Finger control robot arm

1. Introduction

The finger control robot arm function is based on finger control, adding the function of controlling the height movement of the robot arm.

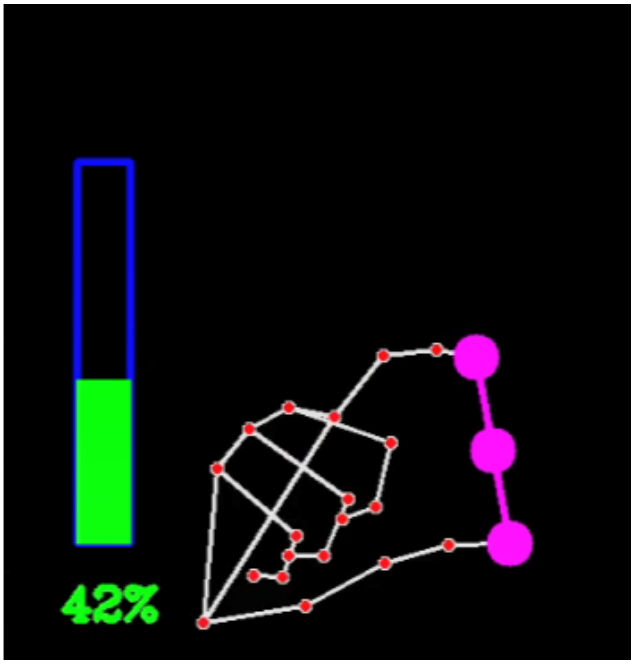
2. Finger control

Click the [f key] to switch the recognition effect. The image effect can be controlled by the distance between the thumb and the index finger (open/close).

2.1. Start

- Enter the following command to start the program

```
ros2 run dofbot_pro_mediapipe 18_HandCtrlArm
```



At this time, put your finger into the camera screen, and the current finger opening and closing percentage will be displayed. When the percentage is less than 40, the robot arm is controlled to move downward, and when the percentage is greater than 50, the robot arm is controlled to move upward.

Press the q key in the image or press Ctrl+c in the terminal to exit the program.

2.2, Source code

Source code location:
~/dofbot_pro_ws/src/dofbot_pro_mediapipe/dofbot_pro_mediapipe/18_HandCtrlArm.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 Arm_Lib import Arm_Device
from threading import Thread

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:
```

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            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 GestureArmControlNode(Node):
    def __init__(self):
        super().__init__('gesture_arm_control')
        self.hand_detector = HandDetector(detectorCon=0.75)
        self.pTime = 0

        self.effect = ["color", "thresh", "blur", "hue", "enhance"]
        self.index = 0
        self.volBar = 400
        self.volPer = 0
        self.value = 0
        self.state = 0

        self.arm = Arm_Device()
        self.arm.Arm_serial_servo_write6_array([90, 180, 0, 0, 90, 30], 1000)

        # Initialize video capture device
        self.cap = cv.VideoCapture(0, cv.CAP_V4L2)
        self.cap.set(cv.CAP_PROP_FRAME_WIDTH, 640)
        self.cap.set(cv.CAP_PROP_FRAME_HEIGHT, 480)
        if not self.cap.isOpened():
            self.get_logger().error("Error: Could not open video device.")
            rclpy.shutdown()

    def process_frame(self, frame):
        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 int(self.volPer) < 40 and self.state != 1:
            self.state = 1
            abc = [90, 180, 0, 0, 90, 30]
            self.arm.Arm_serial_servo_write6_array(abc, 1000)
        if int(self.volPer) > 50 and self.state != 2:
            self.state = 2
            abc = [90, 127, 46, 9, 90, 30]
            self.arm.Arm_serial_servo_write6_array(abc, 1000)

        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)
        return dst

    def run(self):
        while rclpy.ok():
            ret, frame = self.cap.read()
            if not ret:
                self.get_logger().error("Error: Could not read frame from video
device.")
```

```
                break

            action = cv.waitKey(1) & 0xFF
            frame = self.process_frame(frame)
            if action == ord('q'):
                break
            if action == ord('f'):
                self.index = (self.index + 1) % len(self.effect)
            cv.imshow('dst', frame)

        self.cap.release()
        cv.destroyAllWindows()


def main(args=None):
    rclpy.init(args=args)
    gesture_arm_control_node = GestureArmControlNode()
    try:
        gesture_arm_control_node.run()
    except KeyboardInterrupt:
        pass
    finally:
        gesture_arm_control_node.cap.release()
        cv.destroyAllWindows()
        rclpy.shutdown()


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