

人工智慧

手部辨識系統製作 Mediapipe

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[HTTP://120.108.221.55/PROFCHWU/DCTAI](http://120.108.221.55/PROFCHWU/DCTAI)

資料來源

參考網站：

<https://www.youtube.com/watch?v=x4eeX7WJluA>

程式碼：

https://github.com/hibyby/GrandmaCan_python_hand_tracking/blob/main/handTracking.py

Google MediaPipe

Google在跨平臺人工智慧工作管線框架MediaPipe，推出採用最新技術的身體姿勢追蹤功能BlazePose，能夠在手機上即時精確地定位身體姿勢關鍵點，可廣泛用於運動應用程式上，偵測健身或是瑜伽等姿勢。

Home

Getting Started

Solutions

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Framework Concepts

MediaPipe

Live ML anywhere

[MediaPipe](#) offers cross-platform, customizable ML solutions for live and streaming media.



End-to-End acceleration: Built-in fast ML inference and processing accelerated even on common hardware



Build once, deploy anywhere: Unified solution works across Android, iOS, desktop/cloud, web and IoT



Ready-to-use solutions: Cutting-edge ML solutions demonstrating full power of the framework









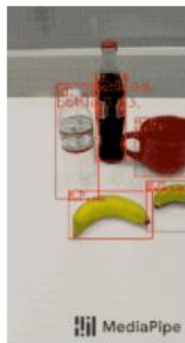





Free and open source: Framework and solutions both under Apache 2.0, fully extensible and customizable

<https://google.github.io/mediapipe/>

提供多種的 ML Solutions

ML solutions in MediaPipe

Face Detection	Face Mesh	Iris	Hands	Pose	Holistic
					
Hair Segmentation	Object Detection	Box Tracking	Instant Motion Tracking	Objectron	KNIFT
					

	Android	iOS	C++	Python	JS
Face Detection	✓	✓	✓	✓	✓
Face Mesh	✓	✓	✓	✓	✓
Iris	✓	✓	✓		
Hands	✓	✓	✓	✓	✓
Pose	✓	✓	✓	✓	✓
Holistic	✓	✓	✓	✓	✓
Selfie Segmentation	✓	✓	✓	✓	✓
Hair Segmentation	✓		✓		
Object Detection	✓	✓	✓		
Box Tracking	✓	✓	✓		
Instant Motion Tracking	✓				
Objectron	✓		✓	✓	✓
KNIFT	✓				
AutoFlip			✓		
MediaSequence			✓		
YouTube 8M			✓		

