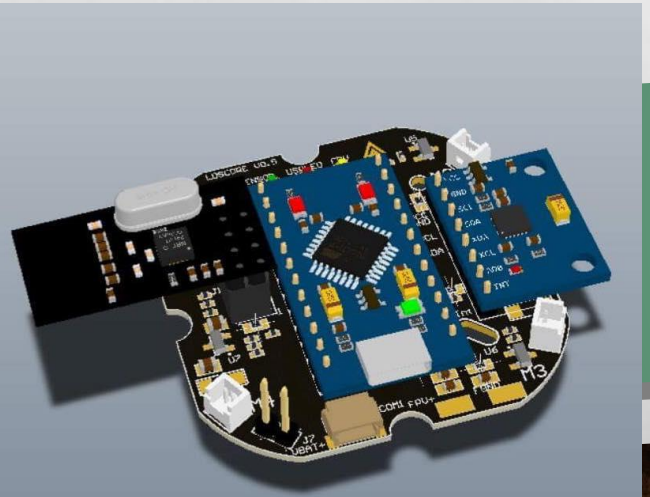
AEROPROBING Inc.

多軸旋翼機飛控實戰課程



PART 2　LDSLITE 旋翼機飛控程式實戰

ARDUINO 安裝與環境設定

此安裝檔放在「**LDSLITE**飛控實戰課程安裝軟體」資料夾中

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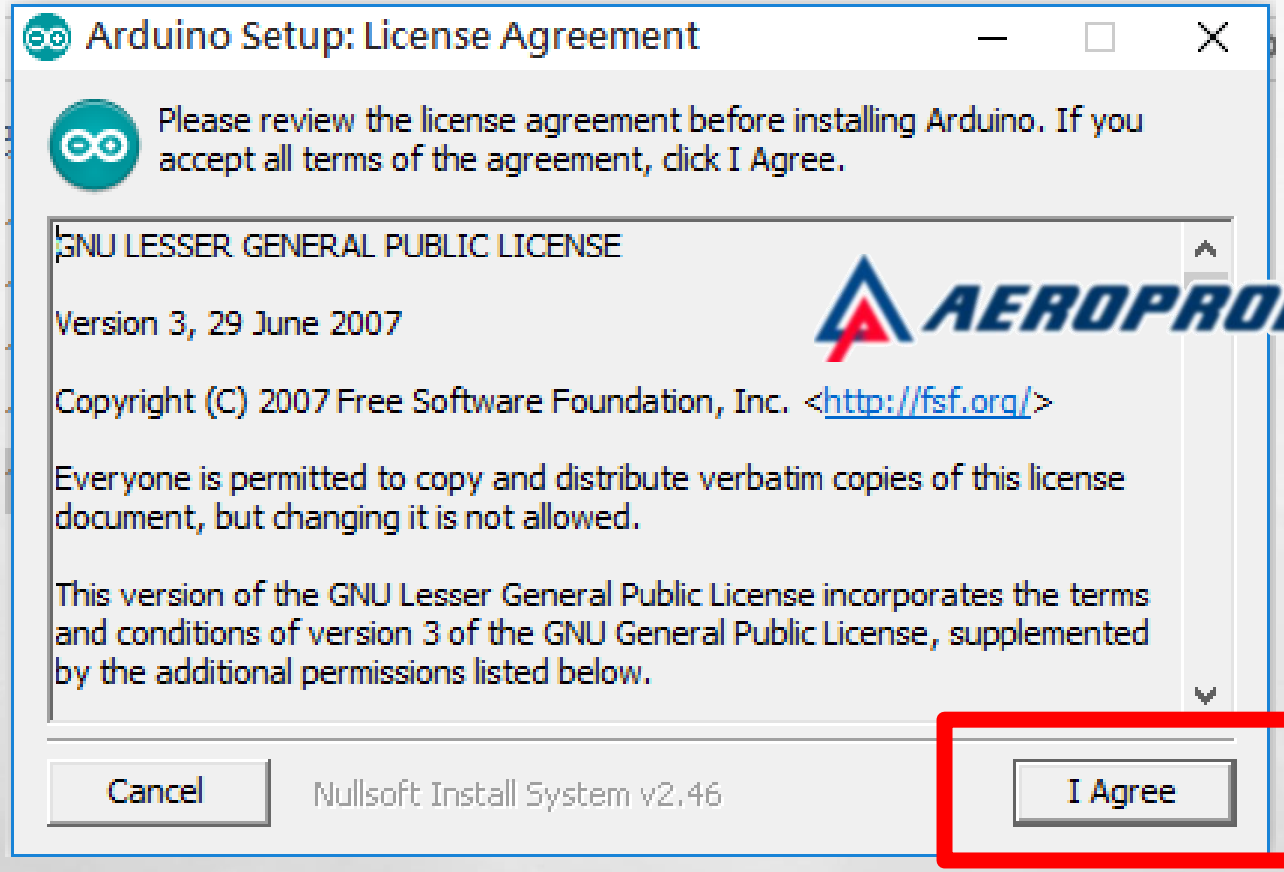
本次課程只接受**1.6.12**以上之版本，較早版本請移除並更新

ARDUINO 安裝與環境設定



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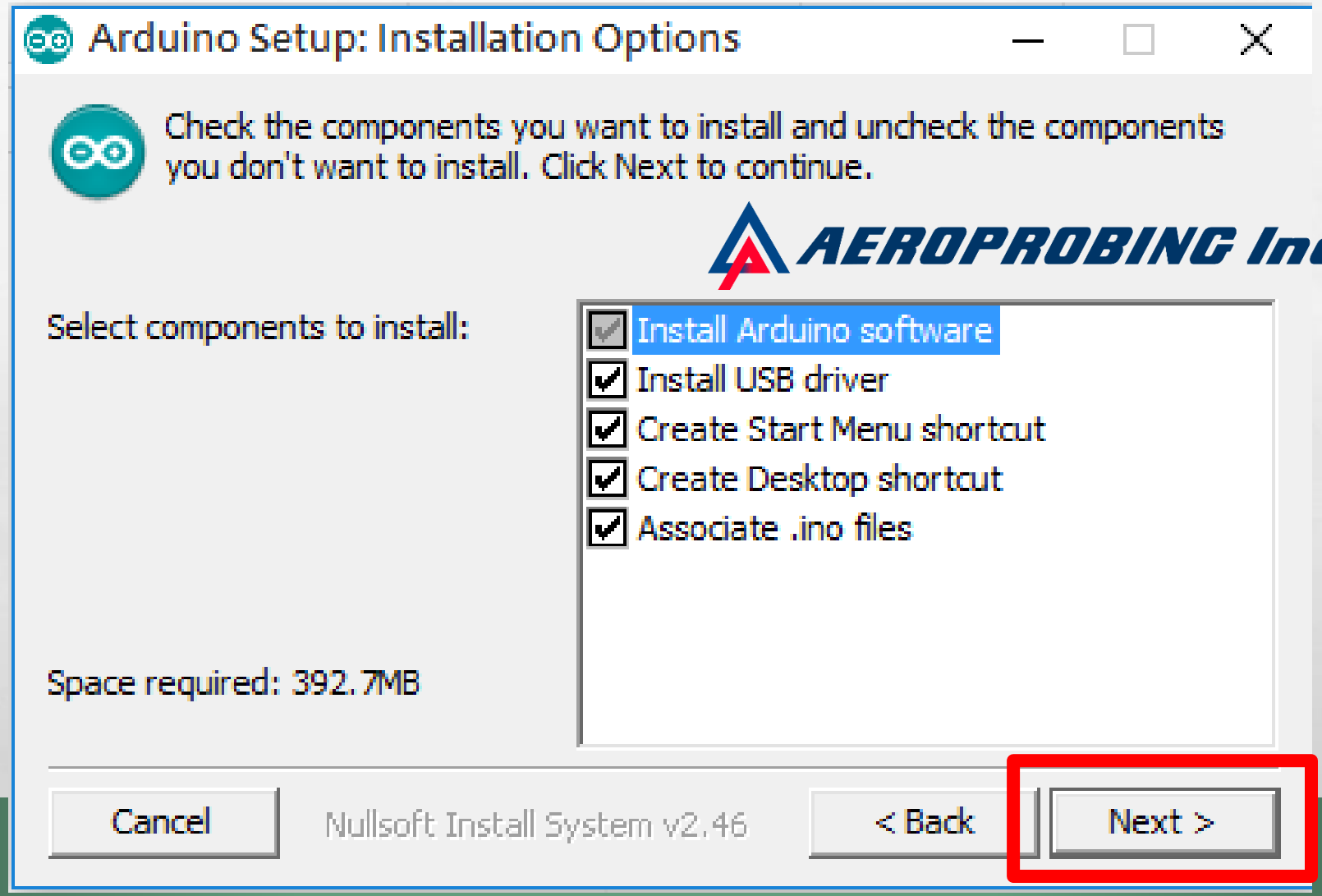
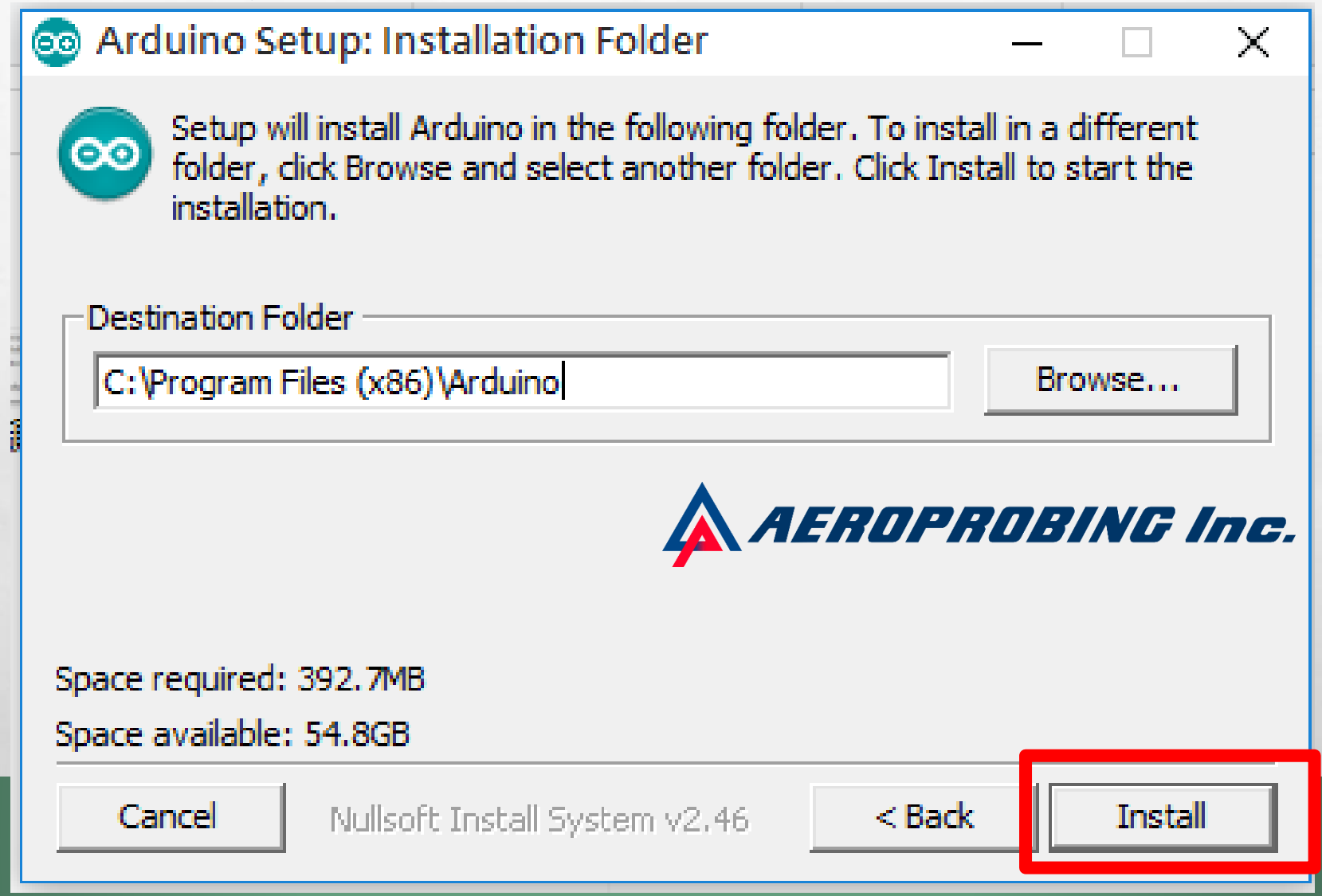
若有舊的非預設LIBRARY安裝前請先將檔案保存

