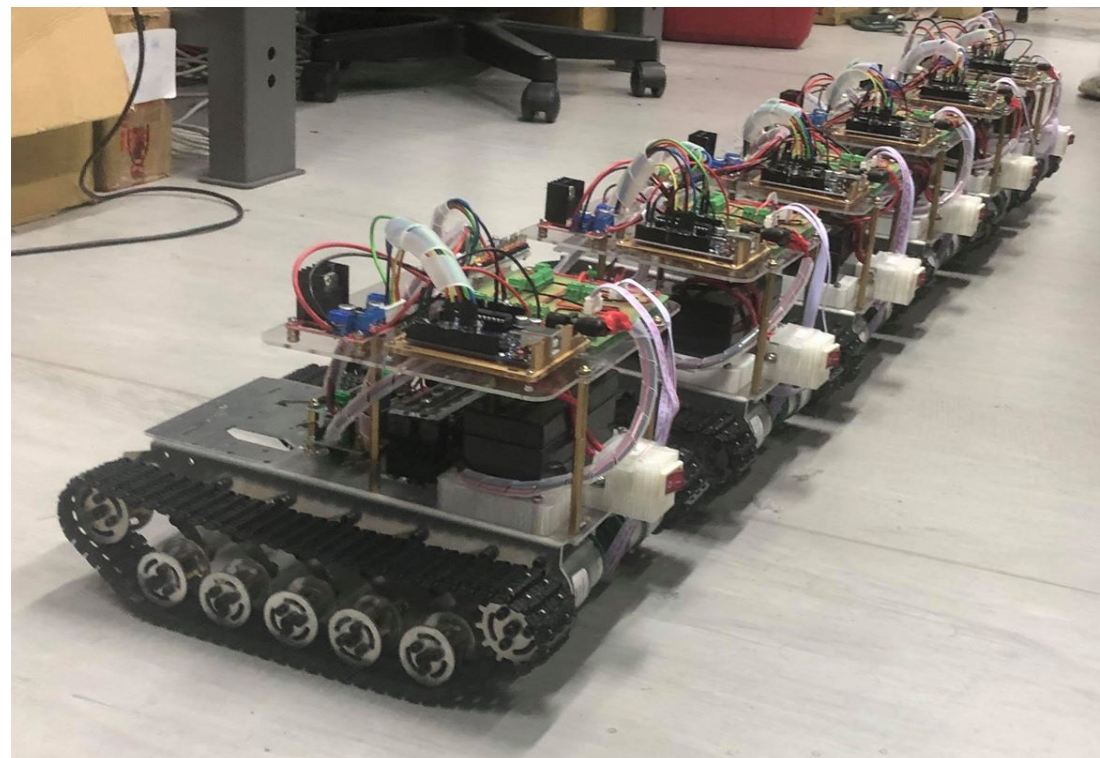


機器人動力與控制

期末專題

outline

1. 期末專題任務介紹
2. 車體機構及硬體配置
3. 控制器 (arduino & pca9685)
4. 馬達驅動器 (h-bridge)
5. 馬達及Encoder
6. 線路圖及電路板
7. 機械手臂
8. 視覺辨識
9. arduino與pc的溝通
10. demo
11. 充電注意事項



期末專題任務介紹

在這次的專題中，我們的目標是讓履帶車前進，並控制車上的4R手臂，使其末端插入目標物的洞裡。

流程：

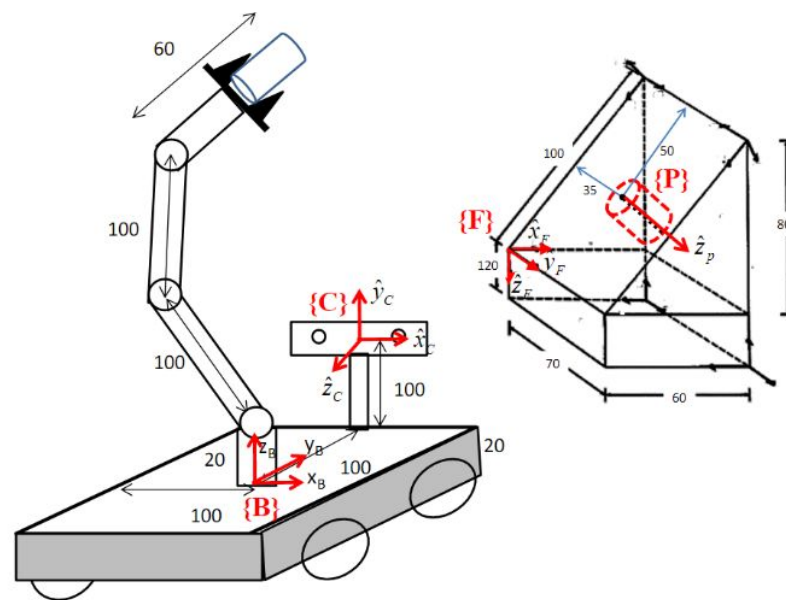
車體擺放在場地任一位置(可看到目標物)



車子移動到目標物旁



手臂移動使物件依序插入三個洞口(大中小)



車體機構及硬體配置

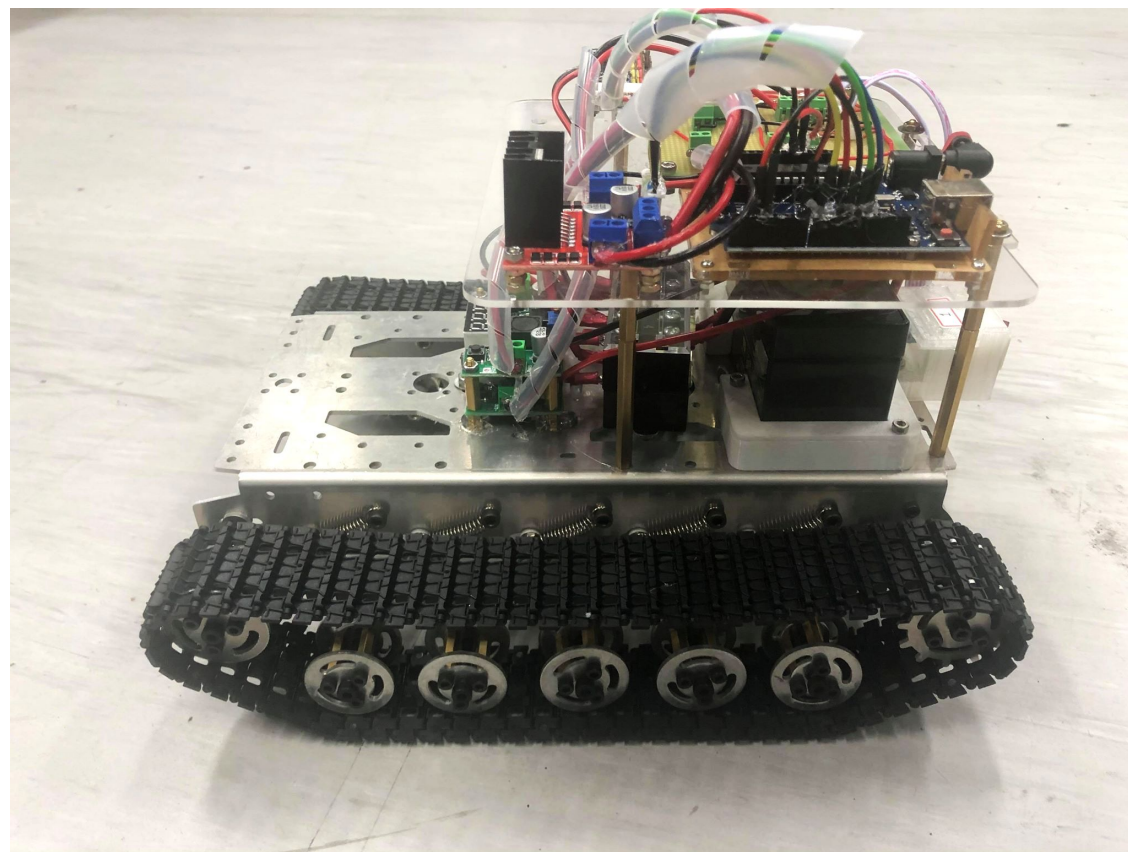
分層介紹

2nd floor:

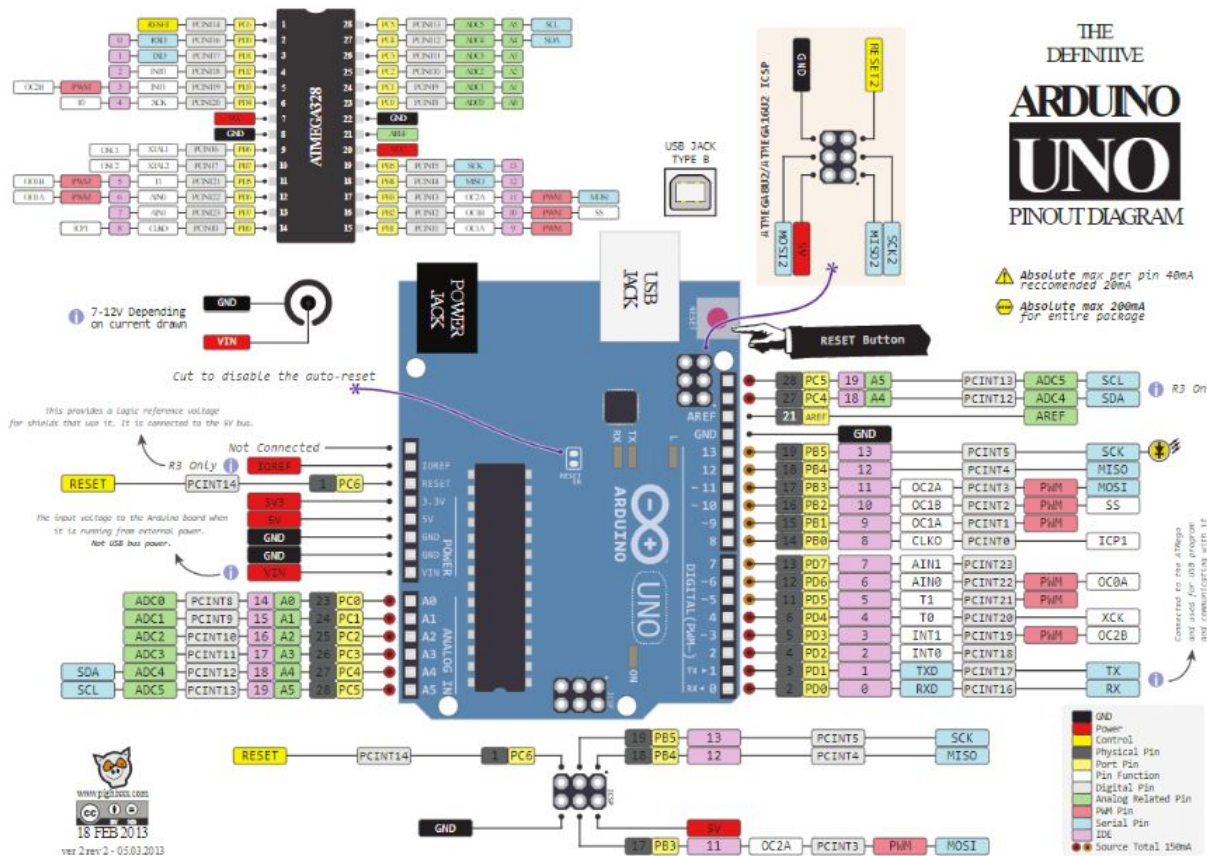
Arduino、pca9685、H-bridge、電路板

1st floor:

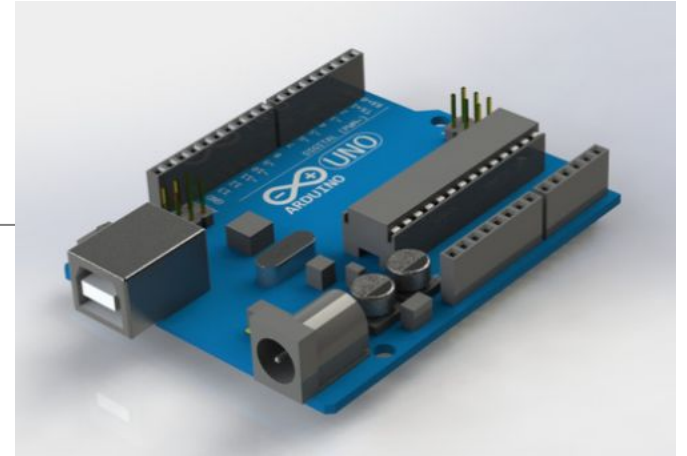
開關、電池、端子台x2、降壓模組x2



Arduino UNO R3



Arduino 腳位分配



pin13 : h-bridge IN1

pin12: h-bridge IN2

pin11~ : h-bridge ENA

pin10~ : h-bridge ENB

pin9~ : 未使用

pin8 : h-bridge IN3

pin7 : h-bridge IN4

pin6~ : 未使用

pin5~ : 未使用

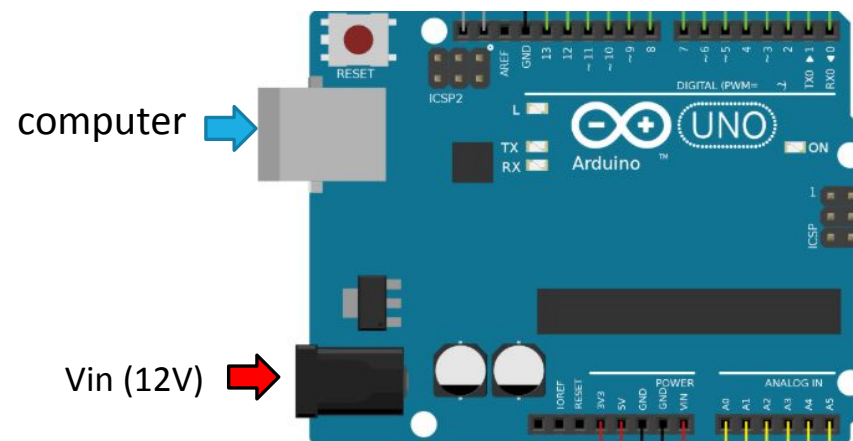
pin4 : 未使用

pin3~ : 馬達B之encoder B相

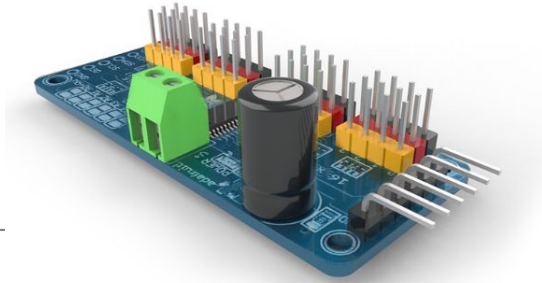
pin2 : 馬達A之encoder B相

A4 : pca9685的SCA

A5 :pca9685的SCL



pca9685



```
#include <Wire.h>
```

```
#include <Adafruit_PWMServoDriver.h>
```