安裝環境

安裝虛擬環境，並確保安裝的python版本與Jupyter notebook

- `conda create -n opencv python==3.8 jupyter`
- `conda activate opencv`

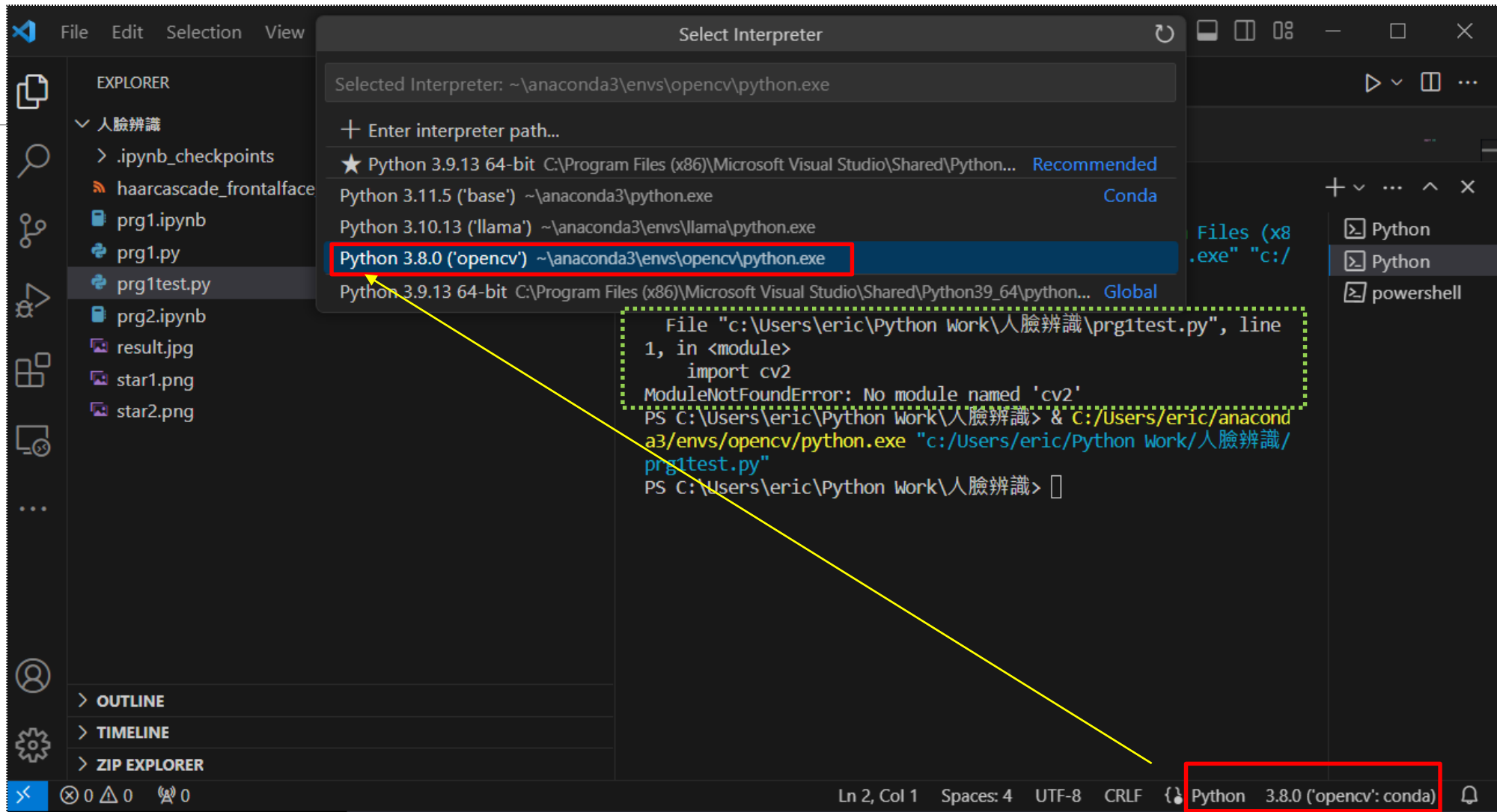
安裝opencv (需先進入opencv的虛擬環境)

```
pip install opencv-python
```

安裝mediapipe

```
pip install mediapipe
```

VS code記得選取正確的虛擬環境



Visual Studio Code

開新檔案 hand.py

```
hand.py  
1 import cv2  
2 import mediapipe as mp  
3
```

Prg1

打開webcam

```
hand.py > ...
1  # prg1
2  #
3  import cv2
4  import mediapipe as mp
5
6  # open webcam
7
8  cap = cv2.VideoCapture(0)
9
10 while True:
11     ret, img = cap.read()
12     if ret:
13         cv2.imshow('img', img)
14
15     if cv2.waitKey(1) == ord('q'):
16         break
17
```

Prg2 偵測影像並顯示手部座標

```
hand.py > ...
1 # prg1
2 #
3 import cv2
4 import mediapipe as mp
5
6 # open webcam
7
8 cap = cv2.VideoCapture(0)
9
10 #
11 mpHands = mp.solutions.hands
12 hands = mpHands.Hands()
13
14 while True:
15     ret, img = cap.read()
16     if ret:
17         # 把影像轉換成RGB格式，並存入imgRGB變數
18         imgRGB= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
19
20         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
21         result = hands.process(imgRGB)
22         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
23         print(result.multi_hand_landmarks)
24
25         cv2.imshow('img', img)
26
27     if cv2.waitKey(1) == ord('q'):
28         break
29
```

手部的關鍵點座標 (x, y, z)

```
} landmark {
  x: 0.736149251461029
  y: 0.5333127379417419
  z: -0.05488724261522293
}
```