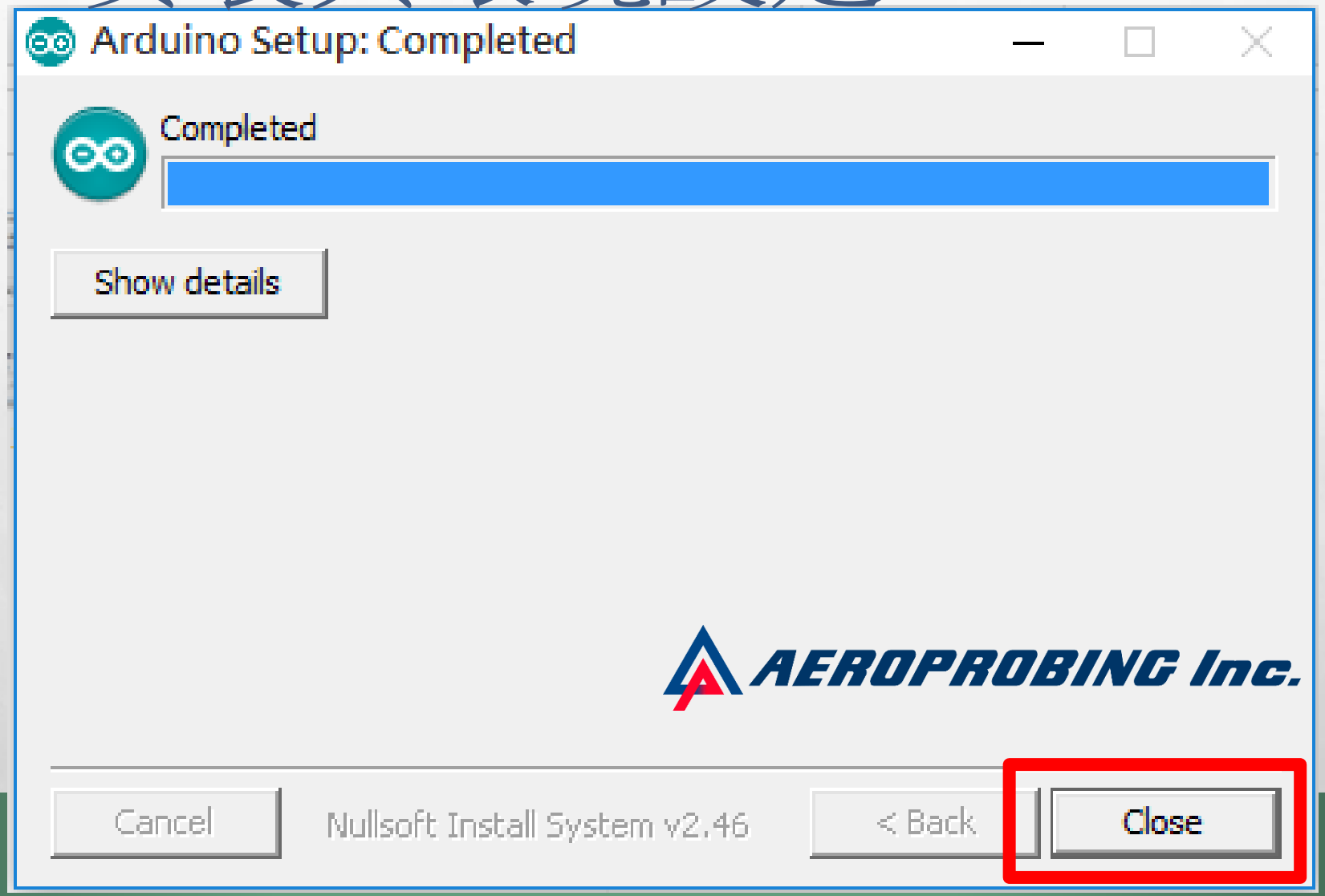
ARDUINO 安裝與環境設定



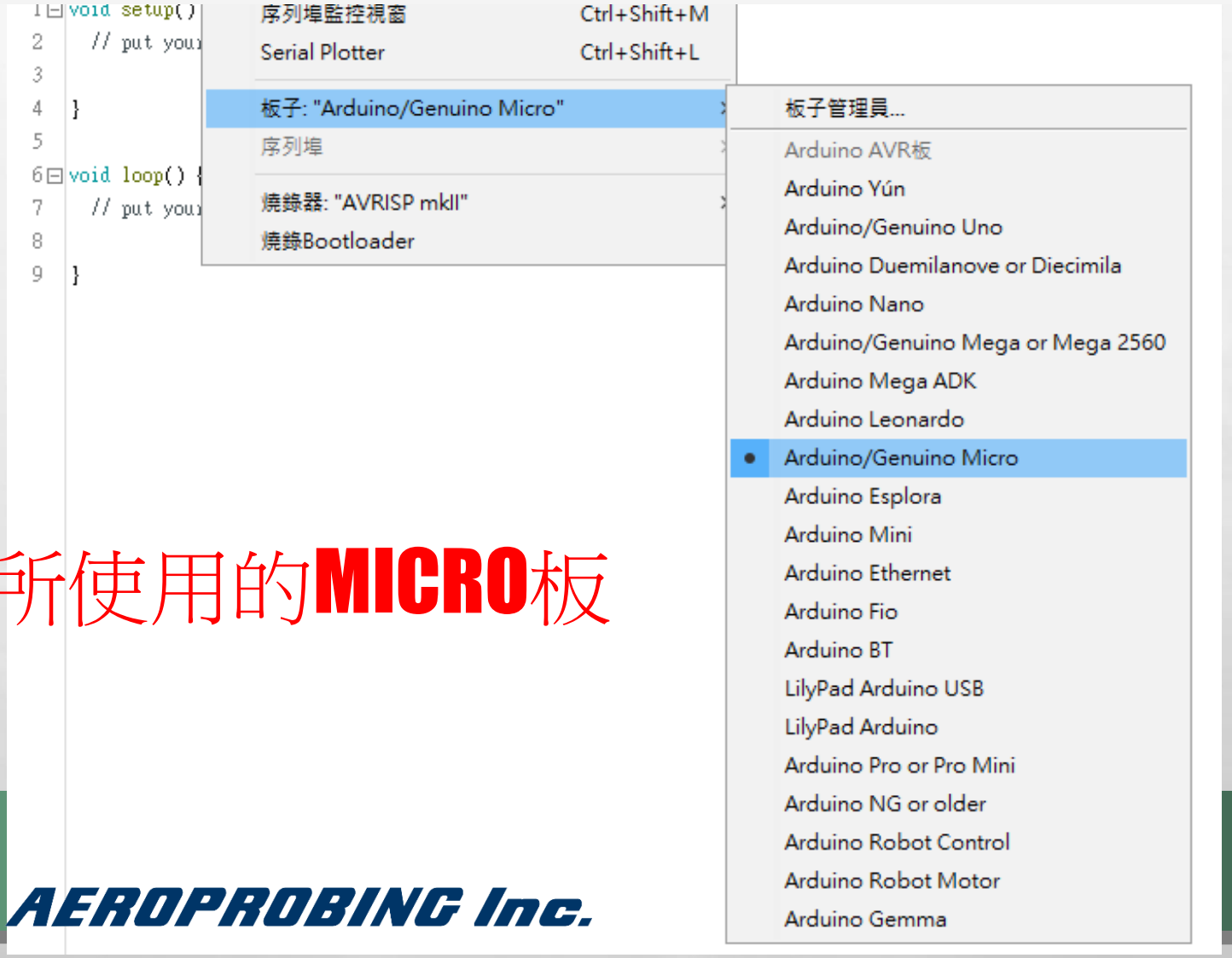
ARDUINO 安裝與環境設定



ARDUINO 安裝與環境設定



ARDUINO 安裝與環境設定



選取此次上課所使用的**MICRO**板

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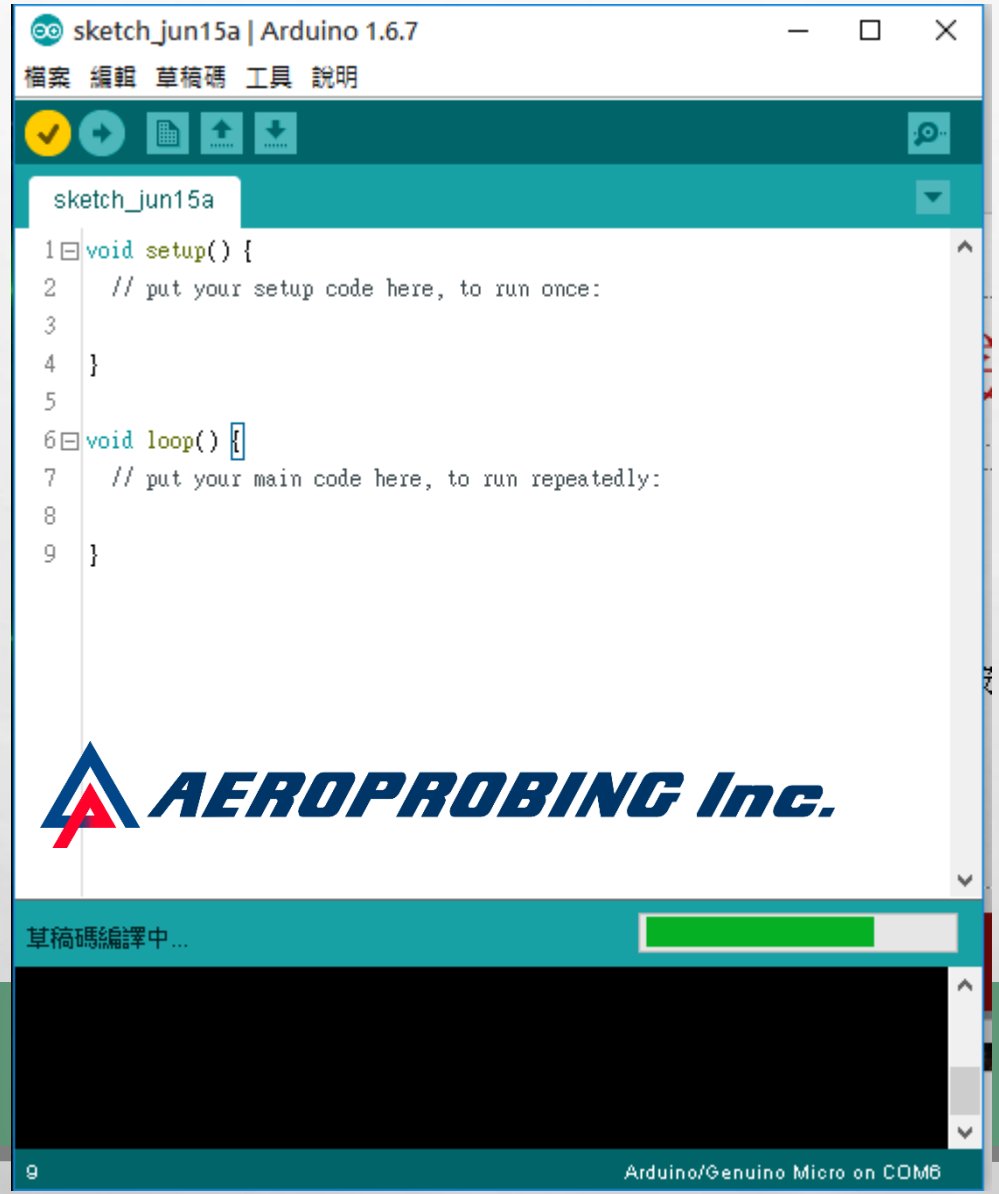
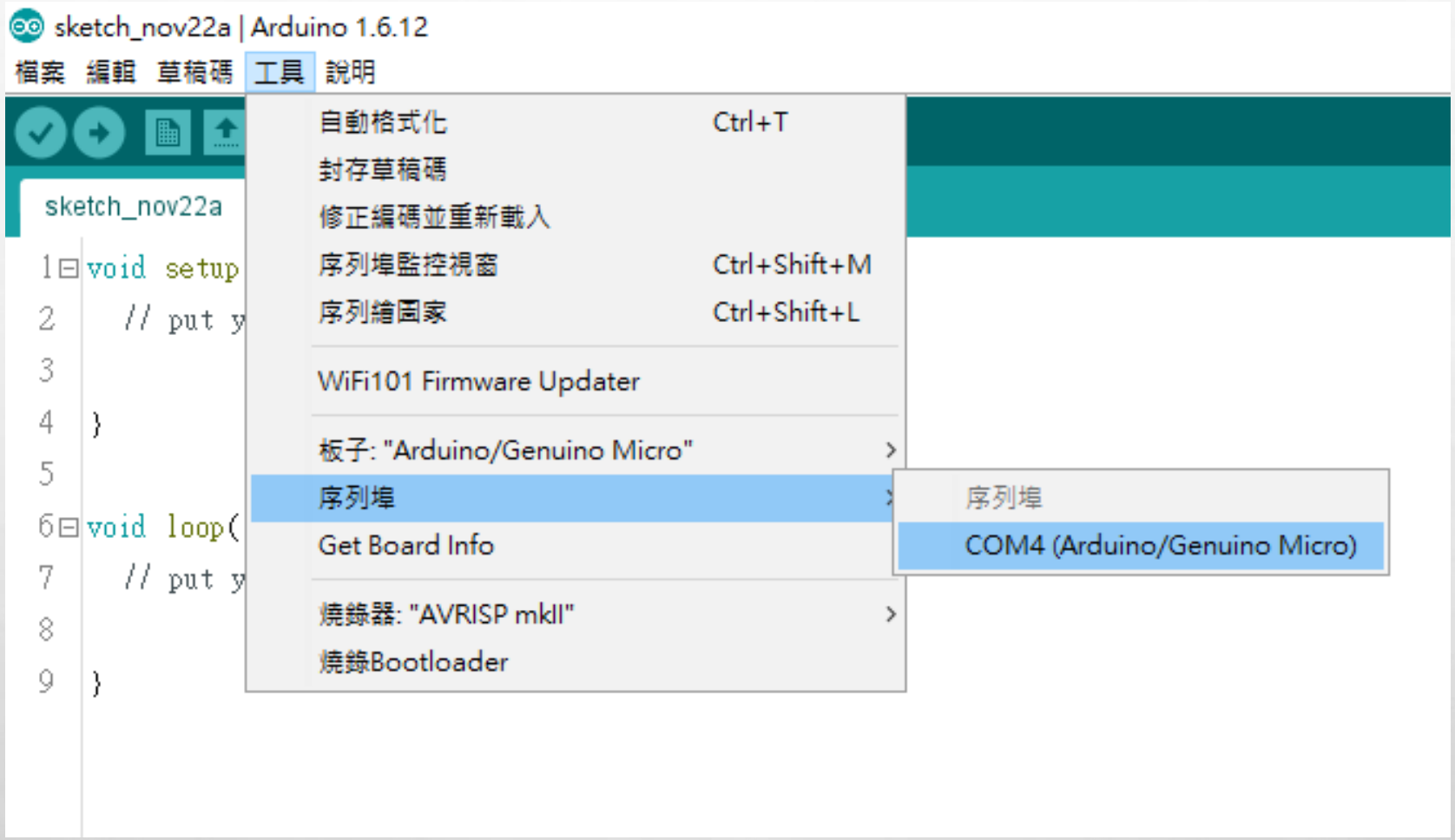
