KNRm 課程

貝登堡智能
KK Intelligent Service,Inc.

目錄

課堂一 ：機器人與Matrix介紹

貝登堡智能
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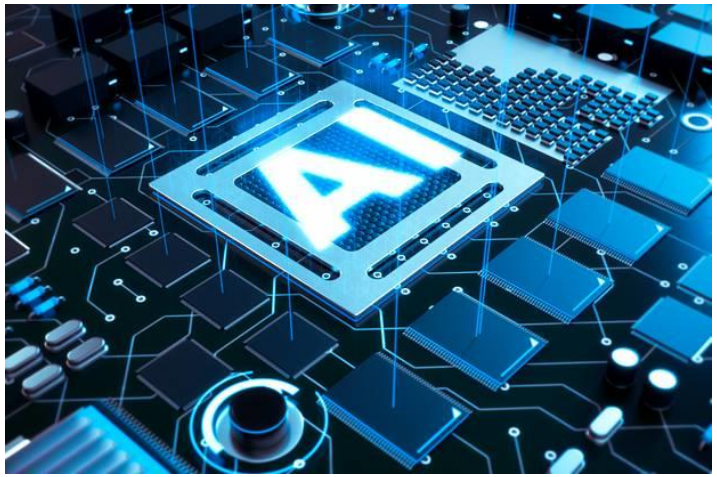
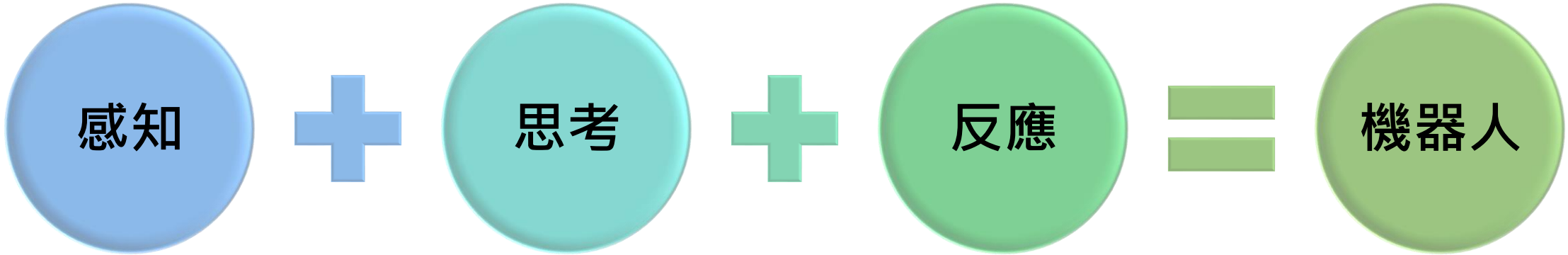
What is “Robot”？



AlphaGo

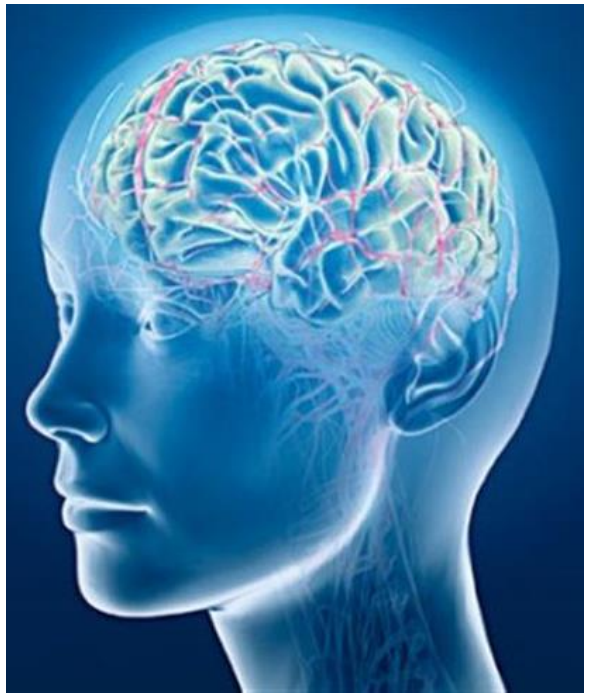

感知
思考
反應
機器人

感知

- 感知身處的環境

思考

- 分析判斷



反應

- 改變環境、對外輸出

How do we build a robot?

