source: Framework and solution under Apache 2.0, fully scalable and customizable.

2、Paintbrushes

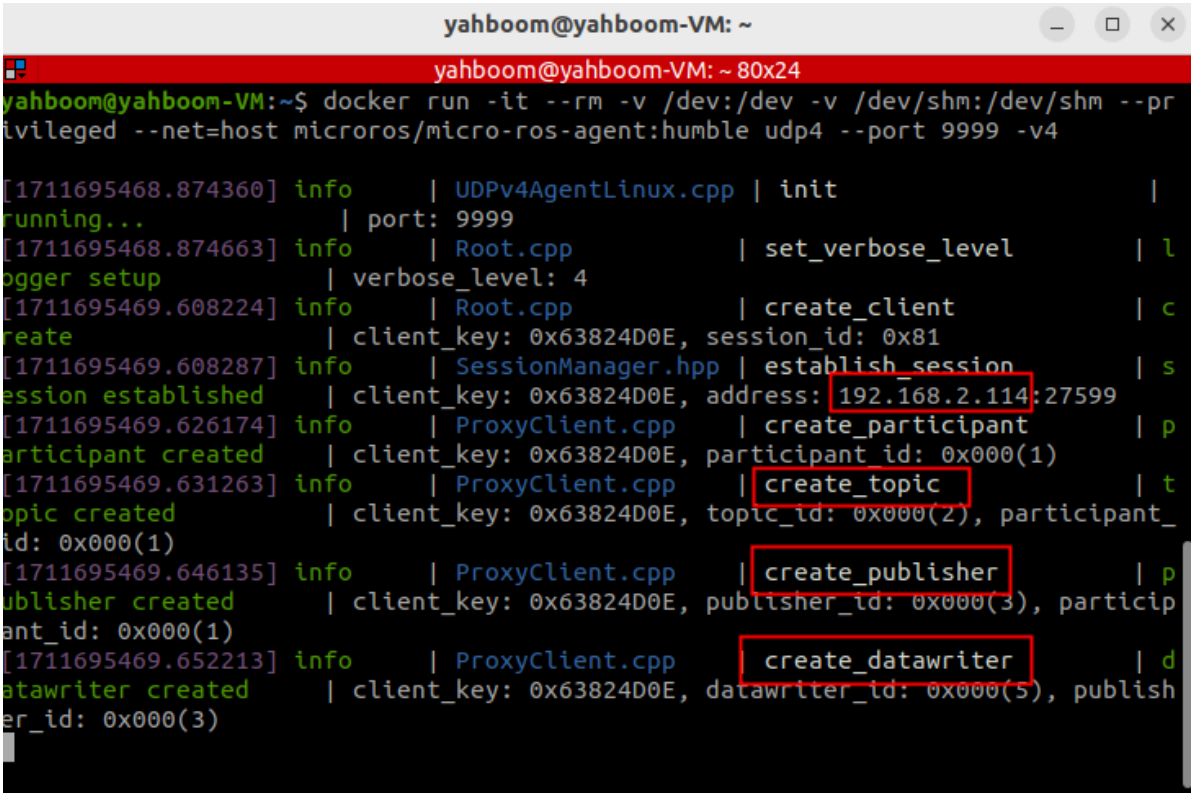
Click [f key] to switch the recognition effect, and the effect of the image can be controlled by the distance between the thumb and the index finger (Zhang/close).

3.1、activate

1. First set the proxy IP for the ROS-wifi image transfer module. For specific steps, please refer to the basic use **1. The use of ROS-wifi image transfer module in micros car** tutorial
2. The Linux system connects to the ROS-wifi image transfer module, starts docket, and enters the following command to connect the ROS-wifi image transfer module

```
#Use the provided system for direct input
sh start_Camera_computer.sh
```