ARDUINO IDE 編譯測試

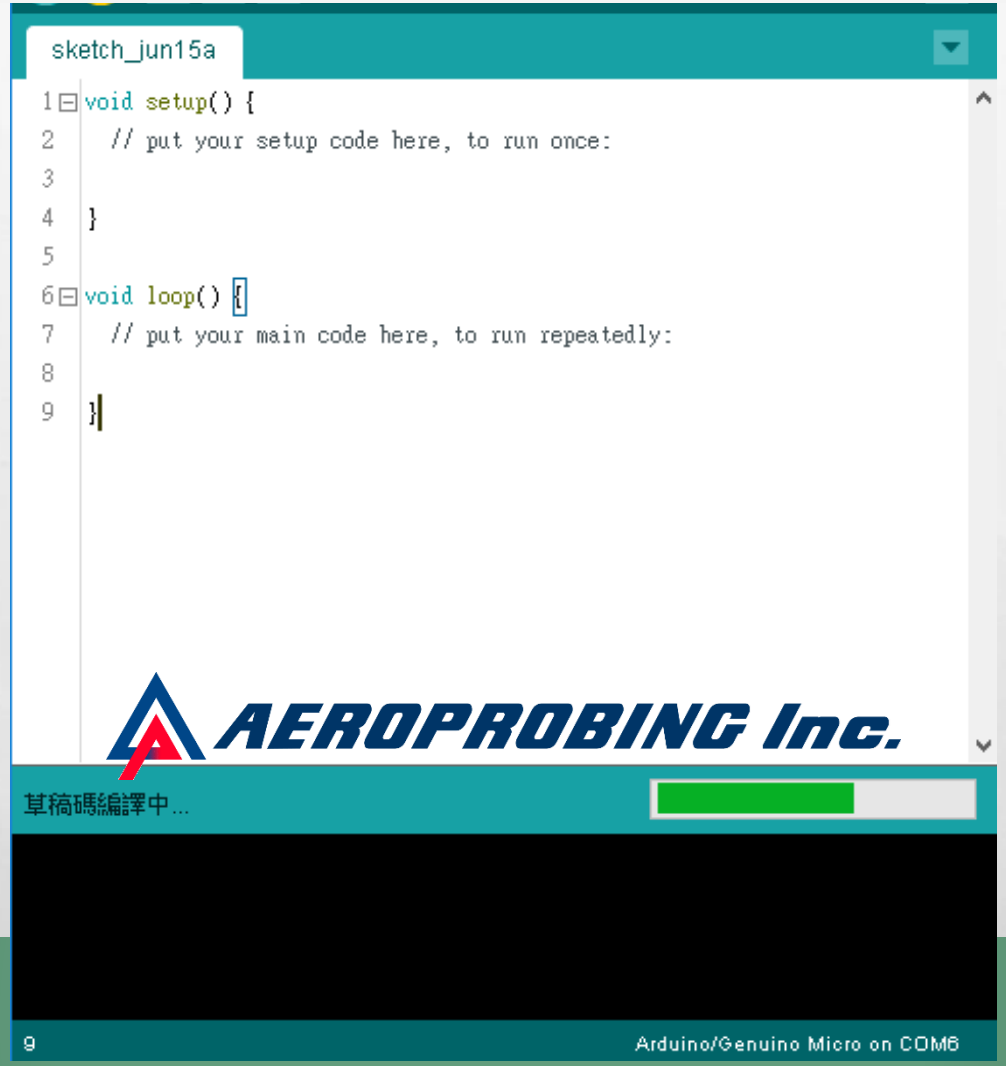


ARDUINO IDE 編譯測試



上傳之前須先用**USB**接上**ARDUINO**並選擇要進行燒錄的序列埠

ARDUINO IDE上傳燒錄程式測試



安裝NOTEPAD++

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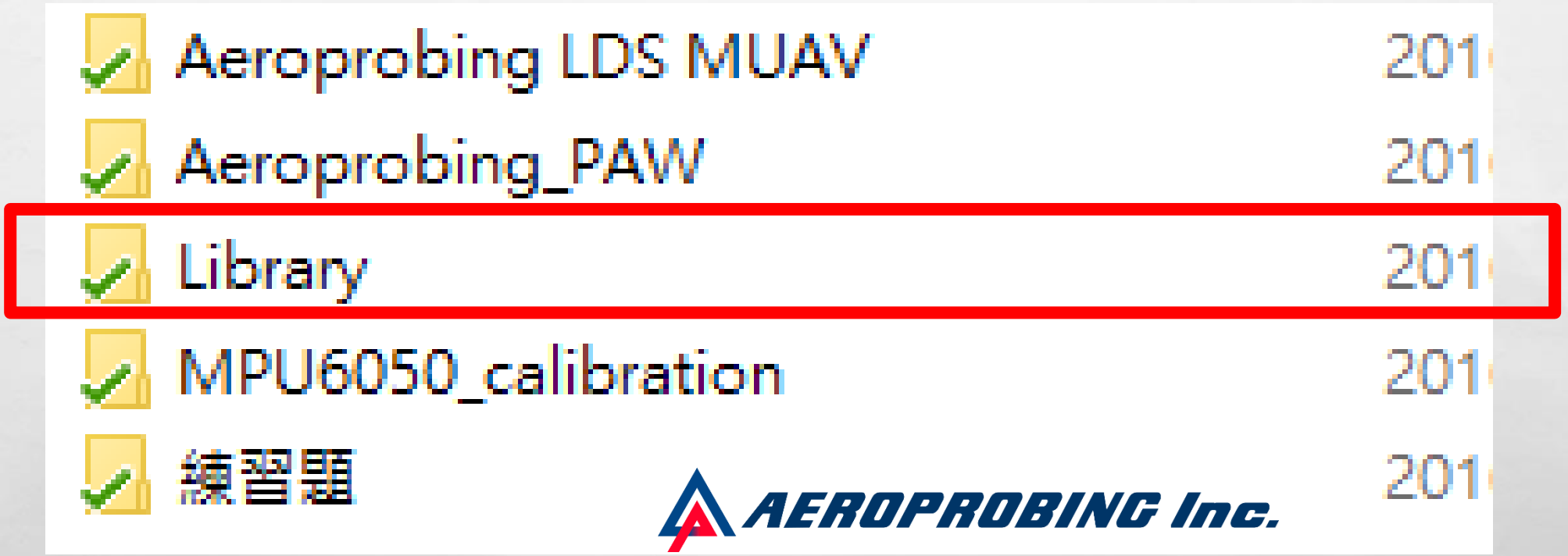
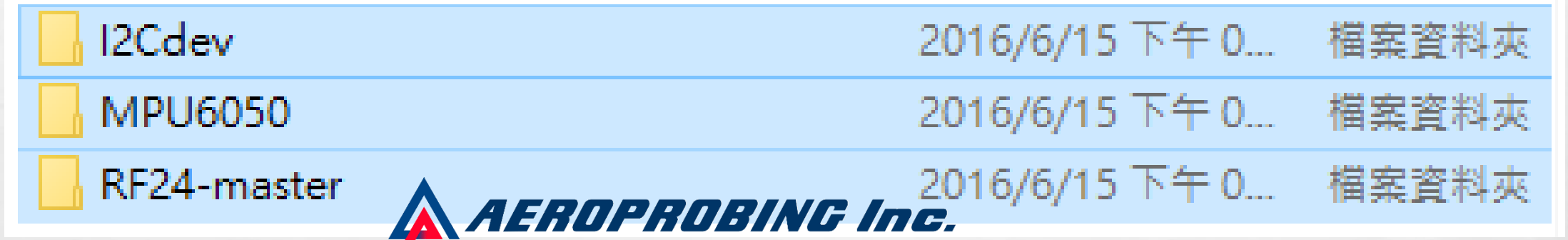
此LIBRARY資料夾位於「LDSLITE飛控實戰程式」資料夾中



