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 (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.

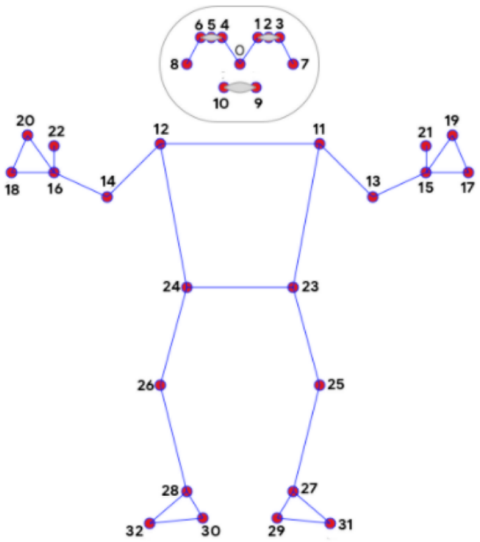
Features of MediaPipe:

- End-to-end acceleration: built-in fast ML inference and processing can be accelerated even on commodity 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 capabilities of the framework.
- Free and open source: framework and solution under Apache2.0, fully extensible and customizable.

2.2, MediaPipe Pose

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

The landmark model in MediaPipe Pose predicts the location of 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

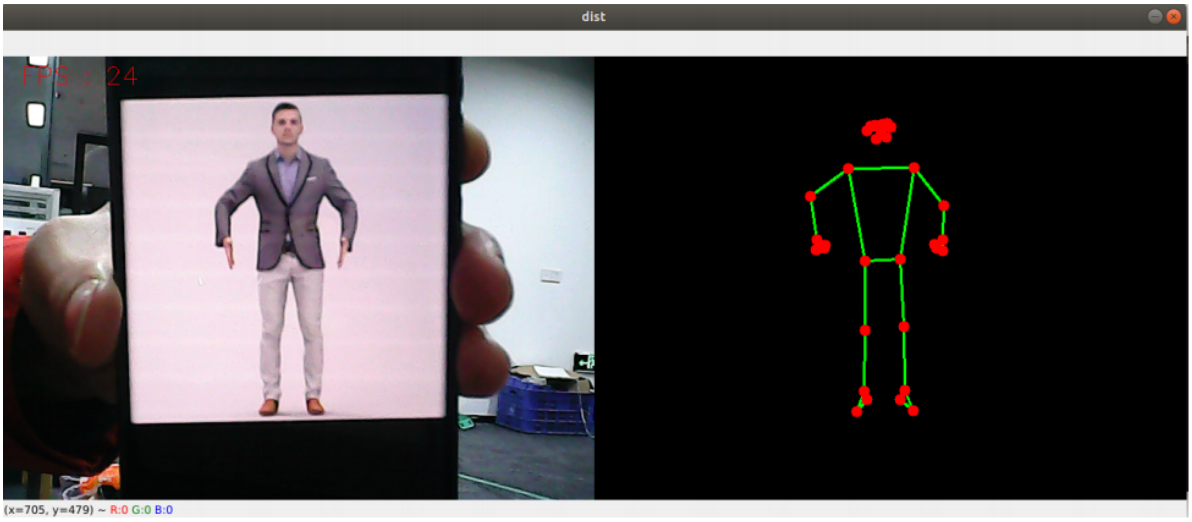
2.3.1, Start

Start the camera

```
ros2 launch ascamera hp60c.launch.py
```

Open a new terminal and enter,

```
ros2 run yahboomcar_mediapipe 02_PoseDetector
```



2.3.2, Source code

Source code location:
~/ascam_ros2_ws/src/yahboomcar_mediapipe/yahboomcar_mediapipe/02_PoseDetector.py

```
#!/usr/bin/env python3
# encoding: utf-8

import rclpy
from rclpy.node import Node
from sensor_msgs.msg import Image
from geometry_msgs.msg import Point
from yahboomcar_msgs.msg import PointArray
import mediapipe as mp
import cv2 as cv
import numpy as np
import time
from cv_bridge import CvBridge

print("import done")

class PoseDetector(Node):
    def __init__(self, name, mode=False, smooth=True, detectionCon=0.5,
trackCon=0.5):
        super().__init__(name)
        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)

        # Create publisher to publish pose points
        self.pub_point = self.create_publisher(PointArray, '/mediapipe/points',
1000)

        # Initialize CvBridge to convert ROS Image messages to OpenCV format
        self.bridge = CvBridge()

        # Create subscription to the image topic
        self.create_subscription(Image,
'/ascamera_hp60c/camera_publisher/rgb0/image', self.image_callback, 10)

        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)

        # FPS variables
        self.pTime = 0
        self.exit_flag = False  # Flag to indicate exit condition

    def image_callback(self, msg):
        # Convert ROS Image message to OpenCV format
        frame = self.bridge.imgmsg_to_cv2(msg, desired_encoding='bgr8')

        # Process the frame for pose detection
        frame, img = self.pubPosePoint(frame, draw=False)

        # Calculate FPS
        cTime = time.time()
        fps = 1 / (cTime - self.pTime)
        self.pTime = cTime
        text = "FPS : " + str(int(fps))

        # Display FPS on frame
        cv.putText(frame, text, (20, 30), cv.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0,
255), 1)

        # Combine the frames (original and pose detection result)
        dist = self.frame_combine(frame, img)

        # Show the combined image
        cv.imshow('Pose Detection', dist)

        # Exit the program if 'q' is pressed
        if cv.waitKey(1) & 0xFF == ord('q'):
            self.exit_flag = True

    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(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

    def run(self):
        # Custom loop for handling ROS 2 callback and OpenCV events
        while rclpy.ok() and not self.exit_flag:
            rclpy.spin_once(self)  # Process one callback
            if self.exit_flag:
                break
        cv.destroyAllWindows()


def main():
    print("start it")
    rclpy.init()
    pose_detector = PoseDetector('pose_detector')

    try:
        pose_detector.run()
    except KeyboardInterrupt:
        pass
    finally:
        pose_detector.destroy_node()
        rclpy.shutdown()
```

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