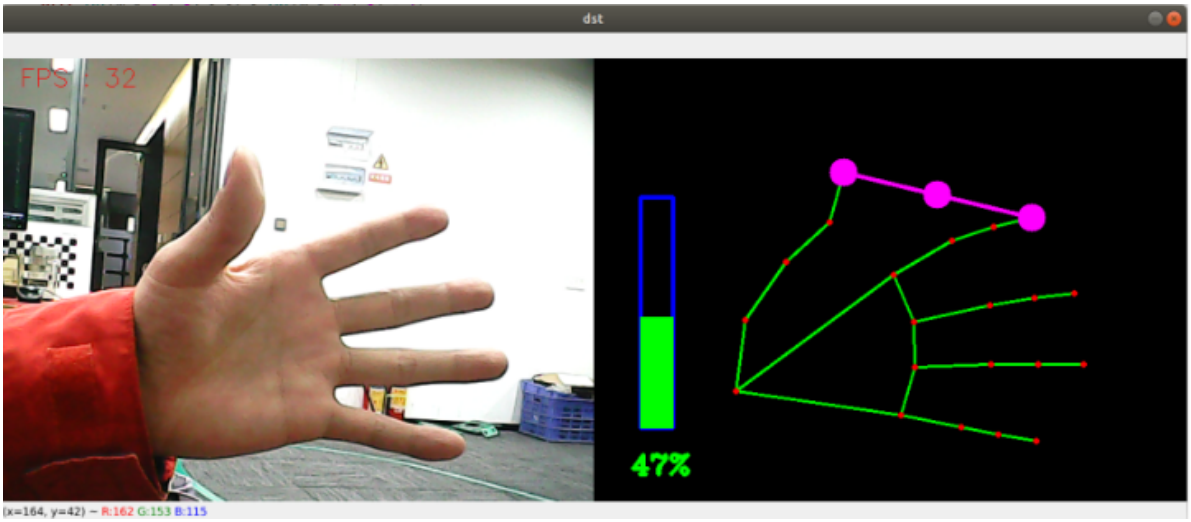
```
#Systems that are not data:
docker run -it --rm -v /dev:/dev -v /dev/shm:/dev/shm --privileged --net=host
microros/micro-ros-agent:humble udp4 --port 9999 -v4
```



If the preceding information is displayed, the proxy connection is successful

3. Open a new terminal and execute the following command

```
ros2 run yahboom_esp32_mediapipe 10_HandCtrl
```



4. Notes

- "If the camera angle is not centered, the Linux system needs to connect to the car agent. Please refer to the specific steps for development preparation before proceeding with tutorial **0. which provides essential information for a quick start (must-read)**. This tutorial will not provide further elaboration."
- After connecting the car's agent, enter the following command

```
ros2 run yahboom_esp32_mediapipe control_servo
```

After the steering engine is in the center, press "ctrl+C" to end the program.

5. If the camera picture is upside down, see **3. Camera picture correction (must-read)** tutorial, this tutorial is no longer explained