ARDUINO IDE 客製涵式庫設定



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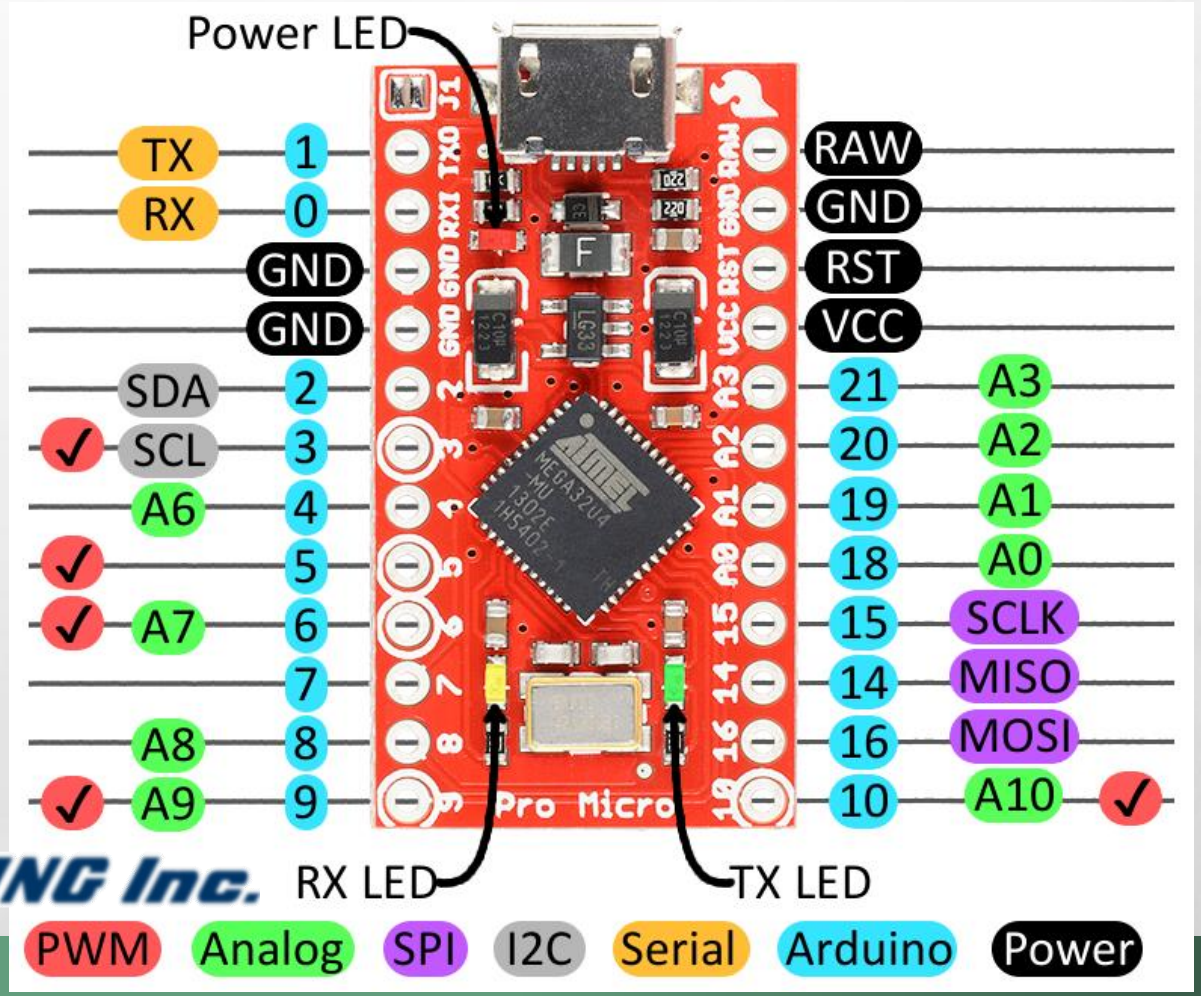
進入**LIBRARY**資料夾，將此三個檔案複製至

C:\PROGRAM FILES (X86)\ARDUINO\LIBRARIES

ARDUINO I/O 講解

- 控制器：**ATmega32u4**
- 工作頻率：**16 MHz**
- 工作電壓：**5V**
- 輸入電壓（推薦）：**7-12V**
- 數位**I/O**接腳：**20**個
- 硬體**PWM**通道：**5**個
- 類比 **I/O**：**9**個
- **5V**數位/類比接腳最大允許電流：**40 mA**
- **3.3V**數位/類比接腳最大允許電流：**50 mA**



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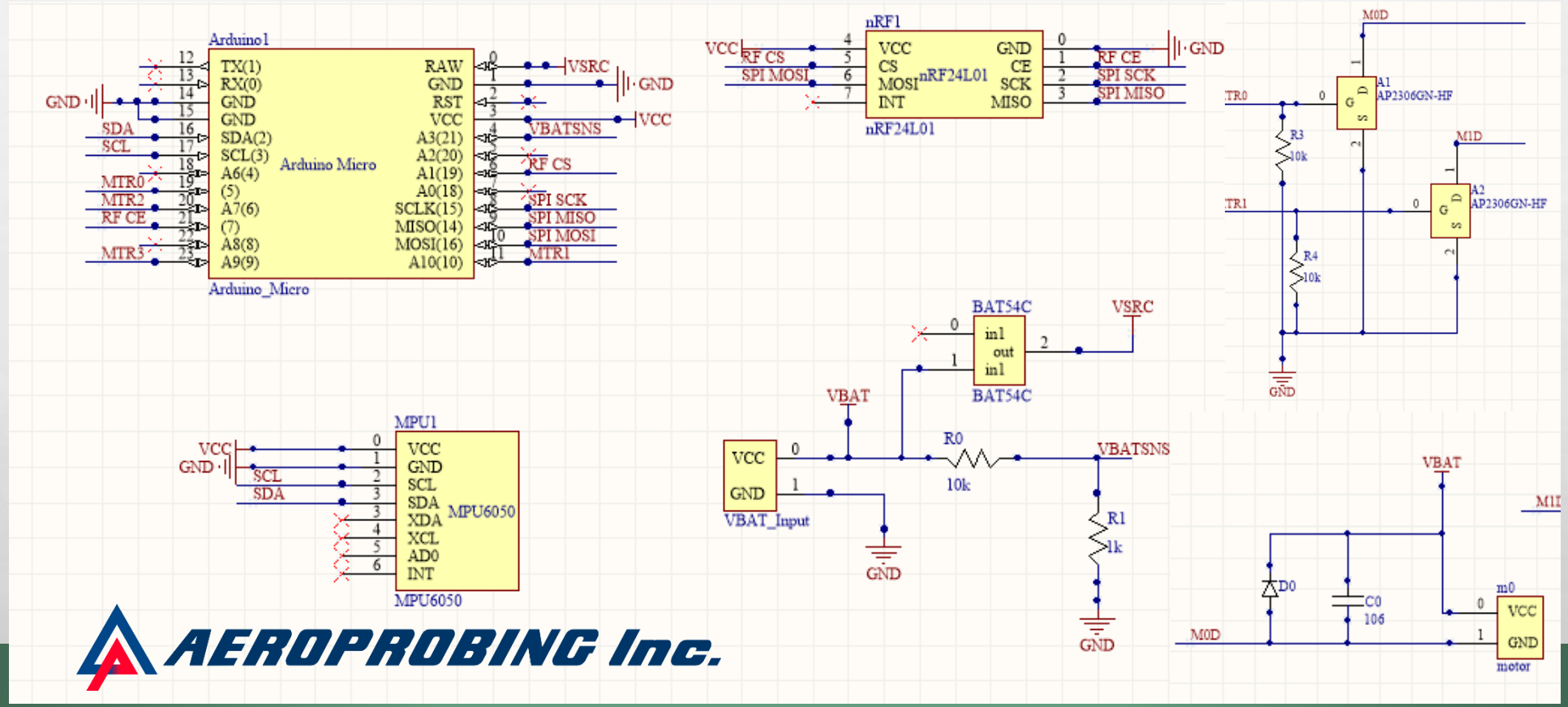
LDSLITE四軸飛行器飛控系統硬體架構



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ARDUINO語法講解與練習

```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

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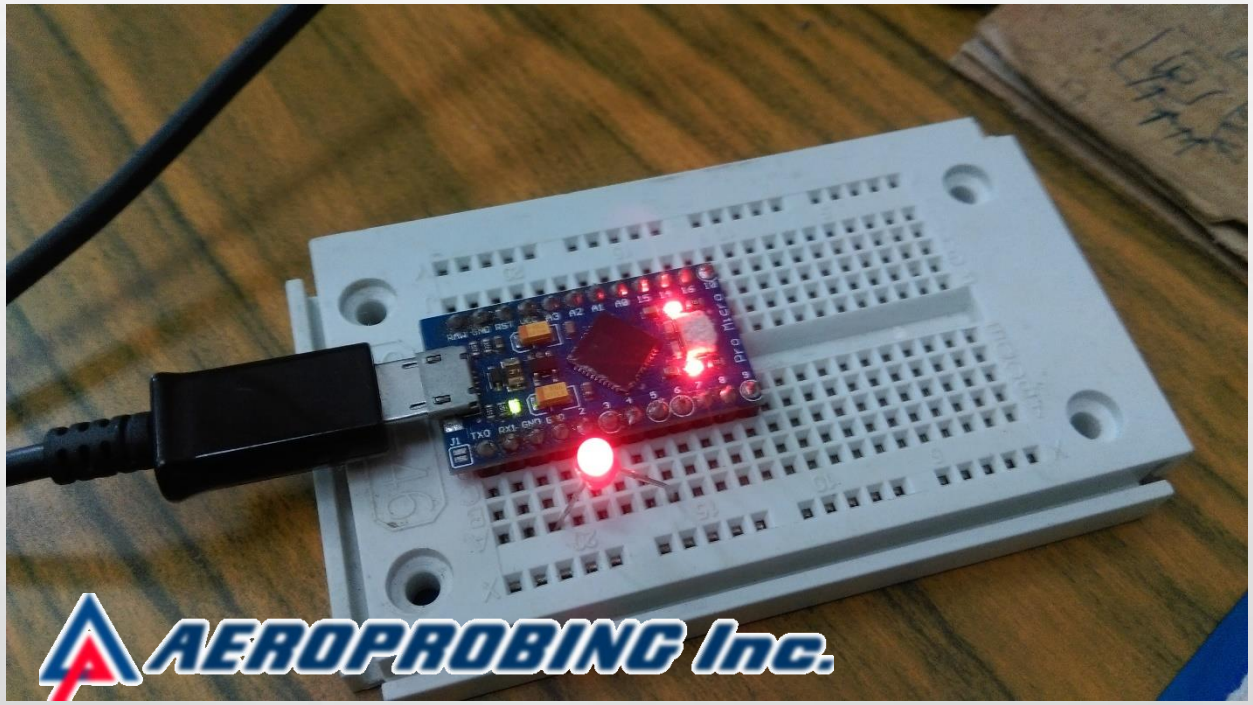
練習一：LED控制



練習一：LED控制


```
1  #define LED 4//LED腳位設定
2  bool Flag = true;//遞增與遞減旗標
3  byte Count = 0;//LED PWM輸出
4  /**************************
5           腳位I/O設定
6  **************************/
7  void ioPinSetup()
8  {
9    pinMode(LED, OUTPUT);   //LED腳位輸出設定
10 }
```

```
12 void setup() {//初始設定
13   ioPinSetup();
14 }
```

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```
void loop() {//主迴圈
  if (Flag)
  {
    Count++;//輸出遞增
    digitalWrite(LED, HIGH);
    if (Count == 255)//當輸出為255時切換成遞減模式
      Flag = false;
  }
  else if (!Flag)
  {
    Count--;//輸出遞減
    digitalWrite(LED, LOW);
    if (Count == 0)//當輸出為0時切換成遞增模式
      Flag = true;
  }
  delay(10);//延遲10ms
}
```