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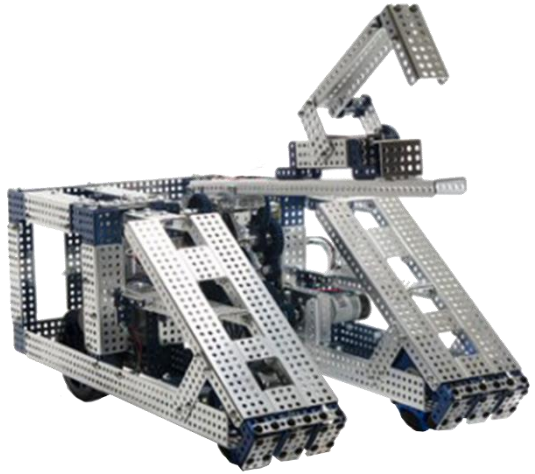
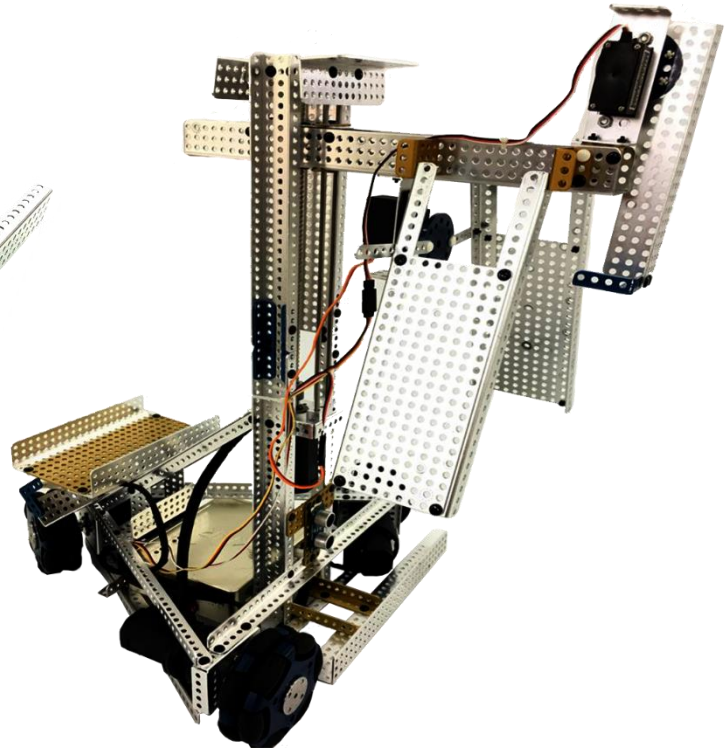
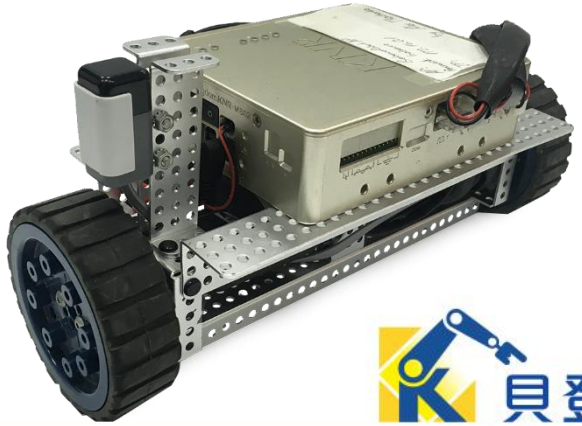
FULLYMAX
Li-Po
Battery
KNR
KNR
KNR