Prg3

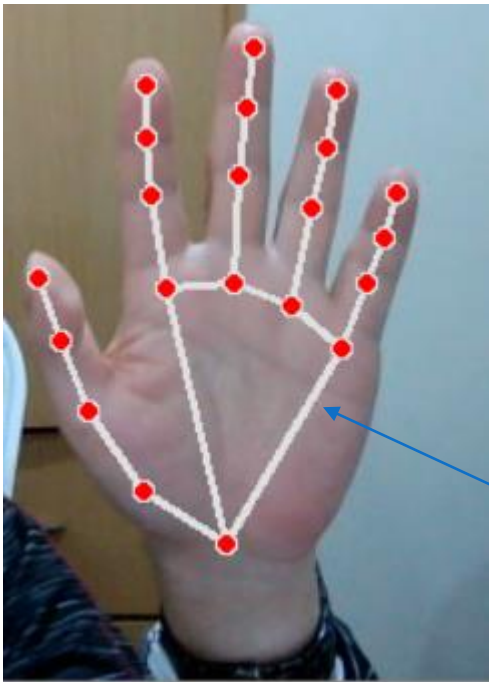
繪製手部關鍵點



```
1 # prg3
2 #
3 import cv2
4 import mediapipe as mp
5
6 # open webcam
7
8 cap = cv2.VideoCapture(0)
9
10 #
11 mpHands = mp.solutions.hands
12 hands = mpHands.Hands()
13
14 # 透過drawing_utils屬性來繪圖
15 mpDraw = mp.solutions.drawing_utils
16
17 while True:
18     ret, img = cap.read()
19     if ret:
20         # 把影像轉換成RGB格式，並存入imgRGB變數
21         imgRGB= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
22
23         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
24         result = hands.process(imgRGB)
25         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
26         print(result.multi_hand_landmarks)
27
28         if result.multi_hand_landmarks:
29             for handLms in result.multi_hand_landmarks:
30                 mpDraw.draw_landmarks(img, handLms)
31
32         cv2.imshow('img', img)
33
34     if cv2.waitKey(1) == ord('q'):
35         break
36
```

Prg4

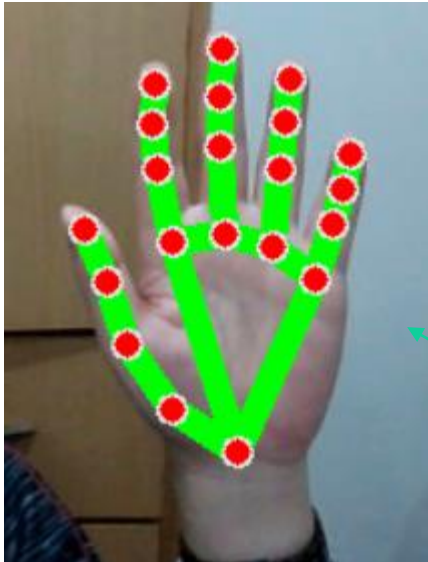
畫出手部 關鍵點連線



```
hand.py > ...
1 # prg4
2 #
3 import cv2
4 import mediapipe as mp
5
6 # open webcam
7
8 cap = cv2.VideoCapture(0)
9
10 #
11 mpHands = mp.solutions.hands
12 hands = mpHands.Hands()
13
14 # 透過drawing_utils屬性來繪圖
15 mpDraw = mp.solutions.drawing_utils
16
17 while True:
18     ret, img = cap.read()
19     if ret:
20         # 把影像轉換成RGB格式，並存入imgRGB變數
21         imgRGB= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
22
23         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
24         result = hands.process(imgRGB)
25         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
26         print(result.multi_hand_landmarks)
27
28         if result.multi_hand_landmarks:
29             for handLms in result.multi_hand_landmarks:
30                 # 僅繪製手部關鍵點
31                 # mpDraw.draw_landmarks(img, handLms)
32
33                 # 繪製手部關鍵點與連線
34                 mpDraw.draw_landmarks(img, handLms, mpHands.HAND_CONNECTIONS)
35
36         cv2.imshow('img', img)
37
38     if cv2.waitKey(1) == ord('q'):
39         break
```