3.2、Code parsing

~/yahboomcar_ws/src/yahboom_esp32_mediapipe/yahboom_esp32_mediapipe/10_HandCtrl.py

```
volPer = value = index = 0
effect = ["color", "thresh", "blur", "hue", "enhance"]
volBar = 400
class handDetector:
    def __init__(self, mode=False, maxHands=2, detectorCon=0.5, trackCon=0.5):
        self.tipIds = [4, 8, 12, 16, 20]
        self.mpHand = mp.solutions.hands
        self.mpDraw = mp.solutions.drawing_utils
        self.hands = self.mpHand.Hands(
            static_image_mode=mode,
            max_num_hands=maxHands,
            min_detection_confidence=detectorCon,
            min_tracking_confidence=trackCon
        )
        self.lmDrawSpec = mp.solutions.drawing_utils.DrawingSpec(color=(0, 0,
255), thickness=-1, circle_radius=15)
        self.drawSpec = mp.solutions.drawing_utils.DrawingSpec(color=(0, 255,
0), thickness=10, circle_radius=10)

    def get_dist(self, point1, point2):
        x1, y1 = point1
        x2, y2 = point2
        return abs(math.sqrt(math.pow(abs(y1 - y2), 2) + math.pow(abs(x1 - x2),
2)))

    def calc_angle(self, pt1, pt2, pt3):
        point1 = self.lmList[pt1][1], self.lmList[pt1][2]
        point2 = self.lmList[pt2][1], self.lmList[pt2][2]
        point3 = self.lmList[pt3][1], self.lmList[pt3][2]
        a = self.get_dist(point1, point2)
        b = self.get_dist(point2, point3)
        c = self.get_dist(point1, point3)
        try:
            radian = math.acos((math.pow(a, 2) + math.pow(b, 2) - math.pow(c,
2)) / (2 * a * b))
            angle = radian / math.pi * 180
        except:
            angle = 0
        return abs(angle)

    def findHands(self, frame, draw=True):
        img = np.zeros(frame.shape, np.uint8)
        img_RGB = cv.cvtColor(frame, cv.COLOR_BGR2RGB)
        self.results = self.hands.process(img_RGB)
        if self.results.multi_hand_landmarks:
            for handLms in self.results.multi_hand_landmarks:
```

```
                if draw: self.mpDraw.draw_landmarks(img, handLms,
self.mpHand.HAND_CONNECTIONS)
        return img

    def findPosition(self, frame, draw=True):
        self.lmList = []
        if self.results.multi_hand_landmarks:
            for id, lm in
enumerate(self.results.multi_hand_landmarks[0].landmark):
                # print(id,lm)
                h, w, c = frame.shape
                cx, cy = int(lm.x * w), int(lm.y * h)
                # print(id, lm.x, lm.y, lm.z)
                self.lmList.append([id, cx, cy])
                if draw: cv.circle(frame, (cx, cy), 15, (0, 0, 255), cv.FILLED)
        return self.lmList

    def frame_combine(slef,frame, src):
        if len(frame.shape) == 3:
            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

class MY_Picture(Node):
    def __init__(self, name):
        super().__init__(name)
        self.bridge = CvBridge()
        self.sub_img = self.create_subscription(
            CompressedImage, '/espRos/esp32camera', self.handleTopic, 1)

        self.hand_detector = handDetector()
        self.volPer = self.value = self.index = 0
        self.effect = ["color", "thresh", "blur", "hue", "enhance"]
        self.volBar = 400

    def handleTopic(self, msg):
        start = time.time()
        frame = self.bridge.compressed_imgmsg_to_cv2(msg)
        frame = cv.resize(frame, (640, 480))

        action = cv.waitKey(1) & 0xFF

        img  = self.hand_detector.findHands(frame)
        lmList = self.hand_detector.findPosition(frame, draw=False)
        if len(lmList) != 0:
```

```
            angle = self.hand_detector.calc_angle(4, 0, 8)
            x1, y1 = lmList[4][1], lmList[4][2]
            x2, y2 = lmList[8][1], lmList[8][2]
            cx, cy = (x1 + x2) // 2, (y1 + y2) // 2
            cv.circle(img, (x1, y1), 15, (255, 0, 255), cv.FILLED)
            cv.circle(img, (x2, y2), 15, (255, 0, 255), cv.FILLED)
            cv.line(img, (x1, y1), (x2, y2), (255, 0, 255), 3)
            cv.circle(img, (cx, cy), 15, (255, 0, 255), cv.FILLED)
            if angle <= 10: cv.circle(img, (cx, cy), 15, (0, 255, 0), cv.FILLED)
            self.volBar = np.interp(angle, [0, 70], [400, 150])
            self.volPer = np.interp(angle, [0, 70], [0, 100])
            self.value = np.interp(angle, [0, 70], [0, 255])
            # print("angle: {},self.value: {}".format(angle, self.value))

        if self.effect[self.index]=="thresh":
            gray = cv.cvtColor(frame, cv.COLOR_BGR2GRAY)
            frame = cv.threshold(gray, self.value, 255, cv.THRESH_BINARY)[1]

        elif self.effect[self.index]=="blur":
            frame = cv.GaussianBlur(frame, (21, 21), np.interp(self.value, [0,
255], [0, 11]))

        elif self.effect[self.index]=="hue":
            frame = cv.cvtColor(frame, cv.COLOR_BGR2HSV)
            frame[:, :, 0] += int(self.value)
            frame = cv.cvtColor(frame, cv.COLOR_HSV2BGR)

        elif self.effect[self.index]=="enhance":
            enh_val = self.value / 40
            clahe = cv.createCLAHE(clipLimit=enh_val, tileGridSize=(8, 8))
            lab = cv.cvtColor(frame, cv.COLOR_BGR2LAB)
            lab[:, :, 0] = clahe.apply(lab[:, :, 0])
            frame = cv.cvtColor(lab, cv.COLOR_LAB2BGR)
        if action == ord('f'):
            self.index += 1
            if self.index >= len(self.effect): self.index = 0

        end = time.time()
        fps = 1 / (end - start)
        text = "FPS : " + str(int(fps))
        cv.putText(frame, text, (20, 30), cv.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0,
255), 1)
        cv.rectangle(img, (50, 150), (85, 400), (255, 0, 0), 3)
        cv.rectangle(img, (50, int(self.volBar)), (85, 400), (0, 255, 0),
cv.FILLED)
        cv.putText(img, f'{int(self.volPer)}%', (40, 450),
cv.FONT_HERSHEY_COMPLEX, 1, (0, 255, 0), 3)
        dst = self.hand_detector.frame_combine(frame, img)
        cv.imshow('dst', dst)



def main():
    print("start it")
    rclpy.init()
```

```
    esp_img = MY_Picture("My_Picture")
    try:
        rclpy.spin(esp_img)
    except KeyboardInterrupt:
        pass
    finally:
        esp_img.destroy_node()
        rclpy.shutdown()
```

The main process of the program: subscribe to the image from esp32, through MediaPipe to do the relevant recognition, and then through opencv to display the processed image.