練習二：串列輸入

```
1  #define LED 4//LED腳位設定
2  bool Flag = true;//遞增與遞減旗標
3  int ch = 0;
4  /***************************
5           腳位I/O設定
6  ***************************/
7  void ioPinSetup()
8  {
9    pinMode(LED, OUTPUT);   //LED腳位輸出設定
10 }
11 void setup() {
12   Serial.begin(115200);//baud 設定
13   ioPinSetup();
14 }
```

```
16 void loop() {
17   ch = Serial.read();//讀取鍵盤輸入
18   if (ch == '0')
19   {
20     Serial.println("Serial Input : 0");//輸出文字
21   }
22   else if (ch == '1')
23   {
24     Flag = !Flag;
25     Serial.println("Serial Input : 1");
26     Serial.println("LED blink");
27     digitalWrite(LED, Flag); //outputValue 0~255
28   }
29 }
```

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練習三：馬達控制

```
1  #define motorLB 5
2  #define motorRF 9
3  #define motorLF 10
4  #define motorRB 6
5  int input;
6  int EXinput;
7  int sum = 0;
8  void setup() {
9    Serial.begin(115200);
10   pinMode(motorLF, OUTPUT);
11   pinMode(motorRB, OUTPUT);
12   pinMode(motorRF, OUTPUT);
13   pinMode(motorLB, OUTPUT);
14 }
```

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```
void loop() {
  if (Serial.available() > 0)
  {
    input = Serial.read();
    switch (input)
    {
      case '1':
        Serial.print("motorLB = "); Serial.println(sum);
        break;
      case '3':
        Serial.print("motorRB = "); Serial.println(sum);
        break;
      case '7':
        Serial.print("motorLF = "); Serial.println(sum);
        break;
      case '9':
        Serial.print("motorRF = "); Serial.println(sum);
        break;
      case '5':
        Serial.print("ALL = "); Serial.println(sum);
        break;
      case '0':
        Serial.print("ALL = "); Serial.println(0);
        break;
```

練習三：馬達控制

```
39        case 43:
40          if (sum != 255)
41            sum += 17;
42          Serial.print("sum = "); Serial.println(sum);
43          break;
44        case 45:
45          if (sum != 0)
46            sum -= 17;
47          Serial.print("sum = "); Serial.println(sum);
48          break;
49      }
50      if (input == 43 || input == 45)
51      {
52        input = EXinput;
53      }
54    }
```

```
55    switch (input)
56    {
57      case '1':
58        analogWrite(motorLB, sum);
59        analogWrite(motorRB, 0);
60        analogWrite(motorLF, 0);
61        analogWrite(motorRF, 0);
62        break;
63      case '3':
64        analogWrite(motorLB, 0);
65        analogWrite(motorRB, sum);
66        analogWrite(motorLF, 0);
67        analogWrite(motorRF, 0);
68        break;
69      case '7':
70        analogWrite(motorLB, 0);
71        analogWrite(motorRB, 0);
72        analogWrite(motorLF, sum);
73        analogWrite(motorRF, 0);
74        break;
```

練習三：馬達控制


```
75      case '9':
76        analogWrite(motorLB, 0);
77        analogWrite(motorRB, 0);
78        analogWrite(motorLF, 0);
79        analogWrite(motorRF, sum);
80        break;
81      case '0':
82        digitalWrite(motorLB, LOW);
83        digitalWrite(motorRB, LOW);
84        digitalWrite(motorLF, LOW);
85        digitalWrite(motorRF, LOW);
86        sum = 0;
87        input = 0;
88        break;
89      case '5':
90        analogWrite(motorLB, sum);
91        analogWrite(motorRB, sum);
92        analogWrite(motorLF, sum);
93        analogWrite(motorRF, sum);
94        break;
95    }
96    EXinput = input;
97  }
```

練習四：MPU6050讀取

加速度　　角速度

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ax : -794	ay : -364	az : 15504	gx : -116	gy : -20	gz : 10
ax : -794	ay : -364	az : 15504	gx : -116	gy : -20	gz : 10
ax : -816	ay : -352	az : 15484	gx : -119	gy : -30	gz : 8
ax : -772	ay : -366	az : 15490	gx : -114	gy : -32	gz : 7
ax : -772	ay : -366	az : 15490	gx : -114	gy : -32	gz : 7
ax : -796	ay : -378	az : 15490	gx : -114	gy : -31	gz : 11

練習四：MPU6050讀取

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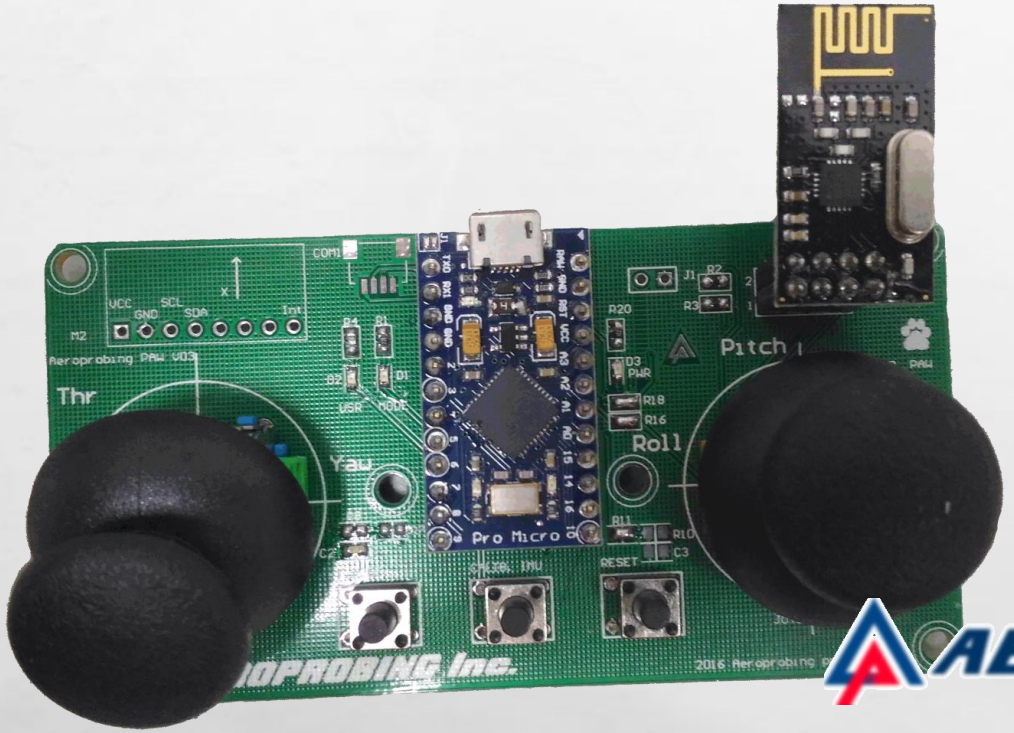
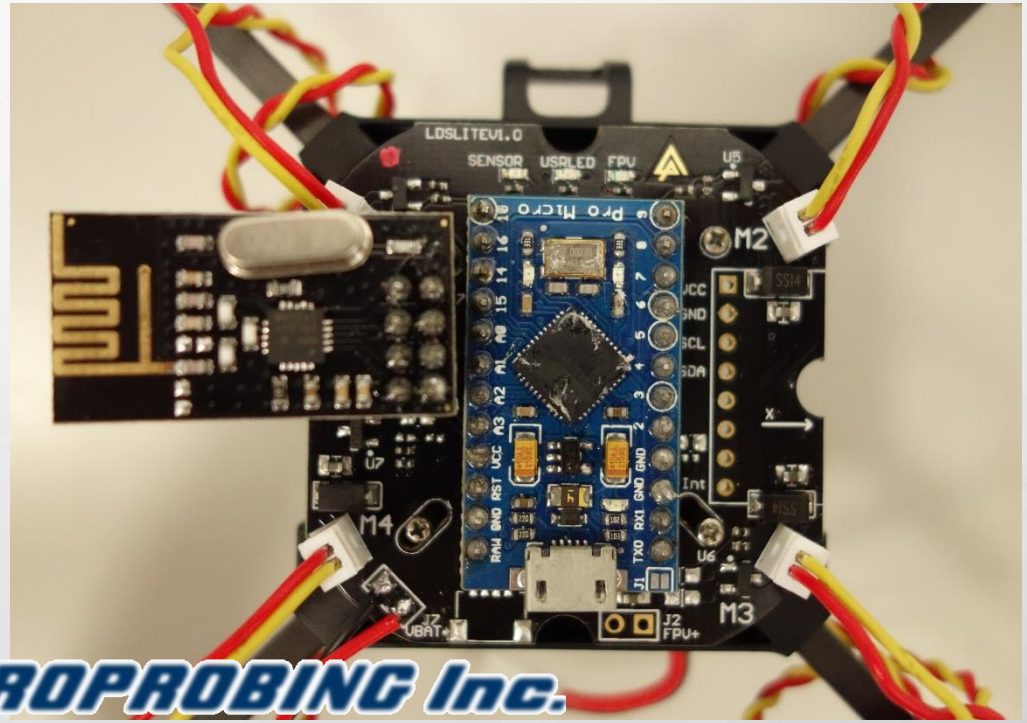
	Yaw	Pitch	Roll
ypr	59.61	-4.05	4.51
ypr	59.60	-4.03	4.48
ypr	59.61	-4.01	4.44
ypr	59.61	-3.98	4.41
ypr	59.61	-3.96	4.37

練習五：NRF24L01通訊





練習五：NRF24L01通訊

RF-master§

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```
1  #include <SPI.h>
2  #include "Wire.h"
3  #include "nRF24L01.h"
4  #include "RF24.h"
5  RF24 radio(7, 19); //RF建構子與腳位設定(ce,csn)
6  #define UserChannel 41
7  const uint64_t pipes[2] = { 0x4080, 0x8040 }; //RF傳輸位址設定
```

練習五：NRF24L01通訊

傳送端

```
mode : 37 Throttle : 0 Yaw :90 Pitch :90 Roll :90
mode : 37 Throttle : 0 Yaw :90 Pitch :90 Roll :90
mode : 37 Throttle : 0 Yaw :90 Pitch :90 Roll :90
mode : 37 Throttle : 0 Yaw :90 Pitch :90 Roll :90
mode : 37 Throttle : 0 Yaw :90 Pitch :90 Roll :90
mode : 37 Throttle : 0 Yaw :90 Pitch :90 Roll :90
mode : 37 Throttle : 0 Yaw :90 Pitch :90 Roll :90
```

接收端

```
mode 37 Throttle 0 Yaw 90 Pitch 90 Roll 90
mode 37 Throttle 0 Yaw 90 Pitch 90 Roll 90
mode 37 Throttle 0 Yaw 90 Pitch 90 Roll 90
mode 37 Throttle 0 Yaw 90 Pitch 90 Roll 90
mode 37 Throttle 0 Yaw 90 Pitch 90 Roll 90
mode 37 Throttle 0 Yaw 90 Pitch 90 Roll 90
mode 37 Throttle 0 Yaw 90 Pitch 90 Roll 90
```

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PAW 2.4GHZ 遙控器 程式檔燒錄方法

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此安裝檔放在「**LDSLITE**飛控實戰課程安裝軟體」資料夾中

PAW 2.4GHZ 遙控器 程式檔燒錄方法

avrdude.conf	2016/8/18 上午 1...	CONF 檔案	453 KB
avrdude.exe	2015/4/16 上午 0...	應用程式	398 KB
devices.txt	2016/9/14 下午 0...	文字文件	1 KB
libusb0.dll	2012/3/18 下午 0...	應用程式擴充	43 KB
license.txt	2012/3/18 下午 0...	文字文件	1 KB
XLoader.exe	2012/3/18 下午 0...	應用程式	271 KB

