# Hand detection

## 1、Introduction

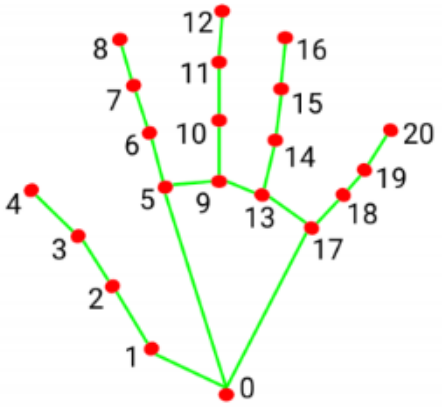
MediaPipe is an open source data stream processing machine learning application development framework developed by Google. It is a graph-based data processing pipeline for building and using multiple forms of data sources, such as video, audio, sensor data, and any time series data. MediaPipe is cross-platform 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 solutions 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.

## 2、MediaPipe Hands




0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP

MediaPipe Hands is a type of high fidelity case tracking and resolution system. It uses machine learning (ML) to infer 21 3D coordinates from frames.

After palm detection of the entire image, precise key point localization of 21 3D joint coordinates within the detected region is performed through regression based on a part labeling model, i.e. direct coordinate prediction. This model learns the internal pose table of the human body, and is even robust to partially observable human body and self occlusion.

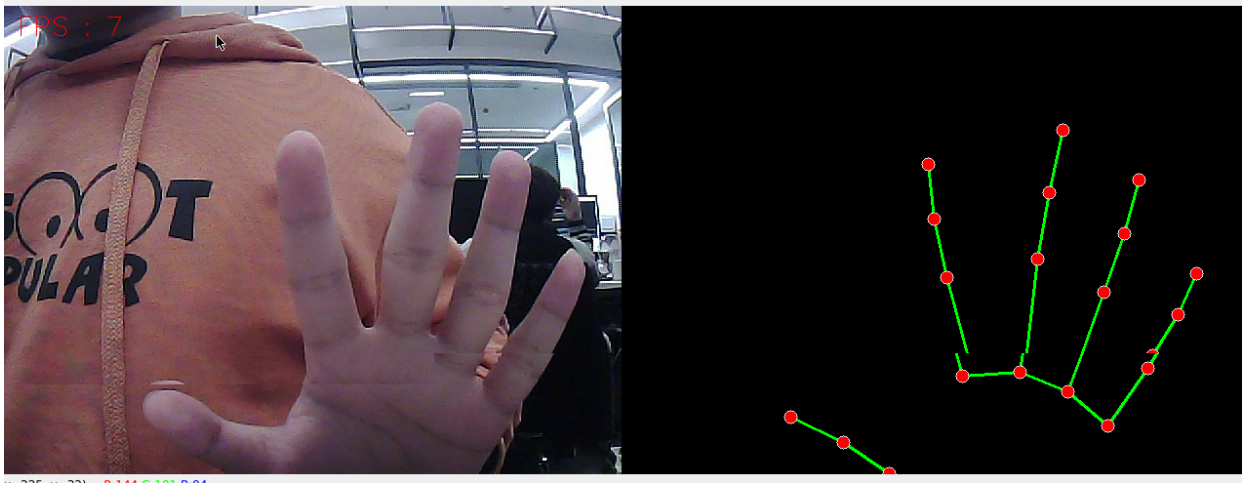
In order to obtain real-world data, 21 3D coordinates were used to dynamically annotate approximately 30K real-world images, as shown below (obtaining Z values from the image depth map, if each corresponding coordinate has a Z value). In order to better cover possible body postures and provide additional supervision on the properties of the body, a high-quality synthetic body model was drawn in various backgrounds and mapped to the corresponding 3D coordinates.

# 3、2 Hand detection

## 3.1、Start

After entering the docker container, enter in the terminal.

```
ros2 run yahboomcar_mediapipe 01_HandDetector
```




## 3.2、Code analysis

After entering the docker container, the location of the source code of this function is as follows

```
/root/yahboomcar_ws/src/yahboomcar_mediapipe/yahboomcar_mediapipe/01_HandDetector.py
```

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

class HandDetector:
    def __init__(self, mode=False, maxHands=2, detectorCon=0.5, trackCon=0.5):
        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.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)

    def pubHandsPoint(self, frame, draw=True):
        pointArray = PointArray()
        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:
            '''
            draw_landmarks():Draw landmarks and connections on the image.
            image: A three-channel RGB image represented as a numpy ndarray.
            landmark_list: Raw message of a list of normalized landmarks to be
annotated on the image.
            connections: A list of placemark index tuples specifying how to connect
placemarks in the drawing.
            landmark_drawing_spec: Lets you specify drawing settings for a
placemark, such as color, line weight, and circle radius.
            connection_drawing_spec: Lets you specify the connection's drawing
settings, such as color and line thickness.
            '''
            for i in range(len(self.results.multi_hand_landmarks)):
                if draw: self.mpDraw.draw_landmarks(frame,
self.results.multi_hand_landmarks[i], self.mpHand.HAND_CONNECTIONS, self.lmDrawSpec,
self.drawSpec)
                self.mpDraw.draw_landmarks(img,
self.results.multi_hand_landmarks[i], self.mpHand.HAND_CONNECTIONS, self.lmDrawSpec,
self.drawSpec)
                for id, lm in
enumerate(self.results.multi_hand_landmarks[i].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

if __name__ == '__main__':
    rospy.init_node('handDetector', anonymous=True)
    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))
    pTime = cTime = 0
    hand_detector = HandDetector(maxHands=2)
    while capture.isOpened():
        ret, frame = capture.read()
        # frame = cv.flip(frame, 1)
        frame, img = hand_detector.pubHandsPoint(frame, draw=False)
        if cv.waitKey(1) & 0xFF == ord('q'): break
        cTime = time.time()
        fps = 1 / (cTime - pTime)
        pTime = cTime
        text = "FPS : " + str(int(fps))
        cv.putText(frame, text, (20, 30), cv.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0, 255),
1)
        dist = hand_detector.frame_combine(frame, img)
        cv.imshow('dist', dist)
        #cv.imshow('frame', frame)
        # cv.imshow('img', img)
    capture.release()
    cv.destroyAllWindows()
```