

9. Finger Control

9.1. 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 used to build data sources in various forms, 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 packets, streams, calculators, graphs, and subgraphs.

Features of MediaPipe:

- End-to-end acceleration: built-in fast ML inference and processing can be accelerated even on ordinary hardware.
- Build once, deploy anywhere: unified solution for Android, iOS, desktop/cloud, web and IoT.
- Ready-to-use solution: cutting-edge ML solution that demonstrates the full functionality of the framework.
- Free and open source: framework and solution under Apache2.0, fully extensible and customizable.

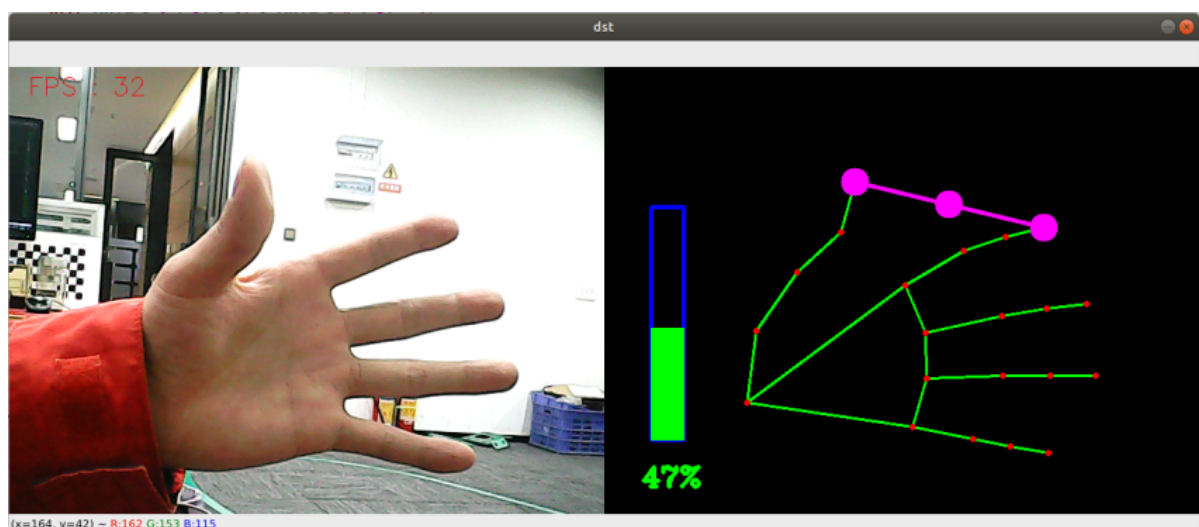
9.2, Finger control

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

9.2.1, Start

- Enter the following command to start the program

```
ros2 run jetcobot_mediapipe 09_HandCtrl
```



9.2.2, Source code

Source code location:

~/jetcobot_ws/src/jetcobot_mediapipe/jetcobot_mediapipe/scripts/09_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(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

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))
# 进行阈值二值化操作, 大于阈值value的, 使用255表示, 小于阈值value的, 使用0表示
if effect[index]=="thresh":
    gray = cv.cvtColor(frame, cv.COLOR_BGR2GRAY)
    frame = cv.threshold(gray, value, 255, cv.THRESH_BINARY)[1]
# 进行高斯滤波,(21, 21)表示高斯矩阵的长与宽都是21, 标准差取value
elif effect[index]=="blur":
    frame = cv.GaussianBlur(frame, (21, 21), np.interp(value, [0, 255],
[0, 11]))
# 色彩空间的转化,HSV转换为BGR
elif effect[index]=="hue":
    frame = cv.cvtColor(frame, cv.COLOR_BGR2HSV)
    frame[:, :, 0] += int(value)
    frame = cv.cvtColor(frame, cv.COLOR_HSV2BGR)
# 调节对比度
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()

```

