Gesture recognition

1.Introduction

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 used to build and utilize various 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 (such as Raspberry Pi), mobile devices (iOS and Android), workstations, and servers, with support for 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.

Features of MediaPipe:

-End to end acceleration: Built in fast ML inference and processing can accelerate even on regular hardware.
-Build once, deploy anytime, anywhere: A unified solution suitable for Android, iOS, desktop/cloud, web, and IoT.
-Ready to use solution: a cutting-edge ML solution that showcases all the functionalities of the framework.
-Free and open-source: frameworks and solutions under Apache 2.0, fully extensible and customizable.

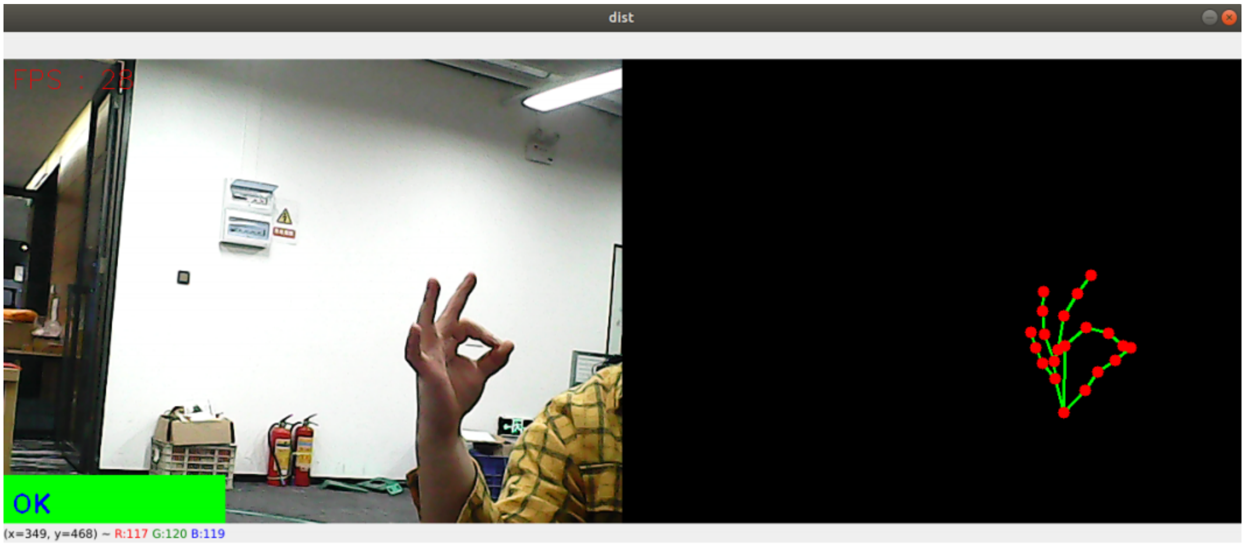
2. Gesture recognition

The hand gesture recognition designed based on the right hand can accurately recognize when specific conditions are met. The recognizable gestures include: Zero, One, Two, Three, Four, Five, Six, Seven, Eight, Ok, Rock, Thumb_up (like), Thumbd_down (thumb down), Heart_stngle (one handed heart comparison), a total of 14 categories.

2.1 Start

- Input following command to start the program

```
rosrun jetcobot_mediapipe 10_GestureRecognition.py
```



2.2 About code

Code path：~/jetcobot_ws/src/jetcobot_mediapipe/scripts/10_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]
        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(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

    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(
                    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 \
                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()
```