8.Brush

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.

8.1. 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.

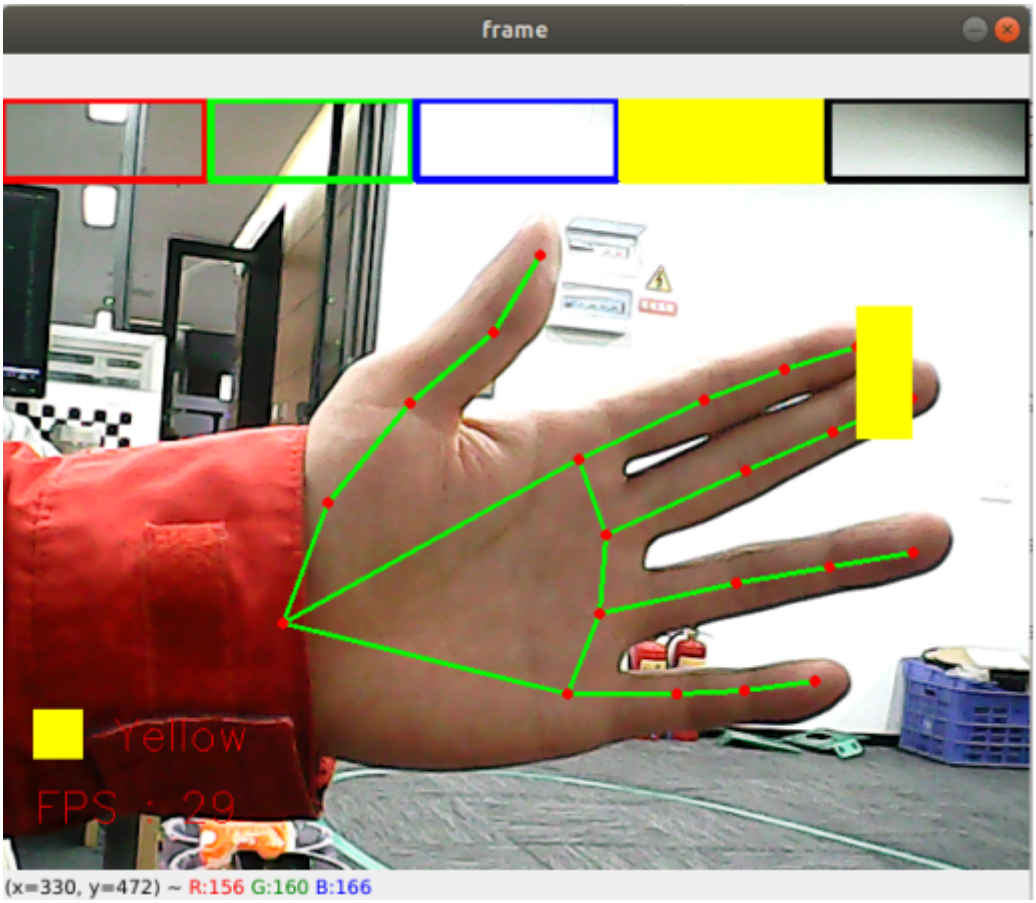
8.2. Brush

When the right middle finger and middle finger are combined, they are in the selection state, and a color selection box pops up at the same time. When the two fingertips move to the corresponding color position, the color is selected (black is the eraser);When the thumb and middle finger are separated, the drawing state begins and you can draw anywhere on the drawing board.

8.2.1.Start up

Terminal input,

```
cd /home/yahboom/dofbot_ws/src/dofbot_mediapipe/scripts
python3 09_VirtualPaint.py
```



8.2.2. Source code

Source code location：/home/dofbot/dofbot_ws/src/dofbot_mediapipe/scripts/09_VirtualPaint.py

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

xp = yp = pTime = boxx = 0
tipIds = [4, 8, 12, 16, 20]
imgCanvas = np.zeros((480, 640, 3), np.uint8)
brushThickness = 5
eraserThickness = 100
top_height = 50
Color = "Red"
ColorList = {
    'Red': (0, 0, 255),
    'Green': (0, 255, 0),
    'Blue': (255, 0, 0),
    'Yellow': (0, 255, 255),
    'Black': (0, 0, 0),
}

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 findHands(self, frame, draw=True):
        self.lmList = []
        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(frame, handLms,
self.mpHand.HAND_CONNECTIONS, self.lmDrawSpec, self.drawSpec)
                else: self.mpDraw.draw_landmarks(frame, handLms,
self.mpHand.HAND_CONNECTIONS)
            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)
                # print(id, cx, cy)
                self.lmList.append([id, cx, cy])
        return frame, self.lmList