Matrix Building System



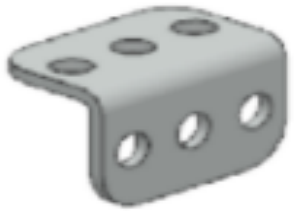




Matrix Parts

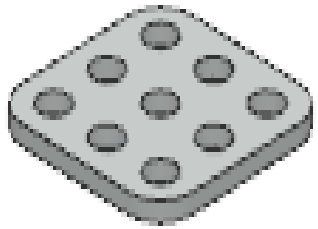
L型樑

- 3孔



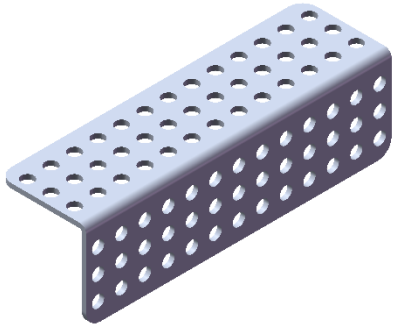
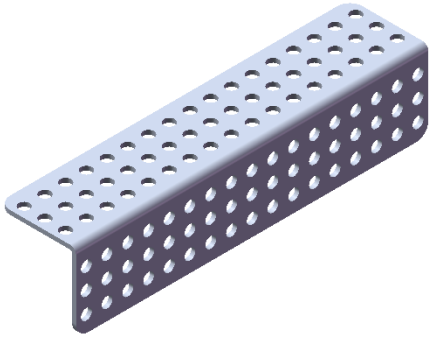
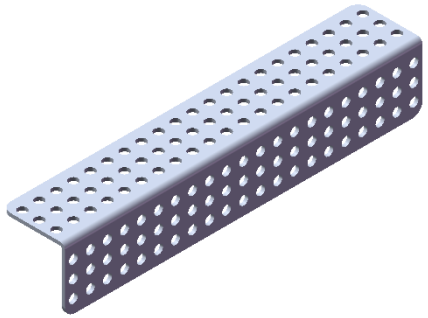
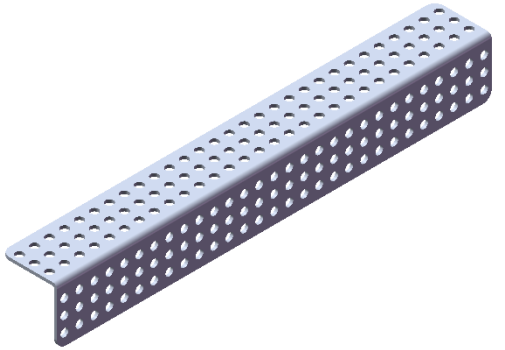
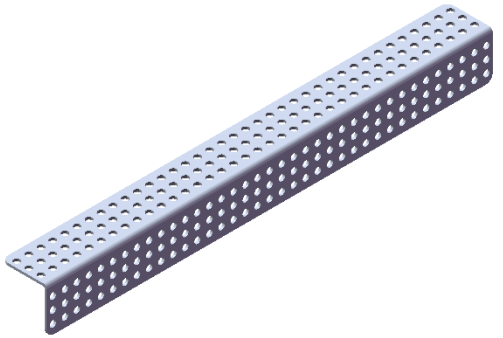
平板