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開啟XLOADER目錄之內容

到ARDUINO 安裝路徑底下搜尋此兩個檔案並且取代XLOADER.EXE旁原有的兩個檔案

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修改燒錄程式組態檔方法

- **AVRDUDE.CONF**檔案位置：
- **C:\PROGRAM FILES (X86)\ARDUINO\HARDWARE\ARDUINO\AVR\BOOTLOADERS\GEMMA**
- **AVRDUDE.EXE**檔案位置：
- **C:\PROGRAM FILES (X86)\ARDUINO\HARDWARE\TOOLS\AVR\BIN**

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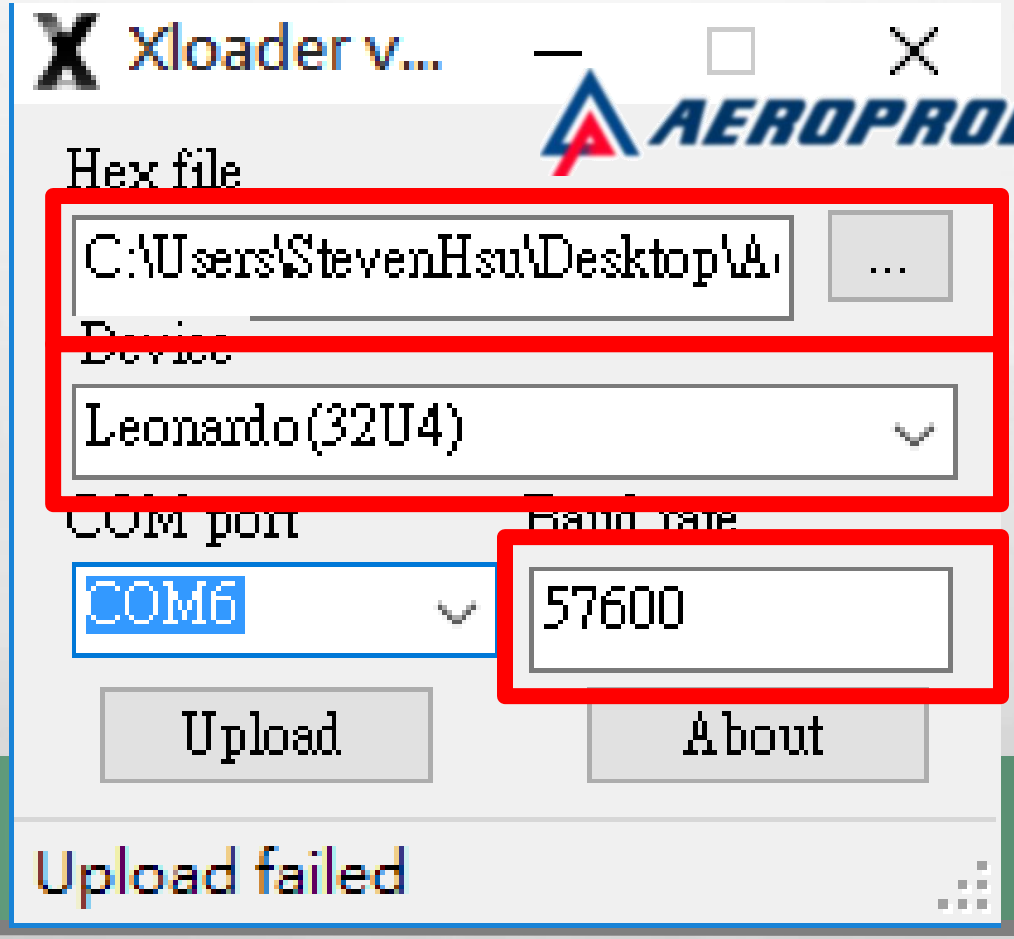
開啟XLOADER.EXE並選擇LEONARDO(32U4)，並設定BAUD為57600、以及HEX檔案位置COM不需要設定



HEX檔案位置:「LDSLITE飛控實戰程\AEROPROBING_PAW」

【學員編號】通訊位址 通訊CHANNEL

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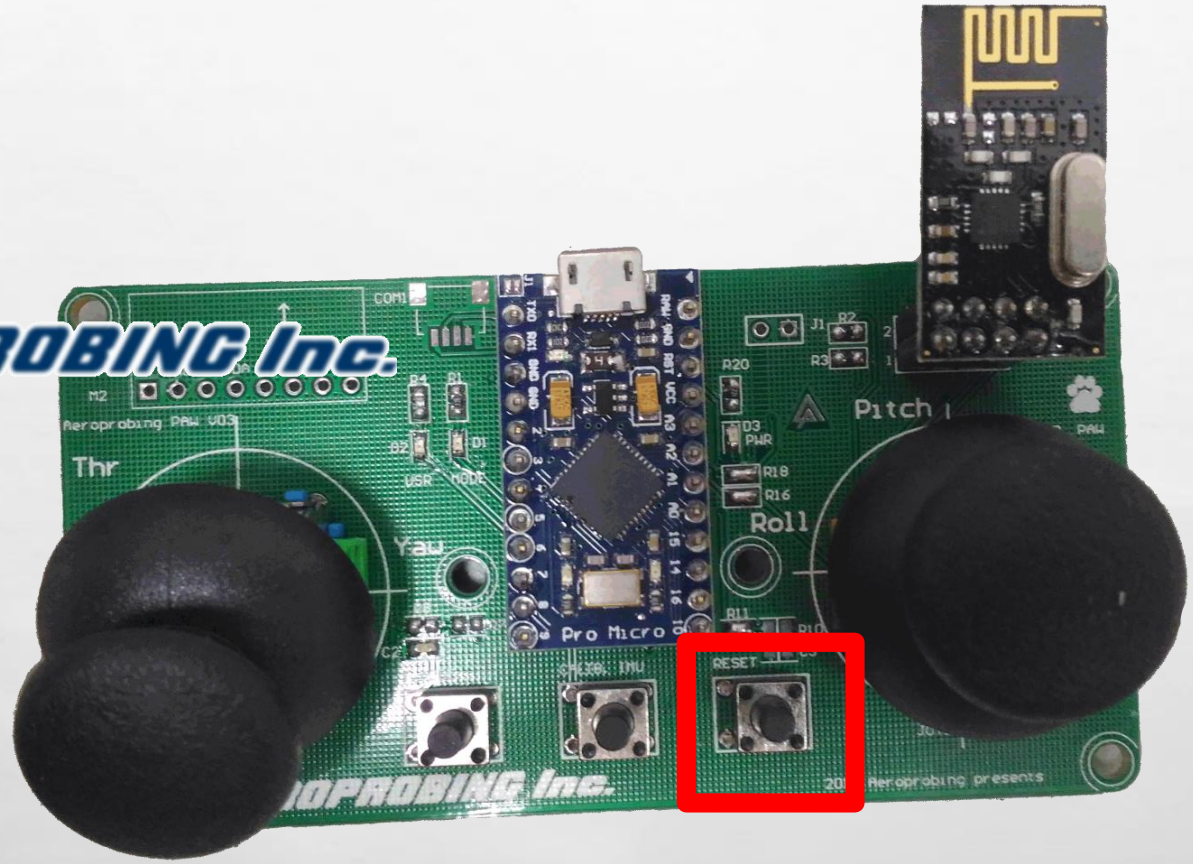
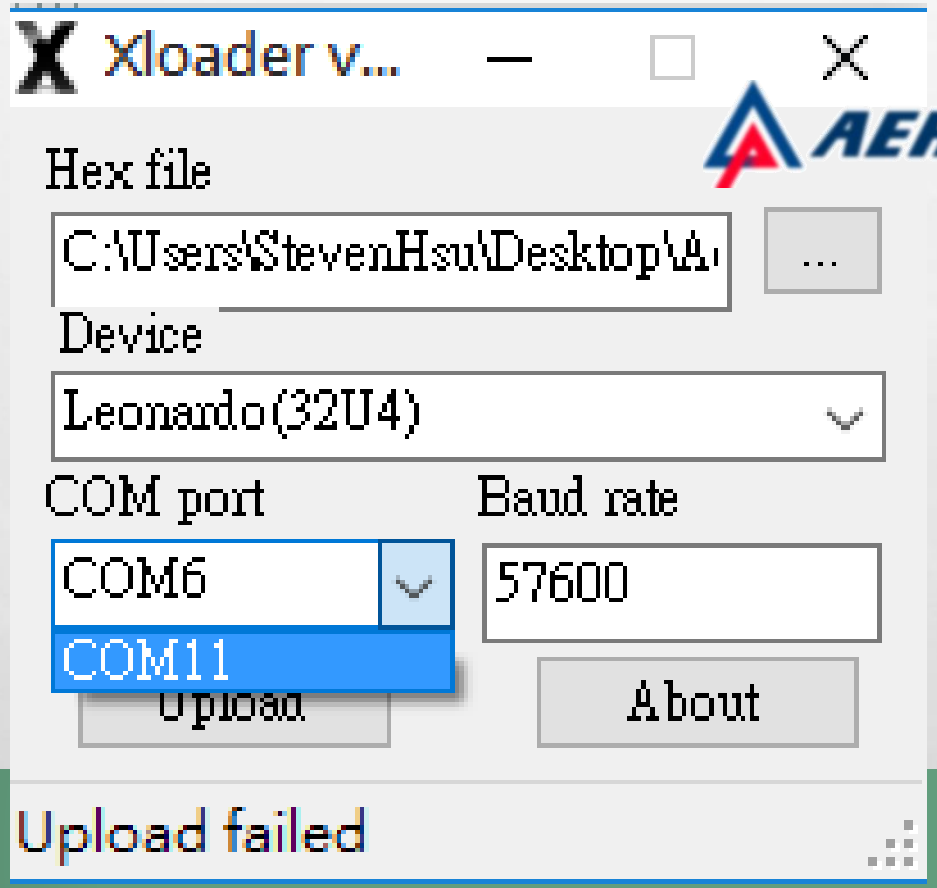
(01)0x1611_0x1116	Channel 1	2016/11/14 下午 ...	檔案資料夾
(02)0x1774_0x7417	Channel 5	2016/11/14 下午 ...	檔案資料夾
(03)0x1971_0x7119	Channel 9	2016/11/2 上午 1...	檔案資料夾
(04)0x2420_0x2024	Channel 13	2016/11/2 上午 1...	檔案資料夾
(05)0x2548_0x4825	Channel 17	2016/11/2 上午 1...	檔案資料夾
(06)0x2573_0x7325	Channel 21	2016/11/2 上午 1...	檔案資料夾
(07)0x2587_0x8725	Channel 25	2016/11/2 上午 1...	檔案資料夾
(08)0x2641_0x4126	Channel 29	2016/11/2 上午 1...	檔案資料夾
(09)0x2710_0x1027	Channel 33	2016/11/2 上午 1...	檔案資料夾
(10)0x3128_0x2831	Channel 37	2016/11/2 上午 1...	檔案資料夾
(11)0x4080_0x8040	Channel 41	2016/11/2 上午 1...	檔案資料夾
(12)0x4090_0x9040	Channel 45	2016/11/2 上午 1...	檔案資料夾
(13)0x4341_0x4143	Channel 49	2016/11/2 上午 1...	檔案資料夾