記得下載 library

```
Adafruit_PWMServoDriver pwm = Adafruit_PWMServoDriver();
```

```
#define SERVOMIN 102 // this is the 'minimum' pulse length count (out of 4096)
```

```
#define SERVOMAX 512 // this is the 'maximum' pulse length count (out of 4096)
```

```
// our servo # counter
```

```
uint8_t servonum = 0;
```

```
void setup() {
```

```
    Serial.begin(9600);
```

```
    pwm.begin();
```

```
    pwm.setPWMFreq(50); // Analog servos run at ~50 Hz updates
```

```
}
```

```
void loop() {
```

```
    for(int i=0; i<4; i++)
```

```
    {
```

```
        for( int angle =0; angle<181; angle +=10){
```

```
            delay(50);
```

```
            pwm.setPWM(i, 0, angleToPulse(angle) );
```

```
        }
```

```
    }
```

```
    delay(500); // wait for 0.5 second
```

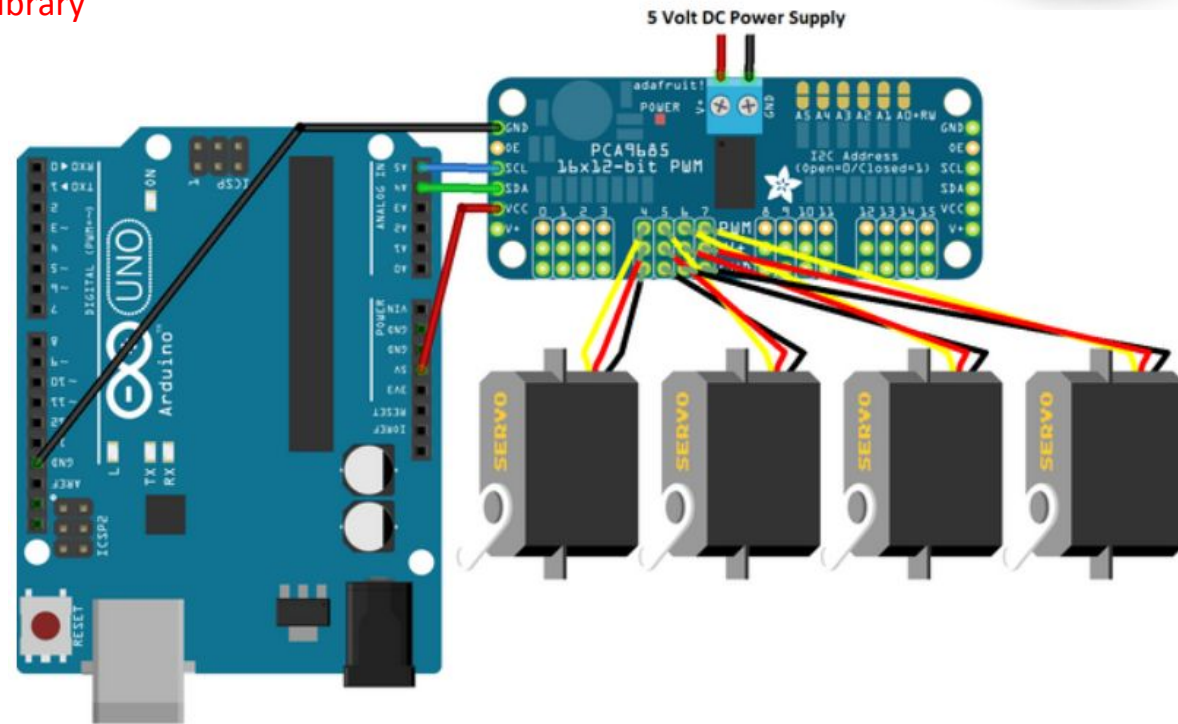
```
}
```

```
int angleToPulse(int ang){
```

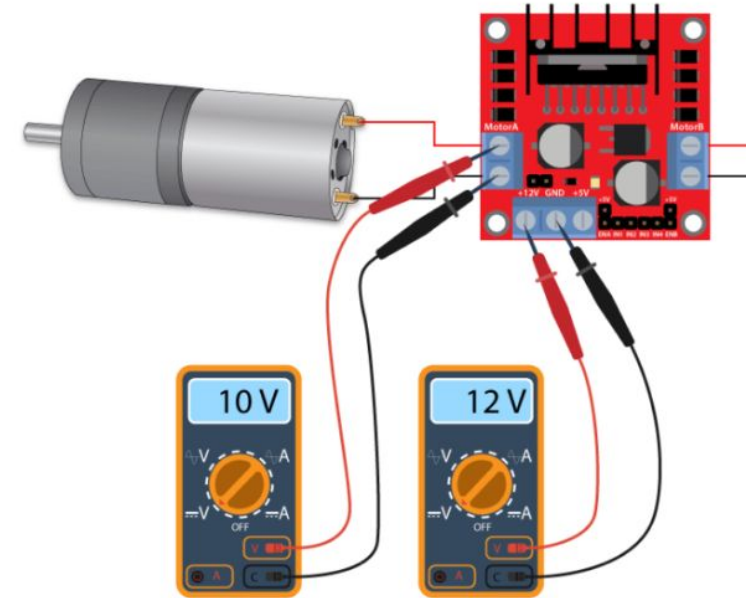
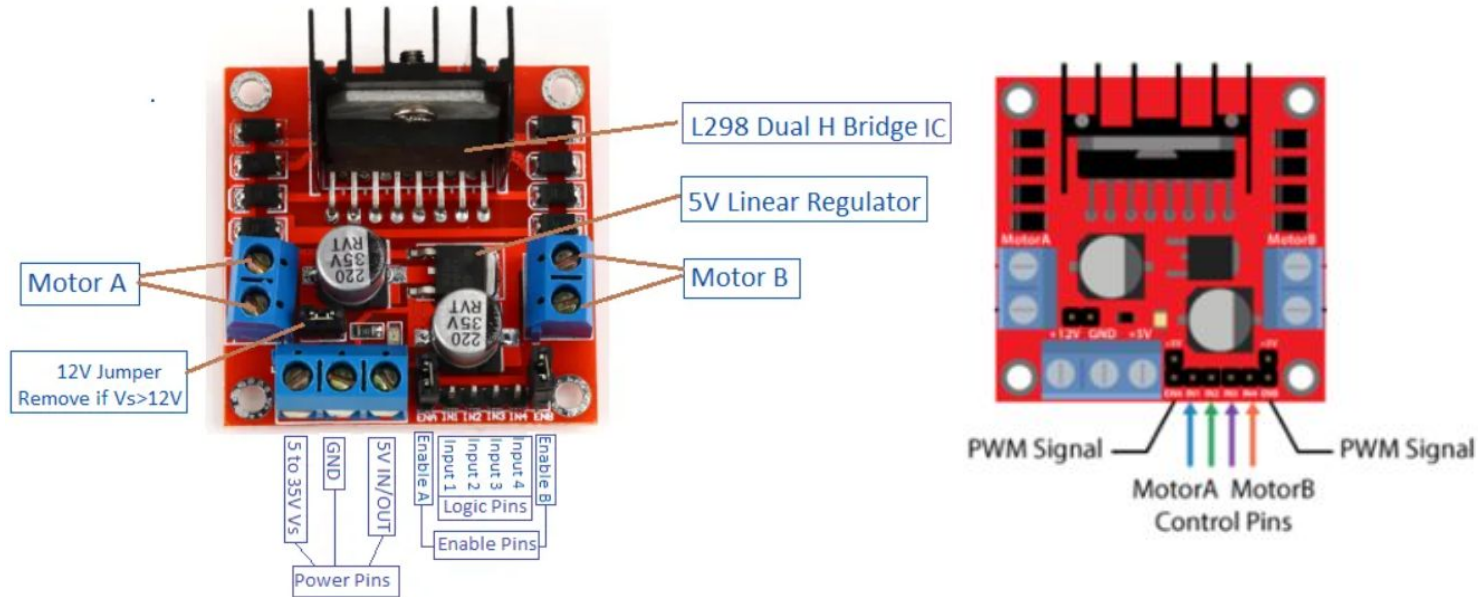
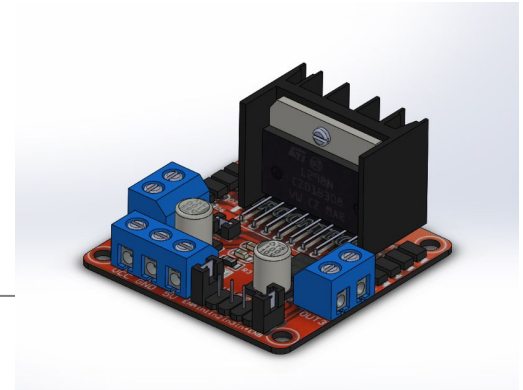
```
    int pulse = map(ang,0, 180, SERVOMIN,SERVOMAX); // map angle of 0 to 180 to Servo min and Servo max
```

```
    return pulse;
```

```
}
```