- 9孔



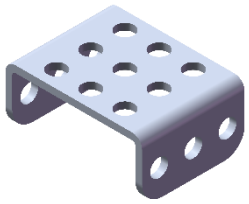
XL L型樑

- 13孔
- 17孔
- 21孔
- 29孔
- 37孔

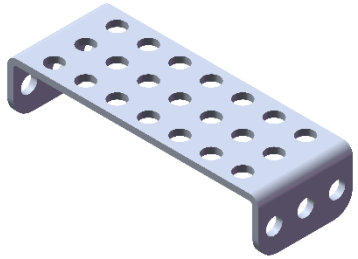






C型樑

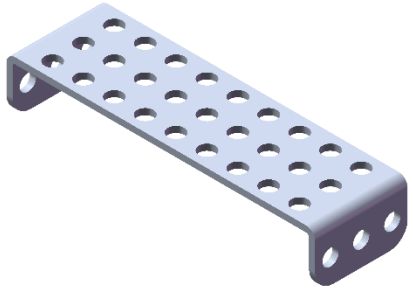
- 3孔



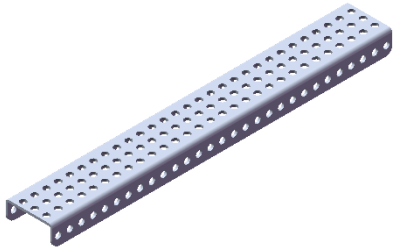
