# Finger control

## 1、Introduction

- MediaPipe is an open source data stream processing machine learning application development framework developed by Google. It is a graph-based data processing pipeline for building and using multiple forms of data sources, such as video, audio, sensor data, and any time series data. MediaPipe is cross-platform and can run on embedded platforms (Raspberry Pi, etc.), mobile devices (iOS and Android), workstations and servers, and supports 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 Packet, Stream, Calculator, Graph and Subgraph.

  Features of MediaPipe：

  - End-to-end acceleration: Built-in fast ML inference and processing accelerates even on commodity hardware.
  - Build once, deploy anywhere: Unified solutions for Android, iOS, desktop/cloud, web and IoT.
  - Ready-to-use solutions: Cutting-edge ML solutions that showcase the full capabilities of the framework.
  - Free and open source: frameworks and solutions under Apache2.0, fully extensible and customizable.

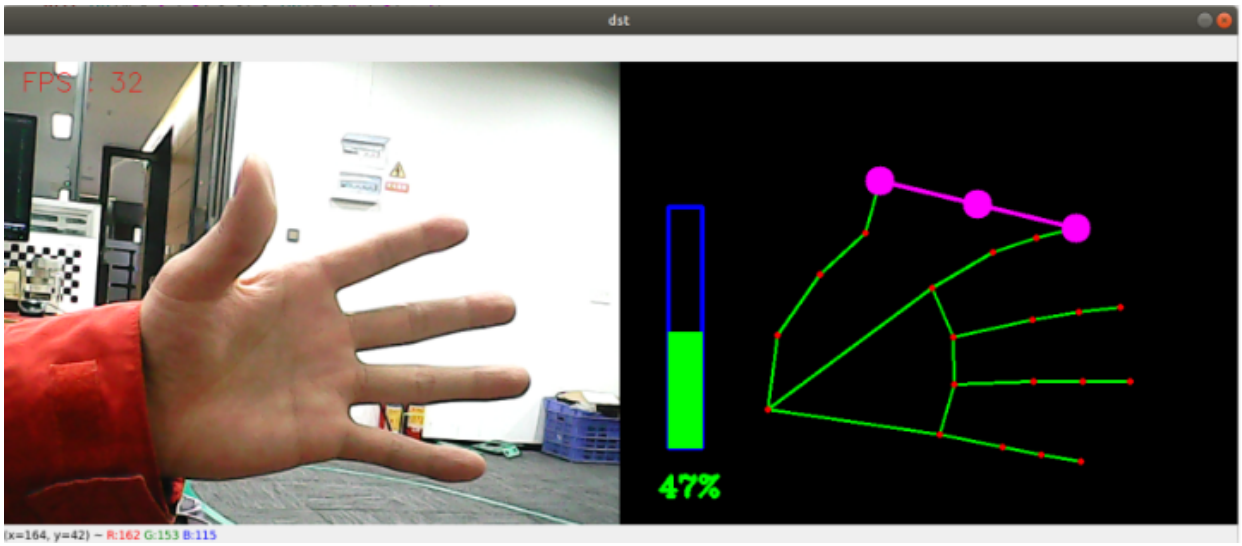
## 2、Finger control

Click the 【f】 button to switch the recognition effect. The image effect can be controlled by the distance between the thumb and index finger (opening/closing).

### 3.1、Start

After entering the docker container, enter the following command in the terminal

```
cd ~/yahboomcar_ws/src/yahboomcar_mediapipe/yahboomcar_mediapipe
python3 10_HandCtrl.py
```




## 3.2、Code analysis

After entering the docker container, the location of the source code of this function is as follows.

```
/root/yahboomcar_ws/src/yahboomcar_mediapipe/yahboomcar_mediapipe/10_HandCtrl.py
```

```
#!/usr/bin/env python3
# encoding: utf-8
import math
import time
import cv2 as cv
import numpy as np
import mediapipe as mp

pTime = cTime = 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


if __name__ == '__main__':
    capture = cv.VideoCapture(4)
    capture.set(6, cv.VideoWriter.fourcc('M', 'J', 'P', 'G'))
    capture.set(cv.CAP_PROP_FRAME_WIDTH, 640)
    capture.set(cv.CAP_PROP_FRAME_HEIGHT, 480)
    print("capture get FPS : ", capture.get(cv.CAP_PROP_FPS))
    hand_detector = handDetector()
    while capture.isOpened():
        ret, frame = capture.read()
        action = cv.waitKey(1) & 0xFF
        # frame = cv.flip(frame, 1)
        img = hand_detector.findHands(frame)
        lmList = hand_detector.findPosition(frame, draw=False)
        if len(lmList) != 0:
            angle = 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)
            volBar = np.interp(angle, [0, 70], [400, 150])
            volPer = np.interp(angle, [0, 70], [0, 100])
            value = np.interp(angle, [0, 70], [0, 255])
            # print("angle: {},value: {}".format(angle, value))
        # Perform threshold binarization operation. If it is greater than the
threshold value, use 255 to represent it. If it is less than the threshold value,
use 0 to represent it.
        if effect[index]=="thresh":
            gray = cv.cvtColor(frame, cv.COLOR_BGR2GRAY)
            frame = cv.threshold(gray, value, 255, cv.THRESH_BINARY)[1]
        # Perform Gaussian filtering, (21, 21) means that the length and width of
the Gaussian matrix are both 21, and the standard deviation is value
        elif effect[index]=="blur":
            frame = cv.GaussianBlur(frame, (21, 21), np.interp(value, [0, 255], [0,
11]))
        # Color space conversion, HSV to BGR
        elif effect[index]=="hue":
            frame = cv.cvtColor(frame, cv.COLOR_BGR2HSV)
            frame[:, :, 0] += int(value)
            frame = cv.cvtColor(frame, cv.COLOR_HSV2BGR)
        # Adjust contrast
        elif effect[index]=="enhance":
            enh_val = 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('q'): break
        if action == ord('f'):
            index += 1
            if index >= len(effect): index = 0
        cTime = time.time()
        fps = 1 / (cTime - pTime)
        pTime = cTime
        text = "FPS : " + str(int(fps))
        cv.rectangle(img, (50, 150), (85, 400), (255, 0, 0), 3)
        cv.rectangle(img, (50, int(volBar)), (85, 400), (0, 255, 0), cv.FILLED)
        cv.putText(img, f'{int(volPer)}%', (40, 450), cv.FONT_HERSHEY_COMPLEX, 1,
(0, 255, 0), 3)
        cv.putText(frame, text, (20, 30), cv.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0, 255),
1)
        dst = hand_detector.frame_combine(frame, img)
        cv.imshow('dst', dst)
        # cv.imshow('frame', frame)
        # cv.imshow('img', img)
    capture.release()
    cv.destroyAllWindows()
```