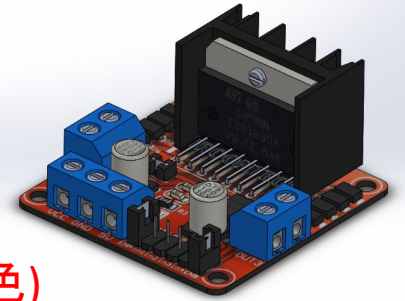


馬達驅動器 (H-bridge)



	晶片	邏輯電壓	邏輯電流	驅動電壓	驅動電流	最大功率	重量
H-bridge	L298N	5V	0mA ~ 36mA	5V ~ 35V	2A (max單橋)	35W	30g

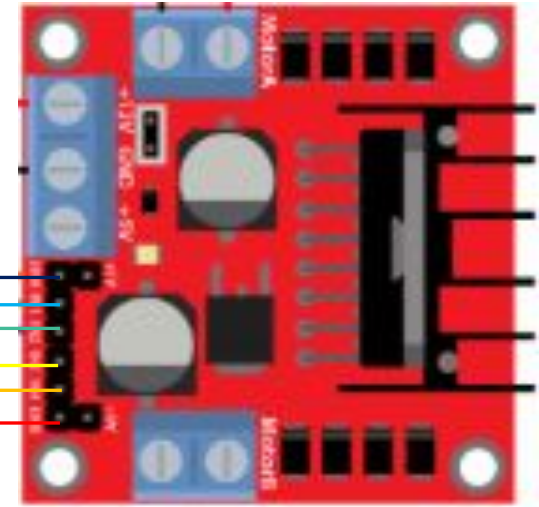
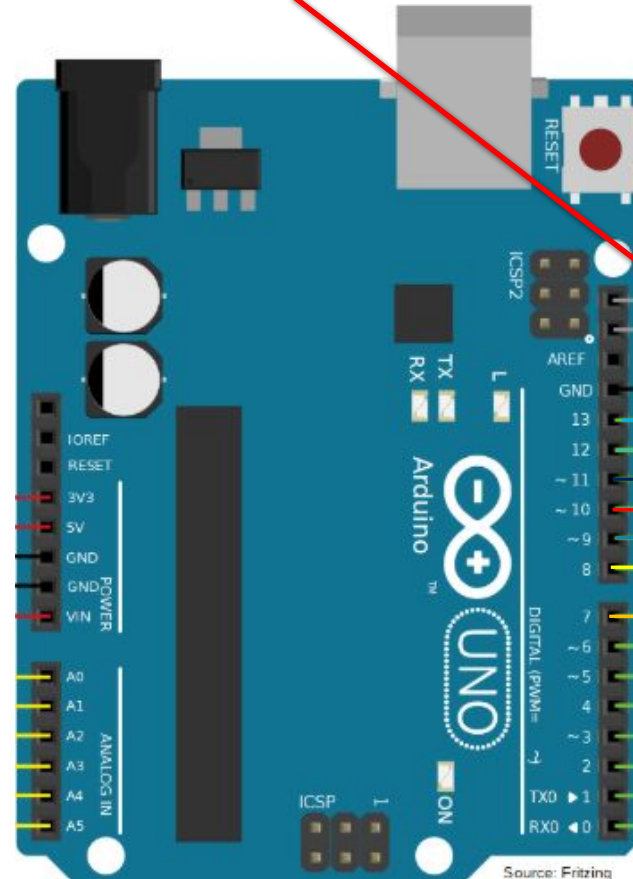
H-bridge 基礎控制 (直走)



```
int ena= 11, left1 = 13, left2 = 12, right1 = 8, right2 = 7, enb= 10;
```

注意腳位! (可參考接線顏色)

```
void setup() {  
  pinMode(left1, OUTPUT);  
  pinMode(left2, OUTPUT);  
  pinMode(right1, OUTPUT);  
  pinMode(right2, OUTPUT);  
  pinMode(ena, OUTPUT);  
  pinMode(enb, OUTPUT);  
  Serial.begin(9600);  
}  
  
void loop() {  
  forward();  
}  
  
void forward() {  
  digitalWrite(left1, HIGH);  
  digitalWrite(left2, LOW);  
  digitalWrite(right1, HIGH);  
  digitalWrite(right2, LOW);  
  analogWrite(ena, 100);  
  analogWrite(enb, 100);  
}
```



Source: Fritzing

馬達及Encoder

車體馬達規格

型號: JGB37-520

電壓: DC12V 額定

電流: 0.25A

空載轉速: 300 rpm

輸出扭矩: 10kg.cm

M+: Motor+

M-: Motor-

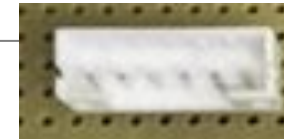
G: Encoder GND

V: Encoder Vin(3.3V)

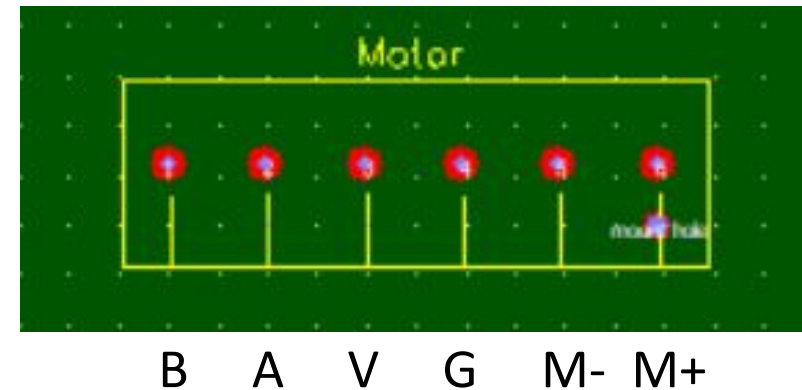
A: Encoder A相

B: Encoder B相

Pinout



注意方向!