Prg5

設定點&線的顏色



```
hand.py > ...
1 # prg5
2 #
3 import cv2
4 import mediapipe as mp
5
6 # open webcam
7
8 cap = cv2.VideoCapture(0)
9
10 #
11 mpHands = mp.solutions.hands
12 hands = mpHands.Hands()
13
14 # 透過drawing_utils屬性來繪圖
15 mpDraw = mp.solutions.drawing_utils
16
17 # 設定點的顏色屬性
18 handLmsStyle = mpDraw.DrawingSpec(color=(0, 0, 255), thickness=5)
19 # 設定線的顏色屬性
20 handConStyle = mpDraw.DrawingSpec(color=(0, 255, 0), thickness=10)
21
22 while True:
23     ret, img = cap.read()
24     if ret:
25         # 把影像轉換成RGB格式，並存入imgRGB變數
26         imgRGB= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
27
28         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
29         result = hands.process(imgRGB)
30         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
31         print(result.multi_hand_landmarks)
32
33         if result.multi_hand_landmarks:
34             for handLms in result.multi_hand_landmarks:
35                 # 僅繪製手部關鍵點
36                 # mpDraw.draw_landmarks(img, handLms)
37
38                 # 繪製手部關鍵點與連線
39                 mpDraw.draw_landmarks(img, handLms, mpHands.HAND_CONNECTIONS, handLmsStyle, handConStyle)
40
41         cv2.imshow('img', img)
```

Prg6

繪製手部關鍵點座標

手部關鍵點座標比率

第i個 (x, y)

Ex. 0.5表示是視窗位置的比率

```
0 0.6759192943572998 0.9447810649871826
1 0.6334993243217468 0.9264832735061646
2 0.5930758714675903 0.903672993183136
3 0.566557765007019 0.8866826891899109
4 0.5508601665496826 0.8546093702316284
5 0.6460853219032288 0.7947497367858887
6 0.6271244287490845 0.8293350338935852
7 0.5951453447341919 0.8980709314346313
8 0.5747203826904297 0.9535505771636963
9 0.6962054371833801 0.8294239044189453
10 0.6757184267044067 0.8774153590202332
11 0.6311092376708984 0.9550268054008484
12 0.6048914194107056 1.00734543800354
13 0.7350889444351196 0.8802058696746826
14 0.7184805870056152 0.9307700991630554
15 0.6772904992103577 1.005534052848816
16 0.6502039432525635 1.0514447689056396
17 0.7644477486610413 0.9361640810966492
18 0.7546484470367432 0.9771474599838257
19 0.7264048457145691 1.030326008796692
20 0.7059462666511536 1.063906192779541
```

```
hand.py > ...
1 # prg6
2 #
3 import cv2
4 import mediapipe as mp
5
6 # open webcam
7
8 cap = cv2.VideoCapture(0)
9
10 #
11 mpHands = mp.solutions.hands
12 hands = mpHands.Hands()
13
14 # 透過drawing_utils屬性來繪圖
15 mpDraw = mp.solutions.drawing_utils
16
17 # 設定點的顏色屬性
18 handLmsStyle = mpDraw.DrawingSpec(color=(0, 0, 255), thickness=5)
19 # 設定線的顏色屬性
20 handConStyle = mpDraw.DrawingSpec(color=(0, 255, 0), thickness=10)
21
22 while True:
23     ret, img = cap.read()
24     if ret:
25         # 把影像轉換成RGB格式，並存入imgRGB變數
26         imgRGB = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
27
28         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
29         result = hands.process(imgRGB)
30         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
31         print(result.multi_hand_landmarks)
32
33         if result.multi_hand_landmarks:
34             for handLms in result.multi_hand_landmarks:
35                 # 僅繪製手部關鍵點
36                 mpDraw.draw_landmarks(img, handLms)
37
38                 # 繪製手部關鍵點與連線
39                 mpDraw.draw_landmarks(img, handLms, mpHands.HAND_CONNECTIONS, handLmsStyle, handConStyle)
40
41                 # 列印出所有手部關鍵點座標 (x, y)
42                 for i, lm in enumerate(handLms.landmark):
43                     print(i, lm.x, lm.y)
44
45     cv2.imshow('img', img)
```

