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 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 (such as Jetson nano), 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.

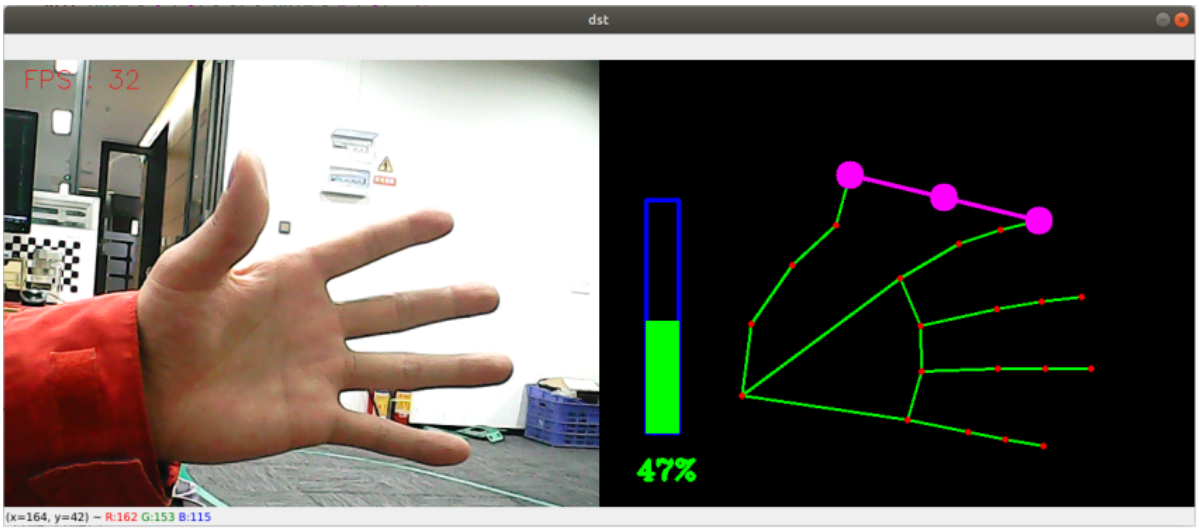
2. Finger control

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

2.1. Start

- Enter the following command to start the program

```
ros2 run dofbot_pro_mediapipe 09_HandCtrl
```



2.2. Source code

Source code location:
~/dofbot_pro_ws/src/dofbot_pro_mediapipe/dofbot_pro_mediapipe/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
import rclpy
from rclpy.node import Node
from sensor_msgs.msg import Image
from cv_bridge import CvBridge

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):
                h, w, c = frame.shape
                cx, cy = int(lm.x * w), int(lm.y * h)
                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

class HandEffectsNode(Node):
    def __init__(self):
        super().__init__('hand_effects_node')
        self.publisher_ = self.create_publisher(Image, 'hand_effects_image', 10)
        self.timer = self.create_timer(0.1, self.timer_callback)
        self.bridge = CvBridge()
        self.hand_detector = HandDetector()
        self.capture = cv.VideoCapture(0, cv.CAP_V4L2)
        self.capture.set(6, cv.VideoWriter.fourcc('M', 'J', 'P', 'G'))
        self.capture.set(cv.CAP_PROP_FRAME_WIDTH, 640)
        self.capture.set(cv.CAP_PROP_FRAME_HEIGHT, 480)
        self.xp = self.yp = self.pTime = self.volPer = self.value = self.index =
0
        self.effect = ["color", "thresh", "blur", "hue", "enhance"]
        self.volBar = 400
```

```
    def timer_callback(self):
        ret, frame = self.capture.read()
        if not ret:
            self.get_logger().error('Failed to capture frame')
            return

        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])

        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('q'):
            self.capture.release()
            cv.destroyAllWindows()
            rclpy.shutdown()
            return
        if action == ord('f'):
            self.index += 1
            if self.index >= len(self.effect): self.index = 0

        cTime = time.time()
        fps = 1 / (cTime - self.pTime)
        self.pTime = cTime
        text = "FPS : " + str(int(fps))
        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)
        cv.putText(frame, text, (20, 30), cv.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0,
255), 1)
        dst = self.hand_detector.frame_combine(frame, img)
        cv.imshow('dst', dst)

        msg = self.bridge.cv2_to_imgmsg(frame, "bgr8")
        self.publisher_.publish(msg)

def main(args=None):
    rclpy.init(args=args)
    hand_effects_node = HandEffectsNode()
    rclpy.spin(hand_effects_node)
    hand_effects_node.destroy_node()
    rclpy.shutdown()

if __name__ == '__main__':
    main()
```