    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_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)



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))
    hand_detector = handDetector(detectorCon=0.85)
    while capture.isOpened():
        ret, frame = capture.read()
        # frame = cv.flip(frame, 1)
        h, w, c = frame.shape
        frame,lmList = hand_detector.findHands(frame, draw=False)
        if len(lmList) != 0:
            # print(lmList)
            # tip of index and middle fingers
            x1, y1 = lmList[8][1:]
            x2, y2 = lmList[12][1:]
            fingers = hand_detector.fingersUp()
            if fingers[1] and fingers[2]:
                # print("Seclection mode")
                if y1 < top_height:
                    if 0 < x1 < int(w / 5) - 1:
                        boxx = 0
                        Color = "Red"
                    if int(w / 5) < x1 < int(w * 2 / 5) - 1:
                        boxx = int(w / 5)
                        Color = "Green"
                    elif int(w * 2 / 5) < x1 < int(w * 3 / 5) - 1:
                        boxx = int(w * 2 / 5)
                        Color = "Blue"
                    elif int(w * 3 / 5) < x1 < int(w * 4 / 5) - 1:
                        boxx = int(w * 3 / 5)
                        Color = "Yellow"
                    elif int(w * 4 / 5) < x1 < w - 1:
                        boxx = int(w * 4 / 5)
```

```
                    Color = "Black"
                cv.rectangle(frame, (x1, y1 - 25), (x2, y2 + 25),
ColorList[Color], cv.FILLED)
                cv.rectangle(frame, (boxx, 0), (boxx + int(w / 5), top_height),
ColorList[Color], cv.FILLED)
                cv.rectangle(frame, (0, 0), (int(w / 5) - 1, top_height),
ColorList['Red'], 3)
                cv.rectangle(frame, (int(w / 5) + 2, 0), (int(w * 2 / 5) - 1,
top_height), ColorList['Green'], 3)
                cv.rectangle(frame, (int(w * 2 / 5) + 2, 0), (int(w * 3 / 5) -
1, top_height), ColorList['Blue'], 3)
                cv.rectangle(frame, (int(w * 3 / 5) + 2, 0), (int(w * 4 / 5) -
1, top_height), ColorList['Yellow'], 3)
                cv.rectangle(frame, (int(w * 4 / 5) + 2, 0), (w - 1,
top_height), ColorList['Black'], 3)
            if fingers[1] and fingers[2] == False and math.hypot(x2 - x1, y2 -
y1) > 50:
                # print("Drawing mode")
                if xp == yp == 0: xp, yp = x1, y1
                if Color == 'Black':
                    cv.line(frame, (xp, yp), (x1, y1), ColorList[Color],
eraserThickness)
                    cv.line(imgCanvas, (xp, yp), (x1, y1), ColorList[Color],
eraserThickness)
                else:
                    cv.line(frame, (xp, yp), (x1, y1), ColorList[Color],
brushThickness)
                    cv.line(imgCanvas, (xp, yp), (x1, y1), ColorList[Color],
brushThickness)
                cv.circle(frame, (x1, y1), 15, ColorList[Color], cv.FILLED)
                xp, yp = x1, y1
            else: xp = yp = 0
        imgGray = cv.cvtColor(imgCanvas, cv.COLOR_BGR2GRAY)
        _, imgInv = cv.threshold(imgGray, 50, 255, cv.THRESH_BINARY_INV)
        imgInv = cv.cvtColor(imgInv, cv.COLOR_GRAY2BGR)
        frame = cv.bitwise_and(frame, imgInv)
        frame = cv.bitwise_or(frame, imgCanvas)
        if cv.waitKey(1) & 0xFF == ord('q'): break
        cTime = time.time()
        fps = 1 / (cTime - pTime)
        pTime = cTime
        text = "FPS : " + str(int(fps))
        cv.rectangle(frame, (20, h - 100), (50, h - 70), ColorList[Color],
cv.FILLED)
        cv.putText(frame, Color, (70, h - 75), cv.FONT_HERSHEY_SIMPLEX, 0.9, (0,
0, 255), 1)
        cv.putText(frame, text, (20, h-30), cv.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0,
255), 1)
        cv.imshow('frame', frame)
    capture.release()
    cv.destroyAllWindows()
```