Prg7#1

繪製手部關鍵點座標

手部關鍵點座標比率

第i個 (x, y)

Ex. 0.5表示是視窗位置的比率

```
0 0.6759192943572998 0.9447810649871826
1 0.6334993243217468 0.9264832735061646
2 0.5930758714675903 0.903672993183136
3 0.566557765007019 0.8866826891899109
4 0.5508601665496826 0.8546093702316284
5 0.6460853219032288 0.7947497367858887
6 0.6271244287490845 0.8293350338935852
7 0.5951453447341919 0.8980709314346313
8 0.5747203826904297 0.9535505771636963
9 0.6962054371833801 0.8294239044189453
10 0.6757184267044067 0.8774153590202332
11 0.6311092376708984 0.9550268054008484
12 0.6048914194107056 1.00734543800354
13 0.7350889444351196 0.8802058696746826
14 0.7184805870056152 0.9307700991630554
15 0.6772904992103577 1.005534052848816
16 0.6502039432525635 1.0514447689056396
17 0.7644477486610413 0.9361640810966492
18 0.7546484470367432 0.9771474599838257
19 0.7264048457145691 1.030326008796692
20 0.7059462666511536 1.063906192779541
```

```
hand.py > ...
1 # prg6
2 #
3 import cv2
4 import mediapipe as mp
5
6 # open webcam
7
8 cap = cv2.VideoCapture(0)
9
10 #
11 mpHands = mp.solutions.hands
12 hands = mpHands.Hands()
13
14 # 透過drawing_utils屬性來繪圖
15 mpDraw = mp.solutions.drawing_utils
16
17 # 設定點的顏色屬性
18 handLmsStyle = mpDraw.DrawingSpec(color=(0, 0, 255), thickness=5)
19 # 設定線的顏色屬性
20 handConStyle = mpDraw.DrawingSpec(color=(0, 255, 0), thickness=10)
21
22 while True:
23     ret, img = cap.read()
24     if ret:
25         # 把影像轉換成RGB格式，並存入imgRGB變數
26         imgRGB = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
27
28         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
29         result = hands.process(imgRGB)
30         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
31         print(result.multi_hand_landmarks)
32
33         if result.multi_hand_landmarks:
34             for handLms in result.multi_hand_landmarks:
35                 # 僅繪製手部關鍵點
36                 mpDraw.draw_landmarks(img, handLms)
37
38                 # 繪製手部關鍵點與連線
39                 mpDraw.draw_landmarks(img, handLms, mpHands.HAND_CONNECTIONS, handLmsStyle, handConStyle)
40
41                 # 列印出所有手部關鍵點座標 (x, y)
42                 for i, lm in enumerate(handLms.landmark):
43                     print(i, lm.x, lm.y)
44
45     cv2.imshow('img', img)
```


Prg7#2

繪製手部 關鍵點座標

步驟1. 取得影像的高度與寬度

步驟2. 把相對位置*影像寬與高
轉換為實際的座標

$lm.x * imgWidth$

$lm.y * imgHeight$

步驟3. 計算後之真正座標結果

```
0 465 370
1 432 348
2 411 312
3 404 279
4 394 252
5 438 269
6 432 234
7 428 213
8 426 193
9 463 267
10 465 225
11 465 200
12 465 177
13 485 276
14 492 239
15 495 216
16 497 194
17 503 293
18 515 267
19 521 249
20 525 232
```

```
22 while True:
23     ret, img = cap.read()
24     if ret:
25         # 把影像轉換成RGB格式，並存入imgRGB變數
26         imgRGB= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
27
28         # 取得影像的高度與寬度
29         # 影像高度
30         imgHeight = img.shape[0]
31         # 影像寬度
32         imgWidth = img.shape[1]
33
34         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
35         result = hands.process(imgRGB)
36         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
37         print(result.multi_hand_landmarks)
38
39         if result.multi_hand_landmarks:
40             for handLms in result.multi_hand_landmarks:
41                 # 僅繪製手部關鍵點
42                 # mpDraw.draw_landmarks(img, handLms)
43
44                 # 繪製手部關鍵點與連線
45                 mpDraw.draw_landmarks(img, handLms, mpHands.HAND_CONNECTIONS, handLmsStyle, handConStyle)
46
47                 # 列印出所有手部關鍵點座標 (x, y)
48                 for i, lm in enumerate(handLms.landmark):
49                     # 重新計算座標值
50                     xPos = int(lm.x * imgWidth)
51                     yPos = int(lm.y * imgHeight)
52
53                     # 列印座標
54                     print(i, xPos, yPos)
55
56                 cv2.imshow('img', img)
57
58         if cv2.waitKey(1) == ord('q'):
59             break
```