- 7孔



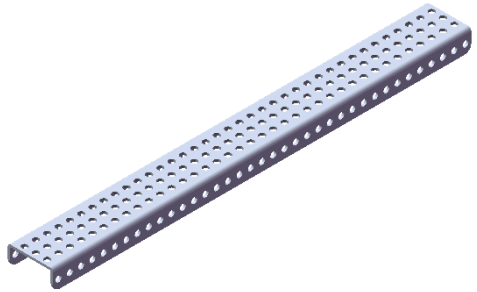
- 9孔



- 29孔



- 37孔



快速插銷

轉軸組

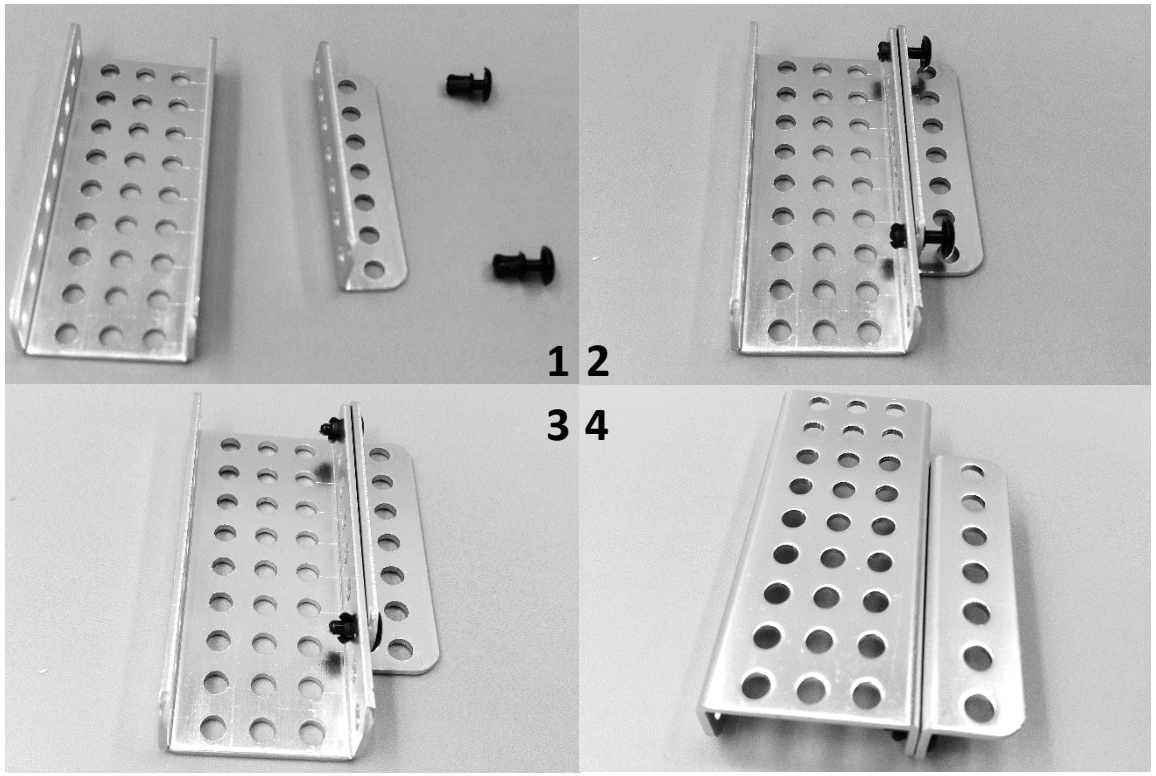
其他零件

- 直流馬達組

組裝方式

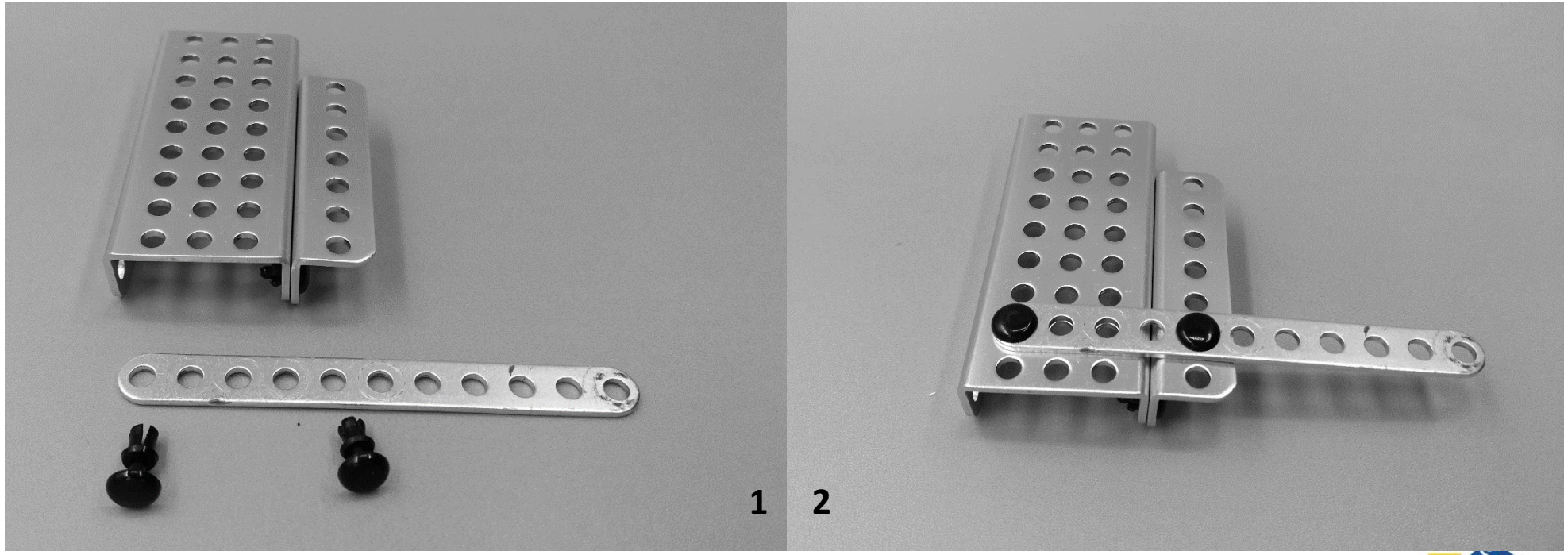
組裝技巧

- 銀色金屬零件採用外對外的方式以黑色插銷連接