Encoder

規格: **編碼器線數360線**、供電3.3V, 編碼器**正負極不可接反**, 接反會燒壞編碼器。



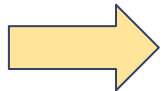
馬達旋轉360°會產生360個方波



編碼器可提供 1° 的解析度
(每個方波代表馬達旋轉1°)



可從方波的頻率得知馬達的轉速



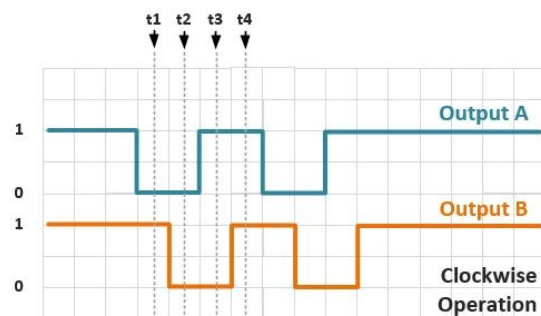
再乘以導輪之圓周長即可得知車子的行進速度

(例如: 頻率360Hz, 則馬達轉速= $360/360 \times 60 = 60(\text{rev/min})$)

encoder AB相

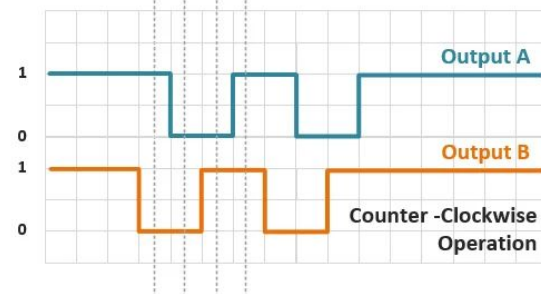
encoder 輸出的訊號分成A、B相，兩者之相位差為 90°

可從A、B相之先後關係得知馬達的轉向



Clockwise Sequence

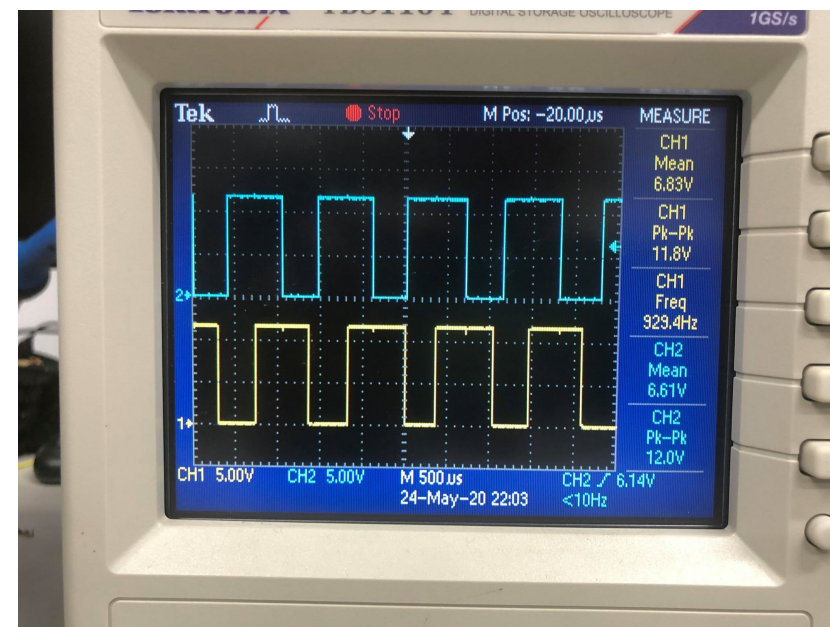
	A	B
t1	0	1
t2	0	0
t3	1	0
t4	1	1



Counter-Clockwise Sequence

	A	B
t1	1	0
t2	0	0
t3	0	1
t4	1	1

實際測試訊號:



encoder AB相

arduino擁有interrupt功能之腳位只有2個 (pin2 & pin3)

所以我們左右馬達統一連接B相到arduino

Arduino Model	Digital Interrupt Pins
Uno, Nano, Mini, other 328-based	2,3
Mega, Mega2560, MegaADK	2, 3, 18, 19, 20, 21
Micro, Leonardo, other 32u4-based	0, 1, 2, 3, 7
Zero	all digital pins, except 4

encoder量測馬達轉速 範例程式

```
#include "TimerOne.h"

// Constants for Interrupt Pins
const byte MOTOR1 = 2; // Motor 1 Interrupt Pin - INT 0
const byte MOTOR2 = 3; // Motor 2 Interrupt Pin - INT 1

// Integers for pulse counters
unsigned int counter1 = 0;
unsigned int counter2 = 0;

// Motor A
int enA = 11;
int in1 = 13;
int in2 = 12;

// Motor B
int enB = 10;
int in3 = 8;
int in4 = 7;

// Float for number of slots in encoder disk
float diskslots = 360; // encoder slot = 360

void setup()
{
    Serial.begin(9600);

    Timer1.initialize(1000000); // set timer for 1sec
    attachInterrupt(digitalPinToInterrupt (MOTOR1), ISR_count1, RISING); // Increase counter 1 when speed sensor pin goes High
    attachInterrupt(digitalPinToInterrupt (MOTOR2), ISR_count2, RISING); // Increase counter 2 when speed sensor pin goes High
    Timer1.attachInterrupt( ISR_timerone ); // Enable the timer
}

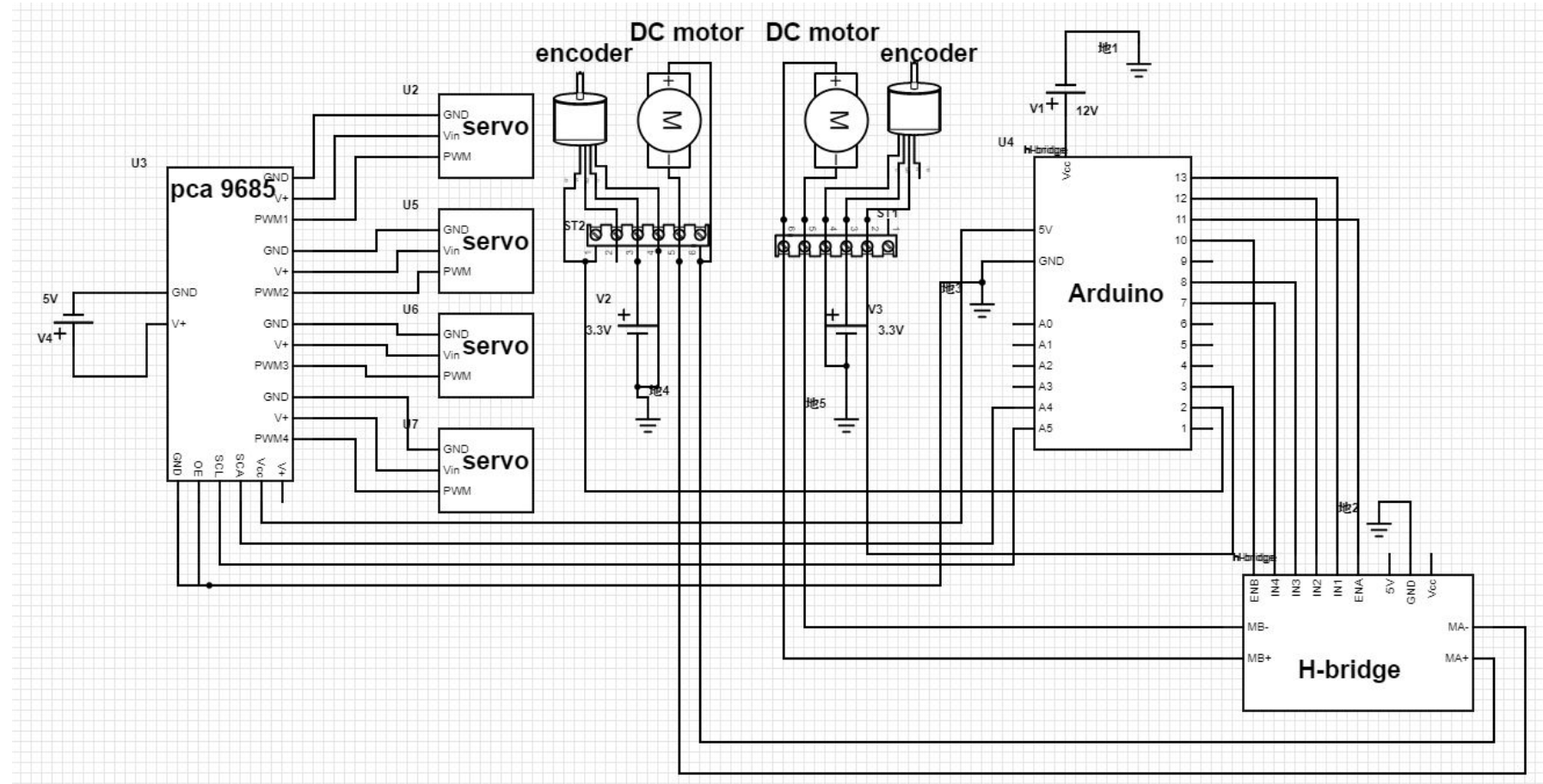
// Motor 1 pulse count ISR
void ISR_count1()
{
    counter1++; // increment Motor 1 counter value
}

// Motor 2 pulse count ISR
void ISR_count2()
{
    counter2++; // increment Motor 2 counter value
}

// TimerOne ISR
void ISR_timerone()
{
    Timer1.detachInterrupt(); // Stop the timer
    Serial.print("Motor Speed 1: ");
    float rotation1 = (counter1 / diskslots) * 60.00; // calculate RPM for Motor 1
    Serial.print(rotation1);
    Serial.print(" RPM - ");
    counter1 = 0; // reset counter to zero
    Serial.print("Motor Speed 2: ");
    float rotation2 = (counter2 / diskslots) * 60.00; // calculate RPM for Motor 2
    Serial.print(rotation2);
    Serial.println(" RPM");
    counter2 = 0; // reset counter to zero
    Timer1.attachInterrupt( ISR_timerone ); // Enable the timer
}
```