將PAW 搖控器重置 (RESET)便能夠進入BOOTLOADER模式



按下此按鈕便能夠將重置 (RESET) 系統

回到XLOADER重新選擇COM



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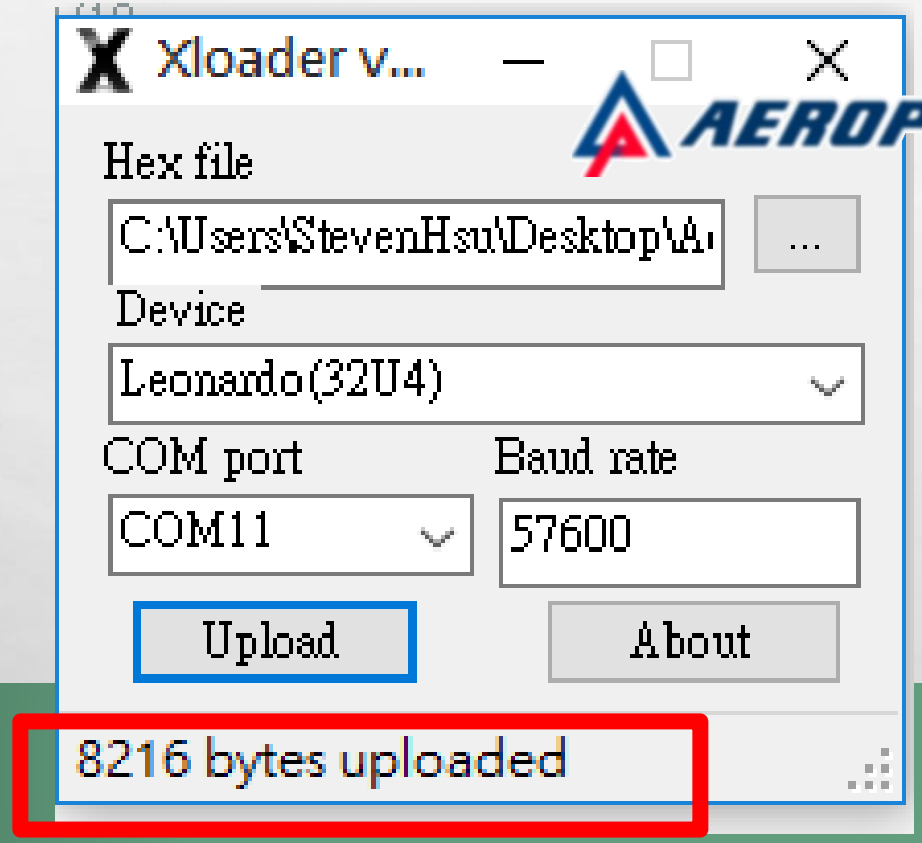
按下按鈕之後馬上**UPLOAD** 因為 **BOOTLOADER** 模式只維持**5**秒左右，上傳的動作要快速，完成後會顯示上傳的資料量



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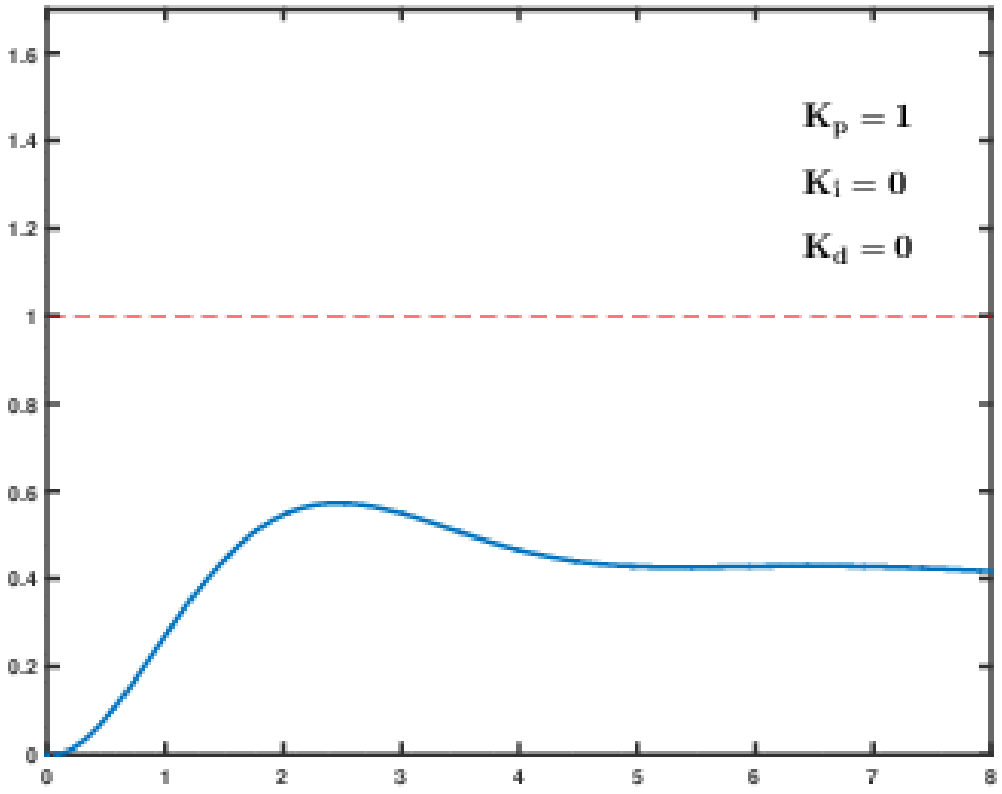
飛控軟體整合實作



$$u(t) = MV(t) = K_p e(t) + K_i \int_0^t e(\tau)\,d\tau + K_d \frac{d}{dt} e(t)$$

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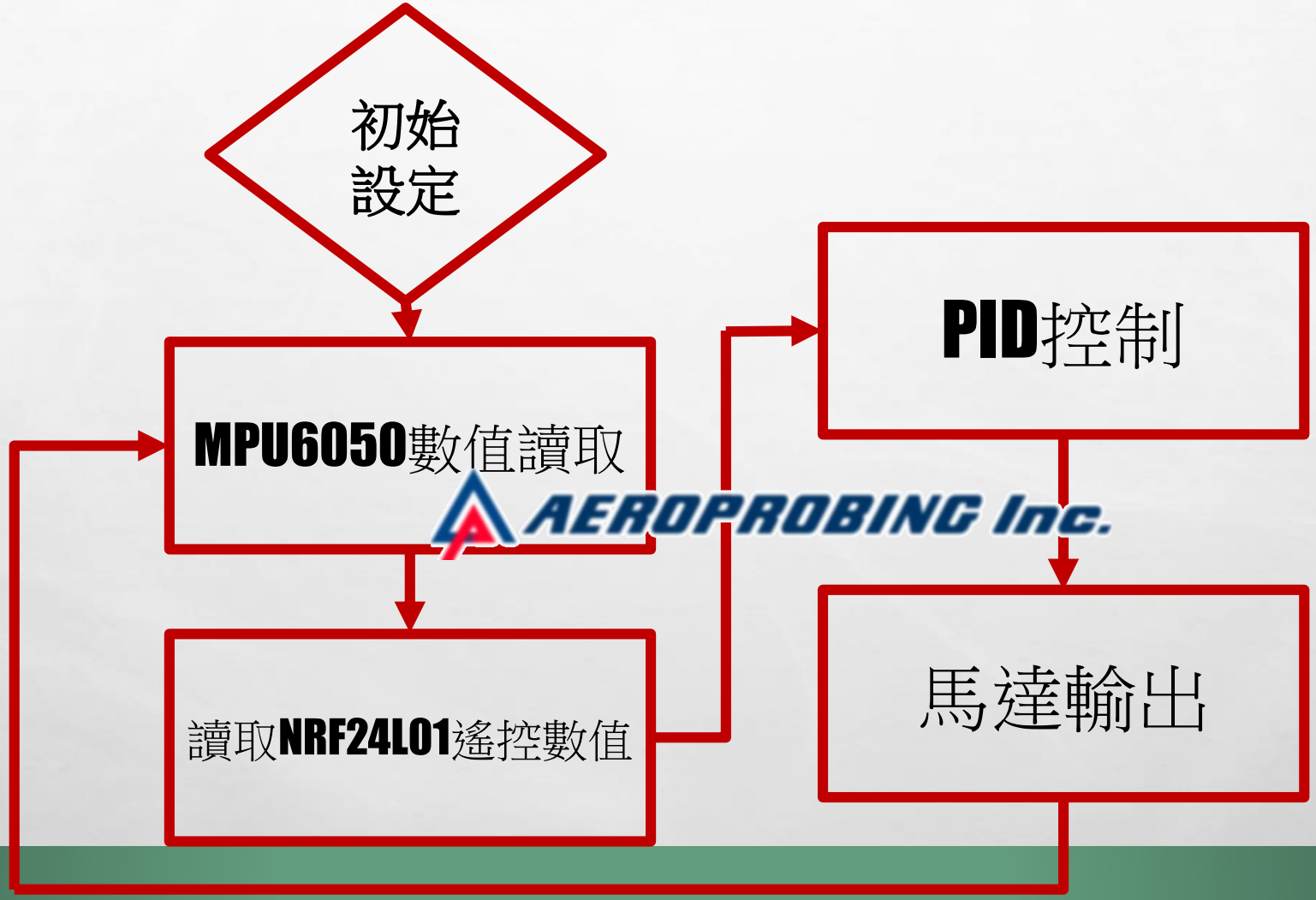
LDSLITE 飛控流程講解



LDSLITE 飛控流程講解

```
70  void loop()
71  {
72    accelgyro.getMotion6(&ax, &ay, &az, &gx, &gy, &gz);
73    yprGetValue();  //角度轉換取得Yaw,Pitch,Roll
74    APB_allSetToZero();//YPRT歸零與積分器歸零
75    APB_throttleLock();
76    if (radio.available() && !channelReadFlag)
77    {
78      APB_rfReadData();//讀取資料
79      readDataBuffer = readData;
80    }
81    else if (!radio.available() && !channelReadFlag)
82    {
83      readData = readDataBuffer;
84      APB_rfLost();//掉線時遞減油門
85    }
```

```
if (!PIDFlag) //不調整PID
{
  APB_SetBalance();//YPRT歸零與積分器歸零或是矯正陀螺儀
  APB_getYPRT(); //取得飛行數據
  APB_pidCalculate();//PID計算
  APB_motorOutput();//馬達輸出
}
else if (PIDFlag)//調整PID
{
  APB_pidSetting(); //取得Kpin,Kiin,Kdin數值
}
APB_LEDblink();
```

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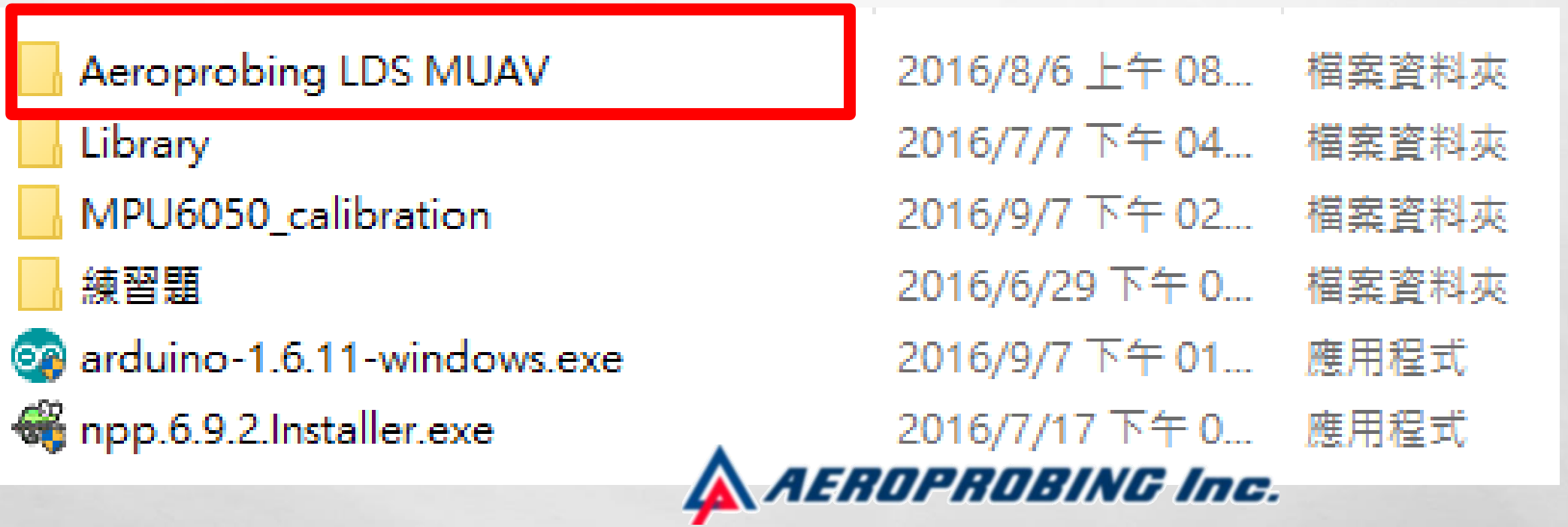
LDSLITE 飛控軟體整合實作