Prg7#3

繪製手部 關鍵點座標



```
22 while True:
23     ret, img = cap.read()
24     if ret:
25         # 把影像轉換成RGB格式，並存入imgRGB變數
26         imgRGB= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
27
28         # 取得影像的高度與寬度
29         # 影像高度
30         imgHeight = img.shape[0]
31         # 影像寬度
32         imgWidth = img.shape[1]
33
34         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
35         result = hands.process(imgRGB)
36         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
37         print(result.multi_hand_landmarks)
38
39         if result.multi_hand_landmarks:
40             for handLms in result.multi_hand_landmarks:
41                 # 僅繪製手部關鍵點
42                 # mpDraw.draw_landmarks(img, handLms)
43
44                 # 繪製手部關鍵點與連線
45                 mpDraw.draw_landmarks(img, handLms, mpHands.HAND_CONNECTIONS, handLmsStyle, handConStyle)
46
47                 # 列印出所有手部關鍵點座標 (x, y)
48                 for i, lm in enumerate(handLms.landmark):
49                     # 重新計算座標值
50                     xPos = int(lm.x * imgWidth)
51                     yPos = int(lm.y * imgHeight)
52
53                     # 列印在畫面上
54                     cv2.putText(img, str(i), (xPos-25, yPos+5), cv2.FONT_HERSHEY_SIMPLEX, 0.4, (0,0,255, 2))
55
56                     # 列印座標
57                     print(i, xPos, yPos)
58
59                 cv2.imshow('img', img)
60
61         if cv2.waitKey(1) == ord('q'):
62             break
```

cv2提供的列印文字功能

```
# 列印在畫面上  
cv2.putText(img, str(i), (xPos-25, yPos+5), cv2.FONT_HERSHEY_SIMPLEX, 0.4, (0,0,255, 2))
```

內容

座標(x,y)

字型

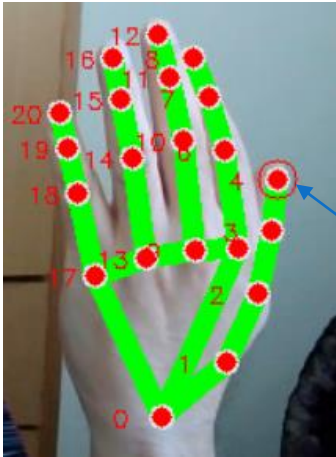
Font
scale
字體
大小

顏色
(B, G, R)

線條粗細

Prg8

指定設定 大拇指畫圓



```
22 while True:
23     ret, img = cap.read()
24     if ret:
25         # 把影像轉換成RGB格式，並存入imgRGB變數
26         imgRGB= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
27
28         # 取得影像的高度與寬度
29         # 影像高度
30         imgHeight = img.shape[0]
31         # 影像寬度
32         imgwidth = img.shape[1]
33
34         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
35         result = hands.process(imgRGB)
36         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
37         print(result.multi_hand_landmarks)
38
39         if result.multi_hand_landmarks:
40             for handLms in result.multi_hand_landmarks:
41                 # 僅繪製手部關鍵點
42                 # mpDraw.draw_landmarks(img, handLms)
43
44                 # 繪製手部關鍵點與連線
45                 mpDraw.draw_landmarks(img, handLms, mpHands.HAND_CONNECTIONS, handLmsStyle, handConStyle)
46
47                 # 列印出所有手部關鍵點座標 (x, y)
48                 for i, lm in enumerate(handLms.landmark):
49                     # 重新計算座標值
50                     xPos = int(lm.x * imgwidth)
51                     yPos = int(lm.y * imgHeight)
52
53                     # 列印在畫面上
54                     cv2.putText(img, str(i), (xPos-25, yPos+5), cv2.FONT_HERSHEY_SIMPLEX, 0.4, (0,0,255, 2))
55
56                     # 列印大拇指
57                     if i == 4:
58                         cv2.circle(img, (xPos, yPos), 10, (0, 0, 255))
59
60                     # 列印座標
61                     print(i, xPos, yPos)
62
63                 cv2.imshow('img', img)
64
65 if cv2.waitKey(1) == ord('q'):
66     break
```

