

## 10. Gesture recognition

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**Note:** There are related running codes on Raspberry Pi and Jetson nano, but due to differences in motherboard performance, the running may not be as smooth. The supporting virtual machine also has the operating environment and programs installed. If the experience on the motherboard is not good, you can remove the camera, plug it into the virtual machine, and connect the camera device to the virtual machine to run the corresponding program on the virtual machine.

### 10.1. 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 solution 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.

### 10.2. Gesture recognition

Gesture recognition designed with the right hand in mind can be accurately recognized when certain conditions are met. The recognized gestures are: [Zero, One, Two, Three, Four, Five, Six, Seven, Eight, Ok, Rock, Thumb\_up (like), Thumb\_down (thumb down), Heart\_single (one-handed heart) ], 14 categories in total.

#### 10.2.1. Startup

Terminal input,

```
cd /home/yahboom/dofbot_ws/src/dofbot_mediapipe/scripts
python3 11_GestureRecognition.py
```



## 10.2. Source code

Source code

location: /home/dofbot/dofbot\_ws/src/dofbot\_mediapipe/scripts/11\_GestureRecognition.py

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

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.lmList = []
        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)

    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]
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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):
    self.lmList = []
    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 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)
            self.mpDraw.draw_landmarks(img,
self.results.multi_hand_landmarks[i], self.mpHand.HAND_CONNECTIONS,
self.lmDrawSpec, self.drawSpec)
            for id, lm in
enumerate(self.results.multi_hand_landmarks[i].landmark):
                h, w, c = frame.shape
                cx, cy = int(lm.x * w), int(lm.y * h)
                self.lmList.append([id, cx, cy])
    return frame, img

def frame_combine(self, 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

def fingersUp(self):
    fingers=[]
    # Thumb
    if (self.calc_angle(self.tipIds[0],
self.tipIds[0] - 1,
self.tipIds[0] - 2) > 150.0) and (
self.calc_angle(

```

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        self.tipIds[0] - 1,
        self.tipIds[0] - 2,
        self.tipIds[0] - 3) > 150.0): fingers.append(1)
    else:
        fingers.append(0)
    # 4 finger
    for id in range(1, 5):
        if self.lmList[self.tipIds[id]][2] < self.lmList[self.tipIds[id] -
2][2]:
            fingers.append(1)
        else:
            fingers.append(0)
    return fingers

def get_gesture(self):
    gesture = ""
    fingers = self.fingersUp()
    if self.lmList[self.tipIds[0]][2] > self.lmList[self.tipIds[1]][2] and \
        self.lmList[self.tipIds[0]][2] > self.lmList[self.tipIds[2]][2]
and \
        self.lmList[self.tipIds[0]][2] > self.lmList[self.tipIds[3]][2]
and \
        self.lmList[self.tipIds[0]][2] > self.lmList[self.tipIds[4]][2]
: gesture = "Thumb_down"

    elif self.lmList[self.tipIds[0]][2] < self.lmList[self.tipIds[1]][2] and
\
        self.lmList[self.tipIds[0]][2] < self.lmList[self.tipIds[2]][2]
and \
        self.lmList[self.tipIds[0]][2] < self.lmList[self.tipIds[3]][2]
and \
        self.lmList[self.tipIds[0]][2] < self.lmList[self.tipIds[4]][2]
and \
        self.calc_angle(self.tipIds[1] - 1, self.tipIds[1] - 2,
self.tipIds[1] - 3) < 150.0 : gesture = "Thumb_up"
        if fingers.count(1) == 3 or fingers.count(1) == 4:
            if fingers[0] == 1 and (
                self.get_dist(self.lmList[4][1:], self.lmList[8][1:])
<self.get_dist(self.lmList[4][1:], self.lmList[5][1:])
            ): gesture = "OK"
            elif fingers[2] == fingers[3] == 0: gesture = "Rock"
            elif fingers.count(1) == 3: gesture = "Three"
            else: gesture = "Four"
        elif fingers.count(1) == 0: gesture = "Zero"
        elif fingers.count(1) == 1: gesture = "One"
        elif fingers.count(1) == 2:
            if fingers[0] == 1 and fingers[4] == 1: gesture = "Six"
            elif fingers[0] == 1 and self.calc_angle(4, 5, 8) > 90: gesture =
"Eight"
            elif fingers[0] == fingers[1] == 1 and self.get_dist(self.lmList[4]
[1:], self.lmList[8][1:]) < 50: gesture = "Heart_single"
            else: gesture = "Two"
        elif fingers.count(1)==5:gesture = "Five"
        if self.get_dist(self.lmList[4][1:], self.lmList[8][1:]) < 60 and \

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        self.get_dist(self.lmList[4][1:], self.lmList[12][1:]) < 60 and
\
        self.get_dist(self.lmList[4][1:], self.lmList[16][1:]) < 60 and
\
        self.get_dist(self.lmList[4][1:], self.lmList[20][1:]) < 60 :
gesture = "Seven"
    if self.lmList[self.tipIds[0]][2] < self.lmList[self.tipIds[1]][2] and \
        self.lmList[self.tipIds[0]][2] < self.lmList[self.tipIds[2]][2]
and \
        self.lmList[self.tipIds[0]][2] < self.lmList[self.tipIds[3]][2]
and \
        self.lmList[self.tipIds[0]][2] < self.lmList[self.tipIds[4]][2]
and \
        self.calc_angle(self.tipIds[1] - 1, self.tipIds[1] - 2,
self.tipIds[1] - 3) > 150.0 : gesture = "Eight"
    return gesture

'''
Zero One Two Three Four Five Six Seven Eight
Ok: OK
Rock: rock
Thumb_up : 点赞
Thumb_down: 拇指向下
Heart_single: 单手比心
'''

if __name__ == '__main__':
    capture = cv.VideoCapture(0)
    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))
    pTime = cTime = 0
    hand_detector = handDetector(detectorCon=0.75)
    while capture.isOpened():
        ret, frame = capture.read()
        # frame = cv.flip(frame, 1)
        frame, img = hand_detector.findHands(frame, draw=False)
        if len(hand_detector.lmList) != 0:
            totalFingers = hand_detector.get_gesture()
            cv.rectangle(frame, (0, 430), (230, 480), (0, 255, 0), cv.FILLED)
            cv.putText(frame, str(totalFingers), (10, 470),
cv.FONT_HERSHEY_PLAIN, 2, (255, 0, 0), 2)
            if cv.waitKey(1) & 0xFF == ord('q'): break
            cTime = time.time()
            fps = 1 / (cTime - pTime)
            pTime = cTime
            text = "FPS : " + str(int(fps))
            cv.putText(frame, text, (10, 30), cv.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0,
255), 1)
            dist = hand_detector.frame_combine(frame, img)
            cv.imshow('dist', dist)
            # cv.imshow('frame', frame)
            # cv.imshow('img', img)
    capture.release()

```

```
cv.destroyAllWindows()
```