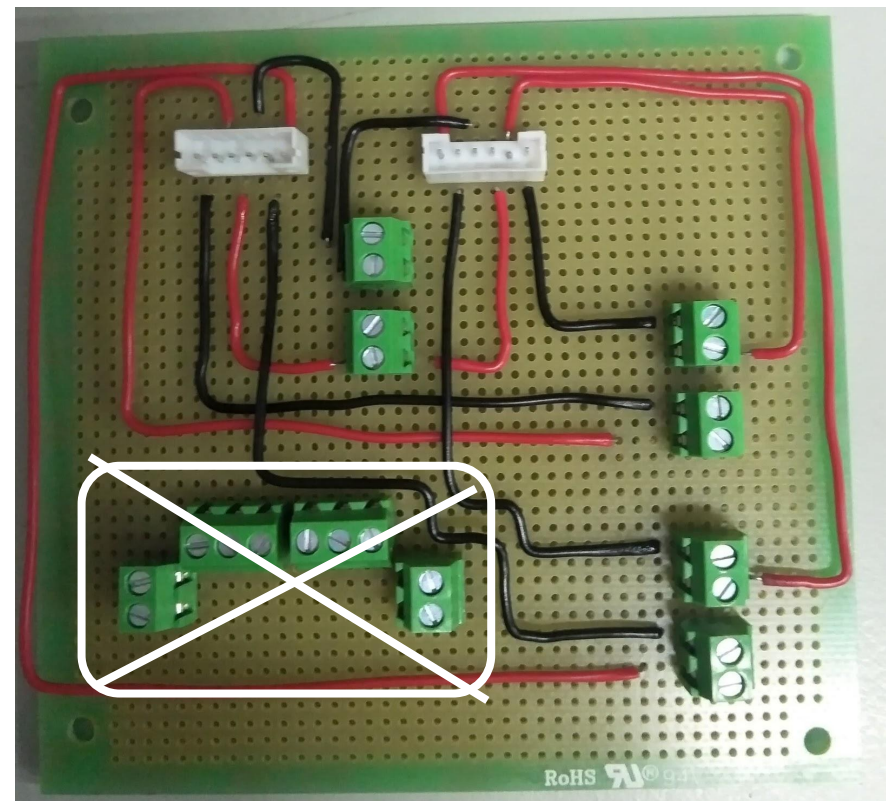
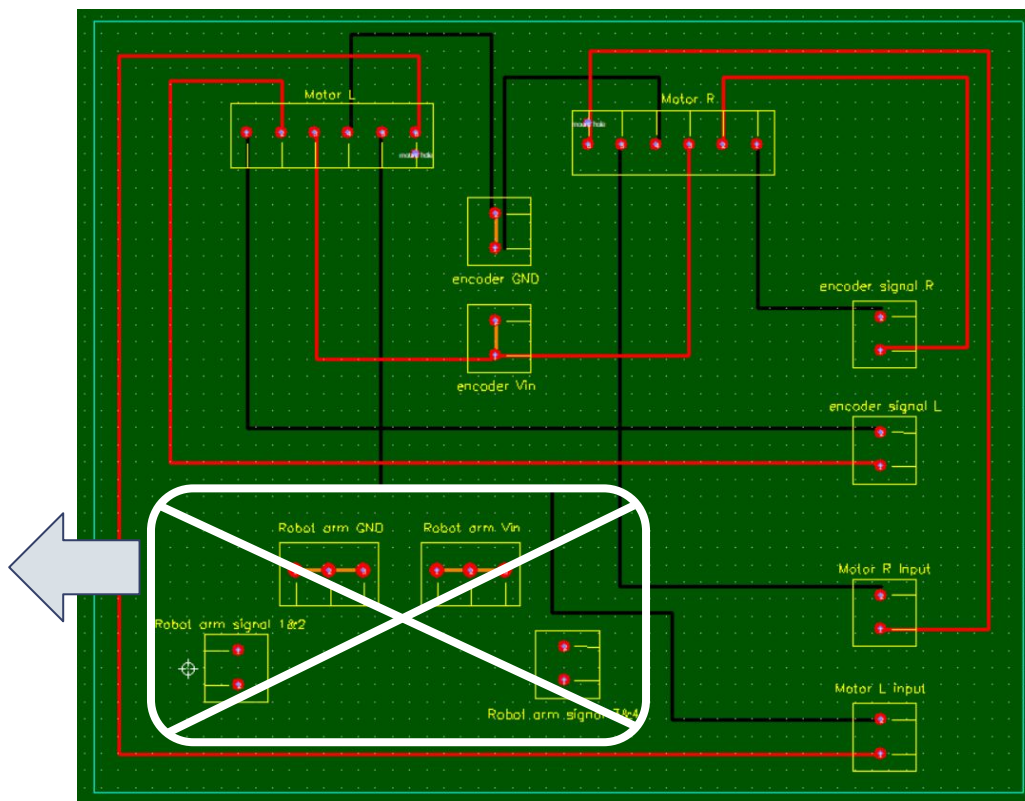
線路圖及電路板