cv2畫圓功能

大拇指畫空心圓

```
if i == 4:  
    cv2.circle(img, (xPos, yPos), 10, (0, 0, 255))
```

大拇指畫實心圓

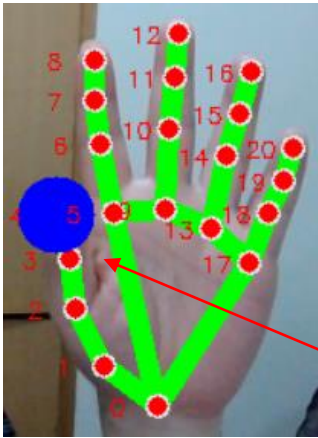
```
if i == 4:  
    cv2.circle(img, (xPos, yPos), 10, (0, 0, 255), cv2.FILLED)
```

大拇指畫大顆的藍色實心圓

```
if i == 4:  
    cv2.circle(img, (xPos, yPos), 20, (255, 0, 0), cv2.FILLED)
```

Prg8#2

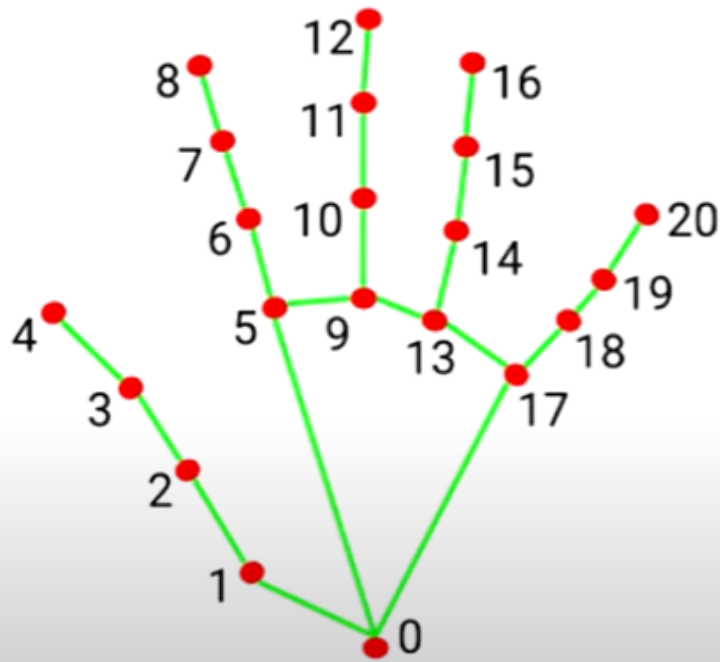
繪製大拇指 實心圓



大拇指為關鍵點4

```
26 while True:
27     ret, img = cap.read()
28     if ret:
29         # 把影像轉換成RGB格式，並存入imgRGB變數
30         imgRGB= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
31
32         # 取得影像的高度與寬度
33         # 影像高度
34         imgHeight = img.shape[0]
35         # 影像寬度
36         imgwidth = img.shape[1]
37
38         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
39         result = hands.process(imgRGB)
40         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
41         print(result.multi_hand_landmarks)
42
43         if result.multi_hand_landmarks:
44             for handLms in result.multi_hand_landmarks:
45                 # 僅繪製手部關鍵點
46                 # mpDraw.draw_landmarks(img, handLms)
47
48                 # 繪製手部關鍵點與連線
49                 mpDraw.draw_landmarks(img, handLms, mpHands.HAND_CONNECTIONS, handLmsStyle, handConStyle)
50
51                 # 列印出所有手部關鍵點座標 (x, y)
52                 for i, lm in enumerate(handLms.landmark):
53                     # 重新計算座標值
54                     xPos = int(lm.x * imgwidth)
55                     yPos = int(lm.y * imgHeight)
56
57                     # 列印在畫面上
58                     cv2.putText(img, str(i), (xPos-25, yPos+5), cv2.FONT_HERSHEY_SIMPLEX, 0.4, (0,0,255, 2))
59
60                     # 列印大拇指
61                     if i == 4:
62                         cv2.circle(img, (xPos, yPos), 20, (255, 0, 0), cv2.FILLED)
63
64                     # 列印座標
65                     print(i, xPos, yPos)
66
67         currentTime = time.time()
68         fps = 1/(currentTime-endTime)
69         endTime = currentTime
70         cv2.putText(img, f"FPS : {int(fps)}", (30, 50), cv2.FONT_HERSHEY_SIMPLEX, 1, (255, 0, 0), 3)
71
72         cv2.imshow('img', img)
```

Hand Landmarks



- 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

Fig 2. 21 hand landmarks.

Prg9 FPS

1. 匯入 import time

2. 新增兩個時間變數

3. 計算fps

4. 顯示在畫面上

```
1 import cv2
