2. Posture detection

2.1. 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 Raspberry Pi), 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.

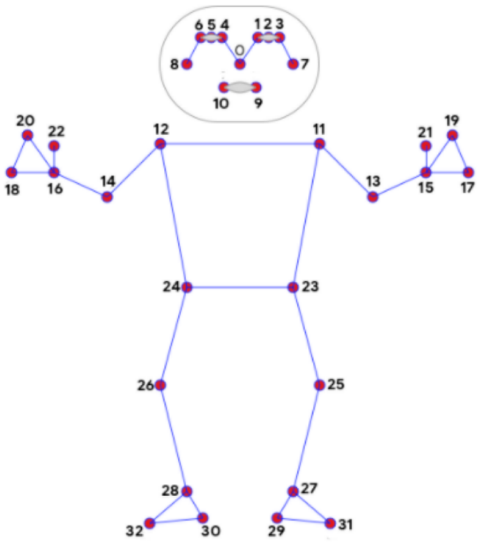
Features of MediaPipe:

- 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 showcases the full power of the framework.
- Free and open source: framework and solution under Apache 2.0, fully extensible and customizable.

2.2, MediaPipe Pose

MediaPipe Pose is an ML solution for high-fidelity body pose tracking, leveraging the BlazePose research to infer 33 3D coordinates and full-body background segmentation masks from RGB video frames, which also powers the ML Kit pose detection API.

The landmark model in MediaPipe Pose predicts the locations of the 33 pose coordinates (see the figure below).



0. nose
1. left_eye_inner
2. left_eye
3. left_eye_outer
4. right_eye_inner
5. right_eye
6. right_eye_outer
7. left_ear
8. right_ear
9. mouth_left
10. mouth_right
11. left_shoulder
12. right_shoulder
13. left_elbow
14. right_elbow
15. left_wrist
16. right_wrist
17. left_pinky
18. right_pinky
19. left_index
20. right_index
21. left_thumb
22. right_thumb
23. left_hip
24. right_hip
25. left_knee
26. right_knee
27. left_ankle
28. right_ankle
29. left_heel
30. right_heel
31. left_foot_index
32. right_foot_index

2.3, Pose detection

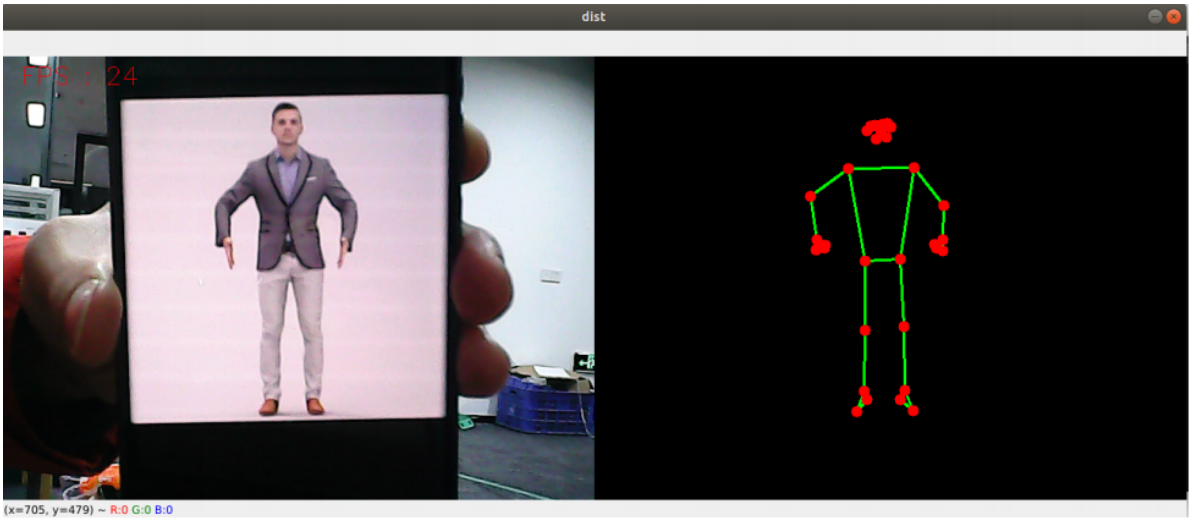
2.3.1, Start

Start the camera

```
roslaunch ascamera hp60c.launch
```

Terminal input,

```
roslaunch yahboomcar_mediapipe 02_PoseDetector.launch
```



2.3.2, Source code

Source code location:
/home/yahboom/ascam_ws/src/yahboomcar_mediapipe/scripts/02_PoseDetector.py

```
#!/usr/bin/env python3
# encoding: utf-8
import time
import rospy
import cv2 as cv
import numpy as np
import mediapipe as mp
from geometry_msgs.msg import Point
from yahboomcar_msgs.msg import PointArray
from sensor_msgs.msg import Image
from cv_bridge import CvBridge

class PoseDetector:
    def __init__(self, mode=False, smooth=True, detectionCon=0.5, trackCon=0.5):
        self.mpPose = mp.solutions.pose
        self.mpDraw = mp.solutions.drawing_utils
        self.pose = self.mpPose.Pose(
            static_image_mode=mode,
            smooth_landmarks=smooth,
            min_detection_confidence=detectionCon,
            min_tracking_confidence=trackCon )
```

```
        self.pub_point = rospy.Publisher('/mediapipe/points', PointArray,
queue_size=1000)
        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)
        self.bridge = CvBridge()
        self.sub_image = rospy.Subscriber('/ascamera_hp60c/rgb0/image', Image,
self.image_callback, queue_size=1)
        self.pTime = 0

    def pubPosePoint(self, frame, draw=True):
        pointArray = PointArray()
        img = np.zeros(frame.shape, np.uint8)
        img_RGB = cv.cvtColor(frame, cv.COLOR_BGR2RGB)
        self.results = self.pose.process(img_RGB)
        if self.results.pose_landmarks:
            if draw: self.mpDraw.draw_landmarks(frame,
self.results.pose_landmarks, self.mpPose.POSE_CONNECTIONS, self.lmDrawSpec,
self.drawSpec)
            self.mpDraw.draw_landmarks(img, self.results.pose_landmarks,
self.mpPose.POSE_CONNECTIONS, self.lmDrawSpec, self.drawSpec)
            for id, lm in enumerate(self.results.pose_landmarks.landmark):
                point = Point()
                point.x, point.y, point.z = lm.x, lm.y, lm.z
                pointArray.points.append(point)
        self.pub_point.publish(pointArray)
        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 image_callback(self, msg):
        try:
            # Convert ROS Image message to OpenCV image
            frame = self.bridge.imgmsg_to_cv2(msg, desired_encoding="bgr8")

            # Process the frame and publish pose points
            frame, img = self.pubPosePoint(frame, draw=True)

            # Calculate and display FPS
            cTime = time.time()
```

```
            fps = 1 / (cTime - self.pTime)
            self.pTime = cTime
            text = "FPS : " + str(int(fps))
            cv.putText(frame, text, (20, 30), cv.FONT_HERSHEY_SIMPLEX, 0.9, (0,
0, 255), 2)

            # Combine and display the frames
            dist = self.frame_combine(frame, img)
            cv.imshow('dist', dist)

            # Check for 'q' key press to quit
            if cv.waitKey(1) & 0xFF == ord('q'):
                rospy.signal_shutdown("User requested shutdown")
        except Exception as e:
            rospy.logerr("Could not process image: {e}")

if __name__ == '__main__':
    rospy.init_node('PoseDetector', anonymous=True)
    pose_detector = PoseDetector()
    rospy.spin()
    cv.destroyAllWindows()
```