線路圖



電路板配置

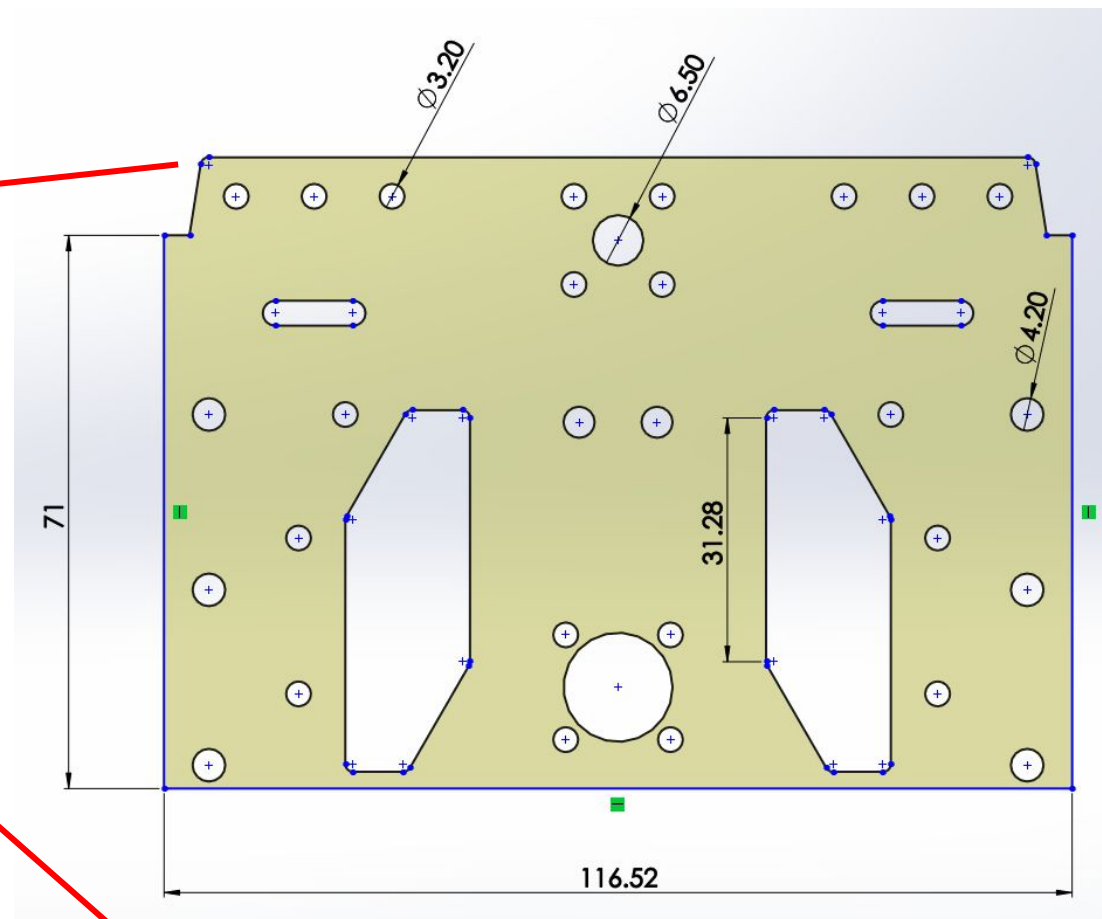
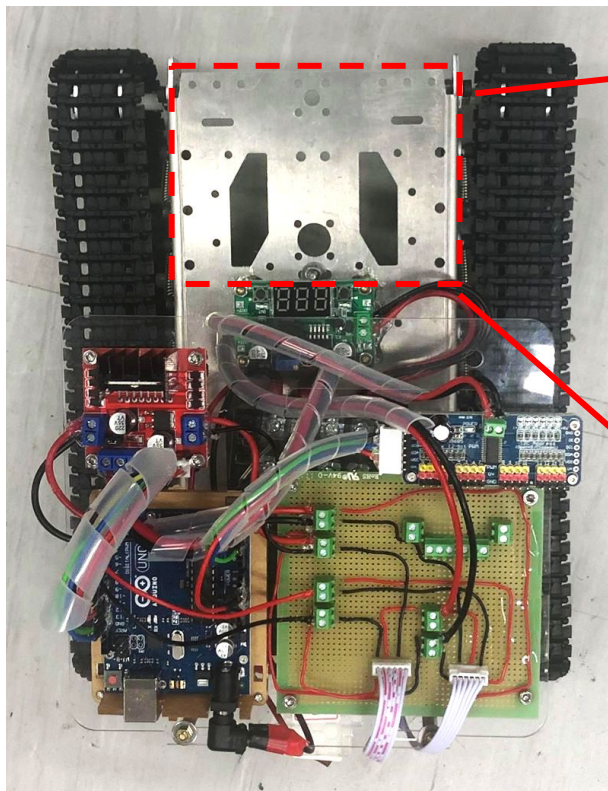
已用pca9685取代



機械手臂

手臂設計空間

俯視圖

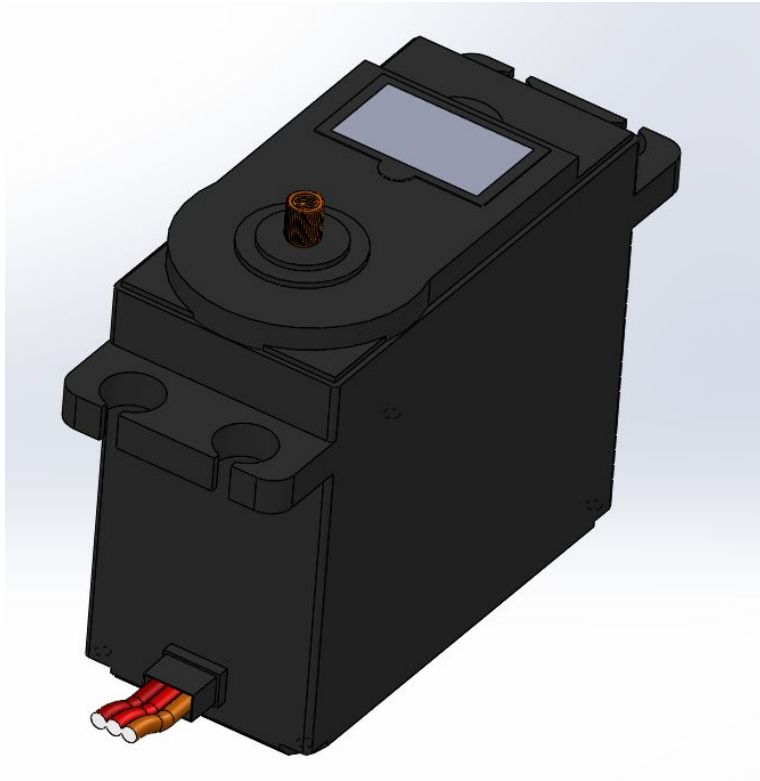


MG996R 規格

MG996R 伺服馬達規格

- 角度：180度 (對應的角度是-90度~+90度)
- 扭力：11KG 大扭力舵機/金屬齒輪伺服器
- 產品淨重: 55g
- 產品拉力: 9.4kg/cm(4.8V), 11kg/cm(6V)
- 反應速度: 0.17sec/60degree(4.8v) 0.14sec/60degree(6v)
- 工作電壓: 4.8-7.2V
- 齒輪形式: 金屬齒輪

MG996R solidworks



CONNECTOR PINOUT:

Ground
+V, Power
Signal

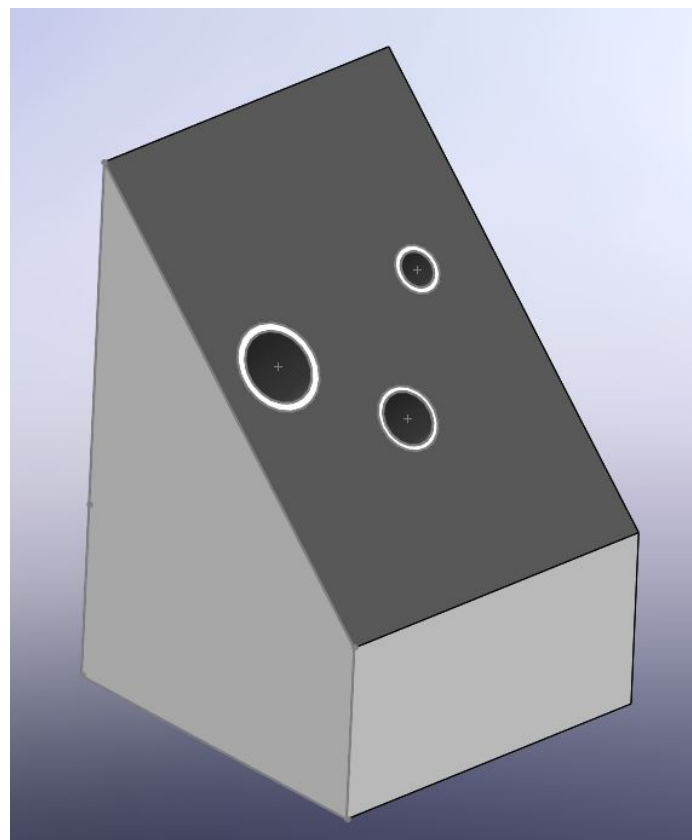


視覺辨識

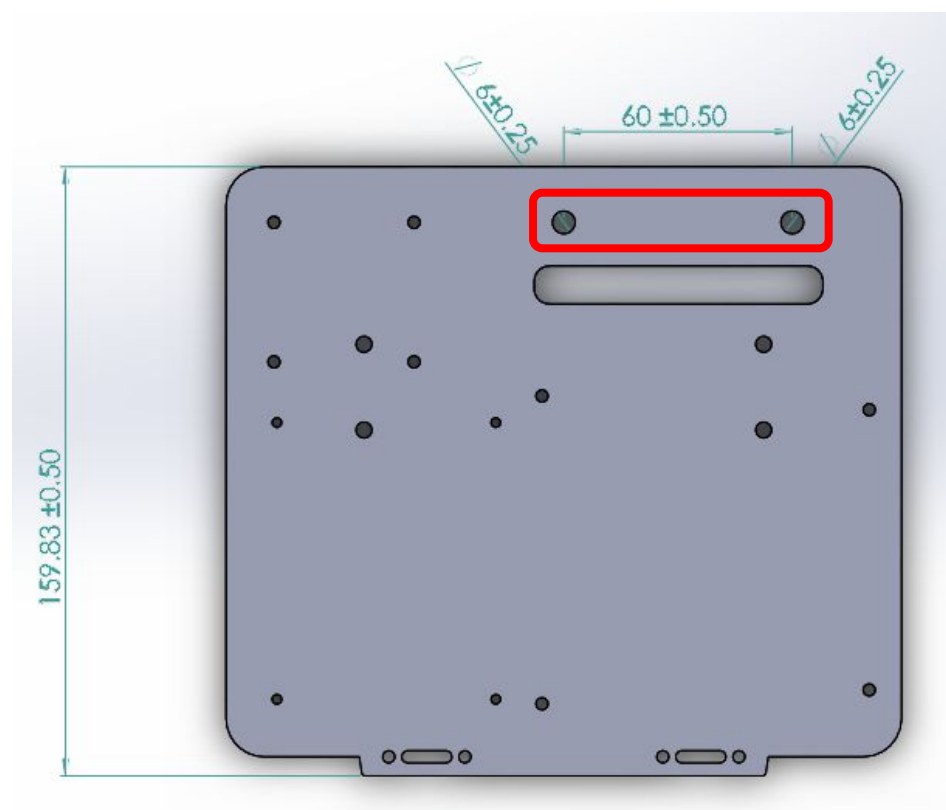
realsense D435



目標物

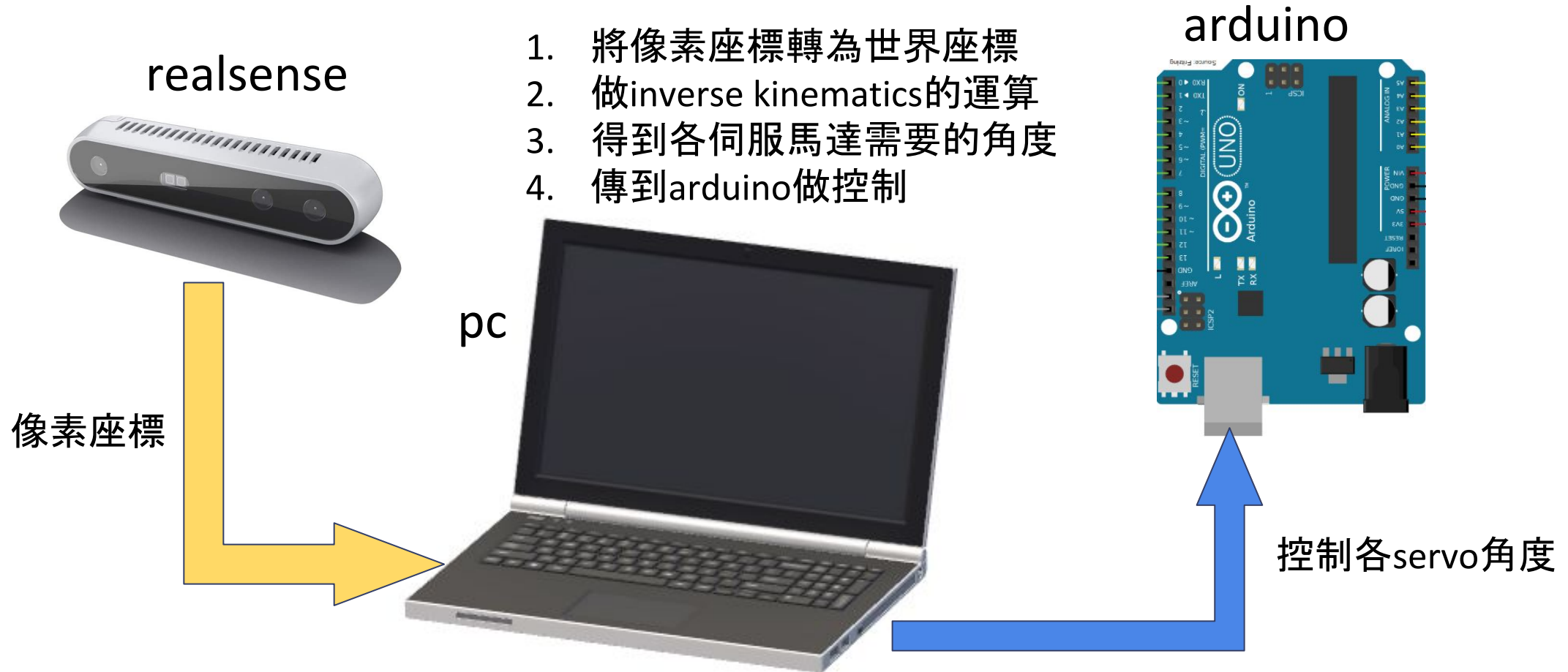


相機提供鎖點



(也可自行設計想要的鎖點位置)

arduino與pc的溝通



arduino與pc的溝通 範例程式

arduino端

```
if (Serial.available()) {
    str = Serial.readStringUntil('\n');
    char *delim = ",";
    char *pch;
    char buf[100];
    i = 0;
    str.toCharArray(buf, sizeof(buf));
    pch = strtok(buf, delim);
    while (pch != NULL) {
        cmd[i] = atof(pch);
        pch = strtok(NULL, delim);
        i++;
    }
    //forward
    if (cmd[2] == 0) {
        MoveForward(CMtoSteps(cmd[1]), cmd[0]);
        delay(1000); // Wait one second
    }
    else if (cmd[2] == 1) {
        MoveReverse(CMtoSteps(cmd[1]), cmd[0]);
        delay(1000); // Wait one second
    }
}
```

arduino的code需先上傳到arduino
(若先run python檔會發生錯誤)

上傳到arduino時記得看一下序列埠是哪一個
(ex.若為COM1則python的COM_PORT參數就改成'COM1')

pc端 (python)

```
import serial
from time import sleep
import sys

COM_PORT = 'COM10'
BAUD_RATES = 9600
ser = serial.Serial(COM_PORT, BAUD_RATES)

try:
    while True:
        cmd = input('speed,distance,direction:\n').lower()
        ser.write((cmd + '\n').encode())
        while ser.in_waiting:
            mcu_feedback = ser.readline().decode()
            print('board response' + mcu_feedback)

except KeyboardInterrupt:
    ser.close()
    print('bye')
```

Demo

<https://drive.google.com/file/d/1jVOSEYCBmgXQUd8nwmonmRnAgljn4SV/view?usp=sharing>

充電注意事項

週五 (5/29) 之後在知武館原創 (200) 會放充電器

- 正接正 負接負
- 充電時把連接電池的線都拔掉
- 充電時會亮紅燈 充滿亮綠燈
- 大概半小時內就會充滿 (不要充太久 電池會壞)