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複製資料夾位置


組合管理
新增
開啟
選取
C:\Users\StevenHsu\Desktop\Class\中階課程教案\全天課程\中階課程軟體\Aeroprobing LDS MUAV\MUAV
名稱
修改日期
類型
大小
AeroprobingLDS.a
2016/7/17 下午 1...
A 檔案
656 KB
AeroprobingLDS.h
2016/7/13 下午 0...
H 檔案
3 KB
MUAV.ino
2016/7/15 上午 1...
Arduino file
4 KB
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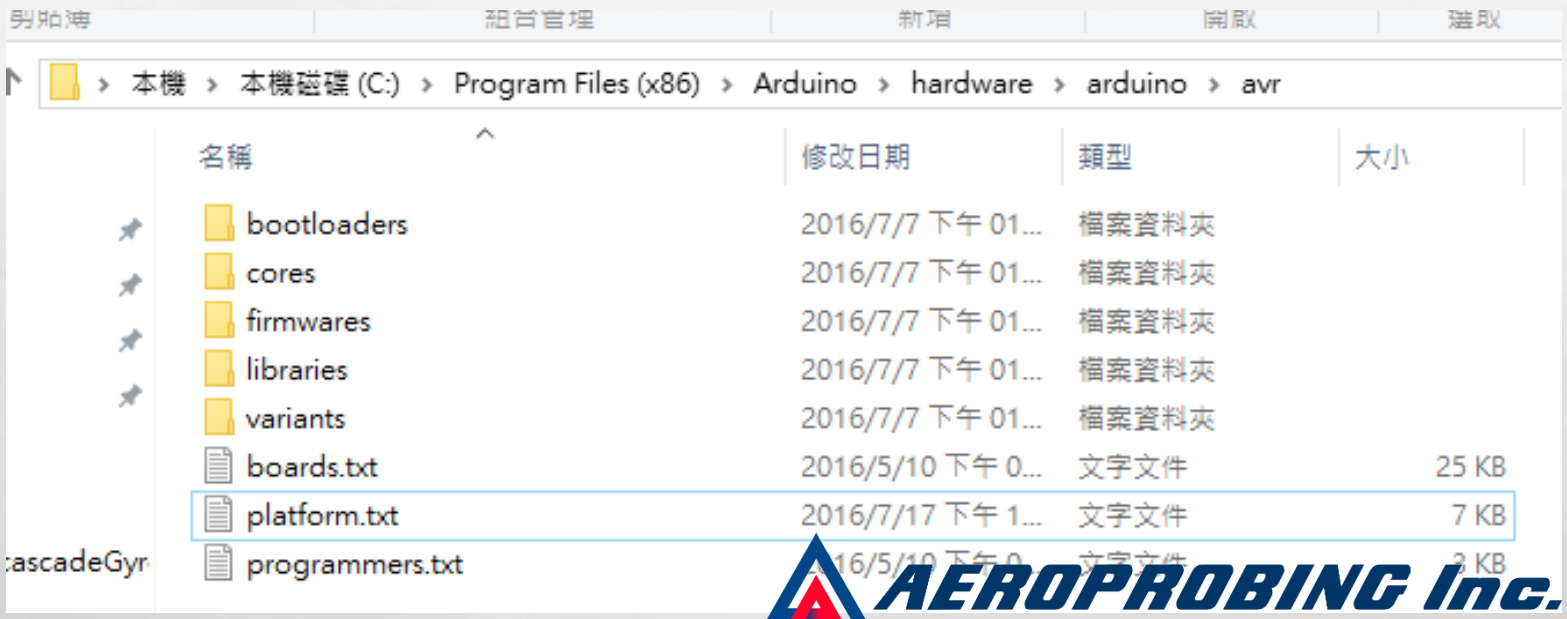
進入下列位置並使用NOTEPAD++開啟PLATFORM.TXT

C:\PROGRAM FILES (X86)\ARDUINO\HARDWARE\ARDUINO\AVR



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在COMBINE GCC-SECTIONS, ARCHIVES, AND OBJECTS(第68行)底下加上AEROPROBINGLDS.A的檔案(必須儲存才有效)

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```
"-L{build.path}" "C:\Users\StevenHsu\Desktop\Class\中階課程教案\全天課程\中階課程教材\Aeroprobing LDS MUAV\MUAV\AeroprobingLDS.a" -lm
```

開啟MUAV.INO

```
14 float Kpout[3] = { //Kp{ Yaw , Pitch , Roll }
15   0.08, 2.2, 2.2
16 };
17 float Kiout[3] = { //Ki{ Yaw , Pitch , Roll }
18   0.003, 0.003, 0.003
19 };
20 float Kdout[3] = { //Kd{ Yaw , Pitch , Roll }
21   0.06, 0.029, 0.029
22 };
3  #endif
4  const uint64_t pipes[2] = { 0x1611, 0x1161 }; //RF傳輸位址設定
```

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更改自己的傳輸位址

開啟AEROPROBINGLDS.H

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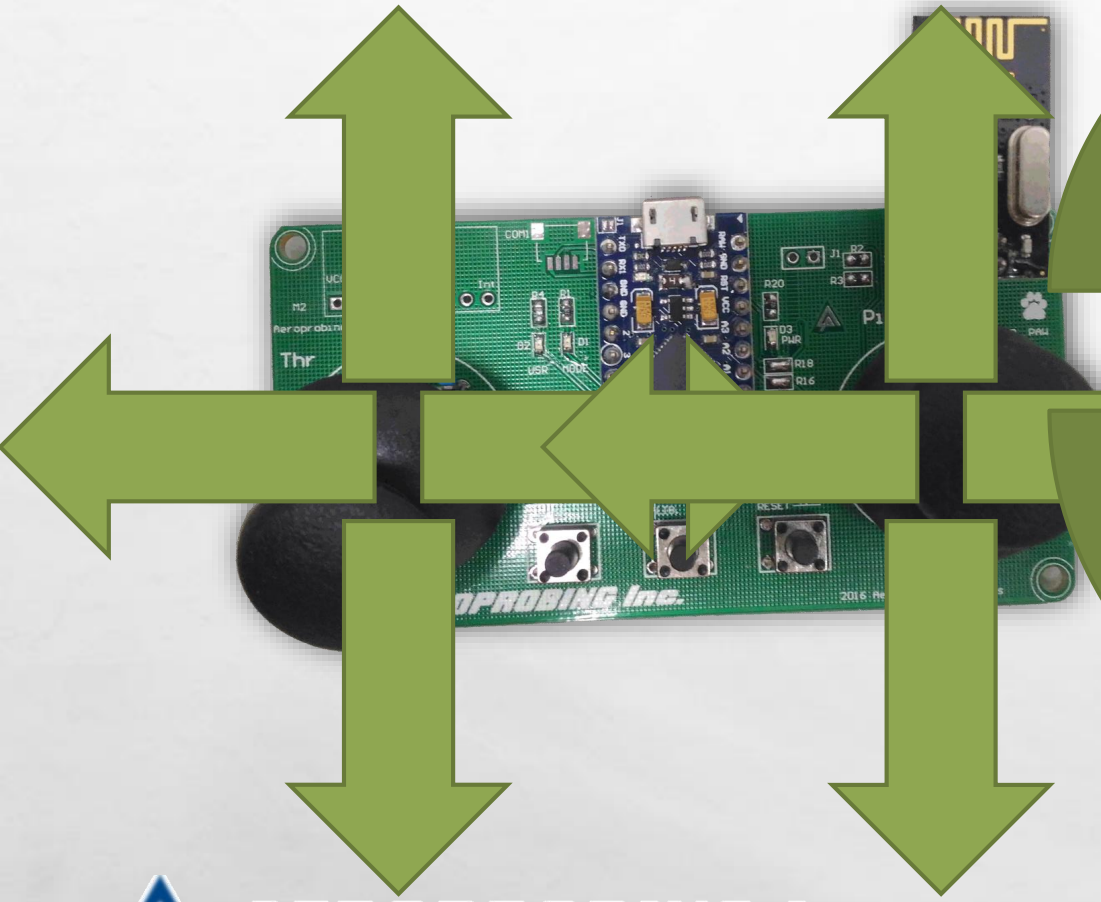
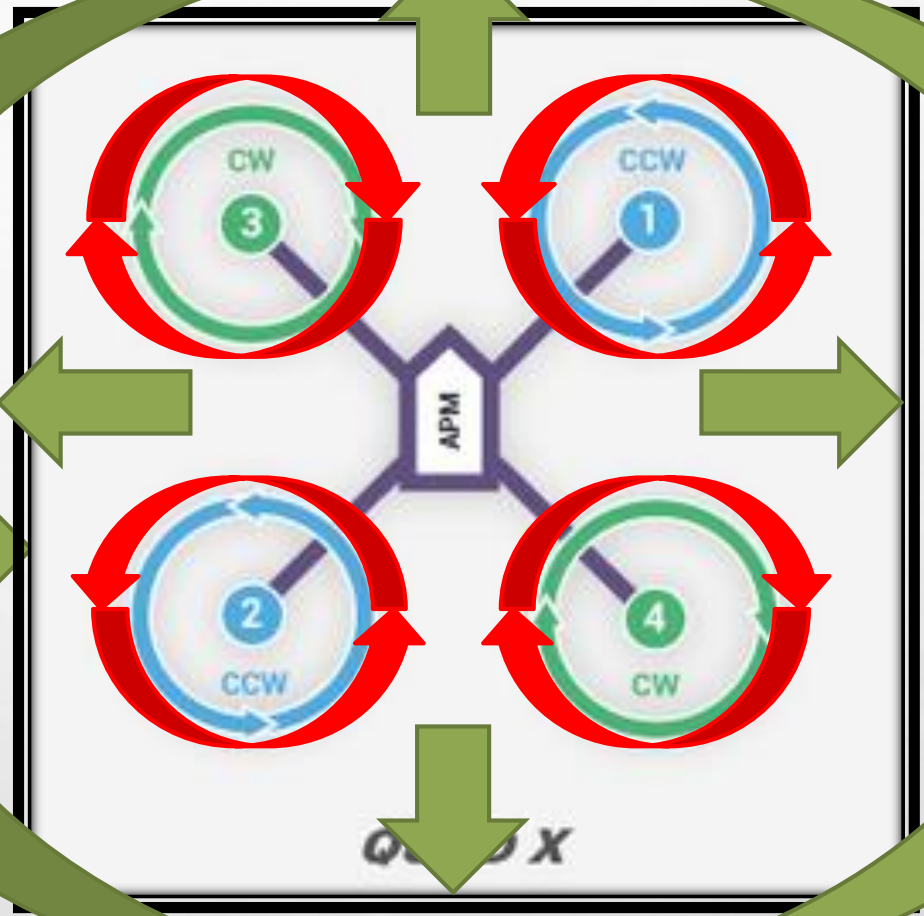
更改自己的傳輸CHANNEL

```
86   **/
87   #define UserChannel 110
88   #define readDataSize 6
89   #define sendDataSize 4
90   extern bool AllSetToZero;
91   extern float RF_YPR[3];
```





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遙控器操作教學

CALIB. IMU 按鈕可以校正陀螺儀
F.MODE 按鈕可以調整控制幅度

PLAY TIME!

Contact us：

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