2 import medianipe as mp
3 import time
4 # open webcam
5 cap = cv2.VideoCapture(0)
6 mpHands = mp.solutions.hands
7 hands = mpHands.Hands()
8 # 透過drawing_utils屬性來繪圖
9 mpDraw = mp.solutions.drawing_utils
10 # 設定點的顏色屬性
11 handLmsStyle = mpDraw.DrawingSpec(color=(0, 0, 255), thickness=5)
12 # 設定線的顏色屬性
13 handConStyle = mpDraw.DrawingSpec(color=(0, 255, 0), thickness=10)
14 # 新增時間變數
15 currentTime = 0
16 endTime = 0
17 while True:
18     ret, img = cap.read()
19     if ret:
20         # 把影像轉換成RGB格式，並存入imgRGB變數
21         imgRGB= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
22         # 影像高度
23         imgHeight = img.shape[0]
24         # 影像寬度
25         imgWidth = img.shape[1]
26         # 透過Mediapipe中的hands.process分析手部資訊，存入result變數
27         result = hands.process(imgRGB)
28         # 透過multi_hand_landmarks屬性，印出手部的關鍵座標
29         print(result.multi_hand_landmarks)
30         if result.multi_hand_landmarks:
31             for handLms in result.multi_hand_landmarks:
32                 # 僅繪製手部關鍵點
33                 # mpDraw.draw_landmarks(img, handLms)
34                 # 繪製手部關鍵點與連線
35                 mpDraw.draw_landmarks(img, handLms, mpHands.HAND_CONNECTIONS, handLmsStyle, handConStyle)
36                 # 列印出所有手部關鍵點座標 (x, y)
37                 for i, lm in enumerate(handLms.landmark):
38                     # 重新計算座標值
39                     xPos = int(lm.x * imgWidth)
40                     yPos = int(lm.y * imgHeight)
41                     # 列印在畫面上
42                     cv2.putText(img, str(i), (xPos-25, yPos+5), cv2.FONT_HERSHEY_SIMPLEX, 0.4, (0,0,255, 2))
43                     # 列印大拇指
44                     if i == 4:
45                         cv2.circle(img, (xPos, yPos), 20, (255, 0, 0), cv2.FILLED)
46                     # 列印座標
47                     print(i, xPos, yPos)
48             # 計算FPS
49             currentTime = time.time()
50             fps = 1/(currentTime-endTime)
51             endTime = currentTime
52             cv2.putText(img, f"FPS : {int(fps)}", (30, 50), cv2.FONT_HERSHEY_SIMPLEX, 1, (255, 0, 0), 3)
53             cv2.imshow('img', img)
54
```


資料來源

1. Youtube

<https://www.youtube.com/watch?v=x4eeX7WJluA>

2. Mediapipe

<https://google.github.io/mediapipe/>

Congratulations.

You can design your real-time Hand Detection System now !