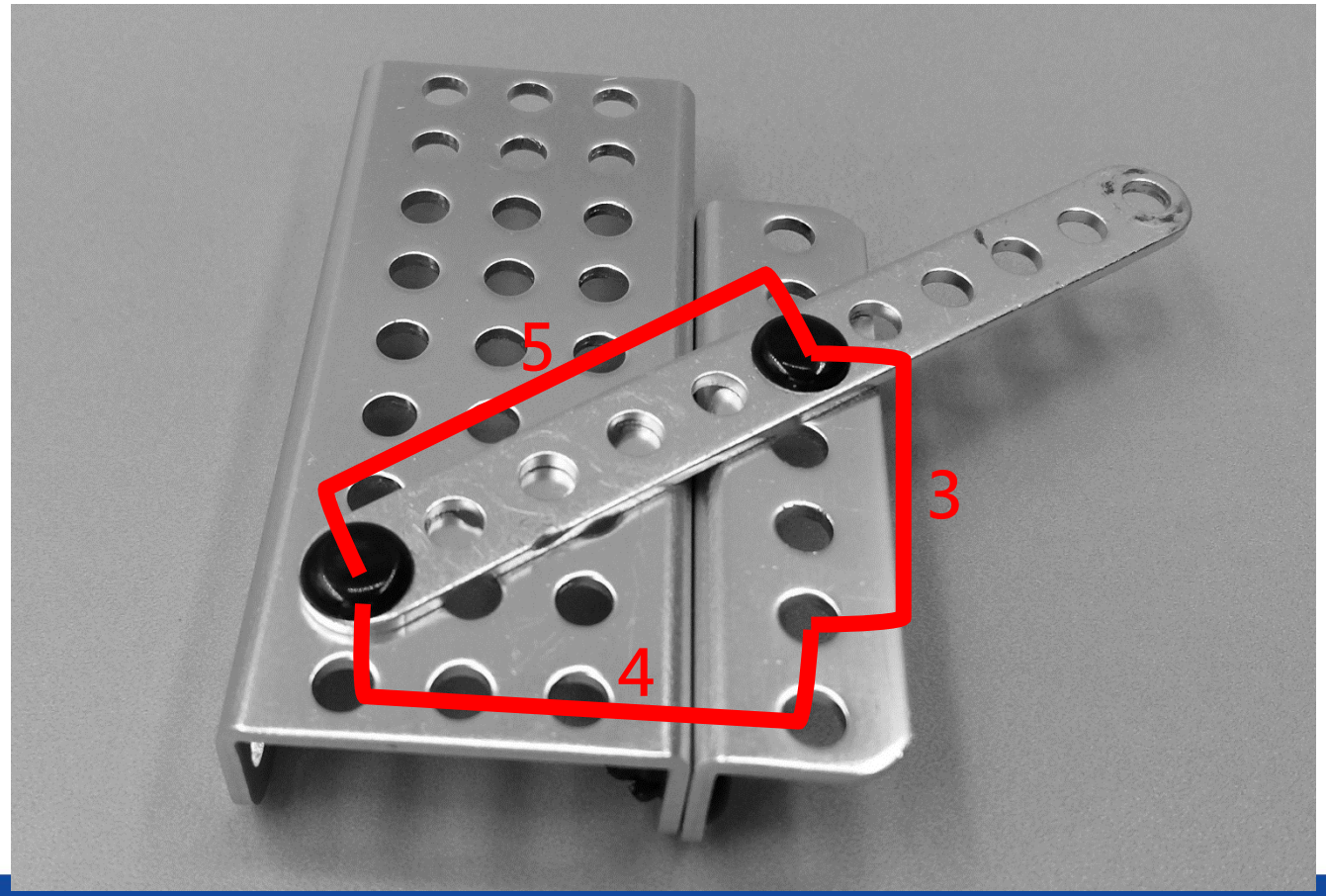
組裝技巧

- 同一平面可繼續連接而不會有孔洞錯位的情況



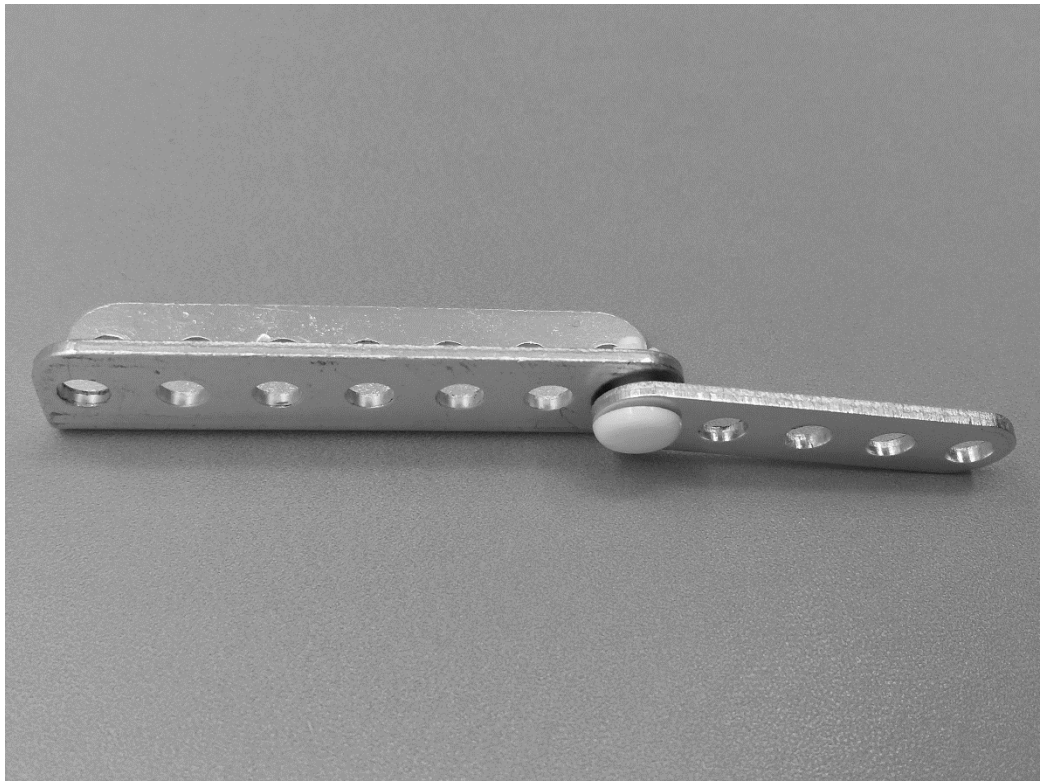
組裝技巧

- 同一平面上也可以以直角三角形的邊長比例做斜邊的連接



組裝技巧

- 需要活動的連接點也可以使用白色插銷



課堂二：KNR基本車組裝

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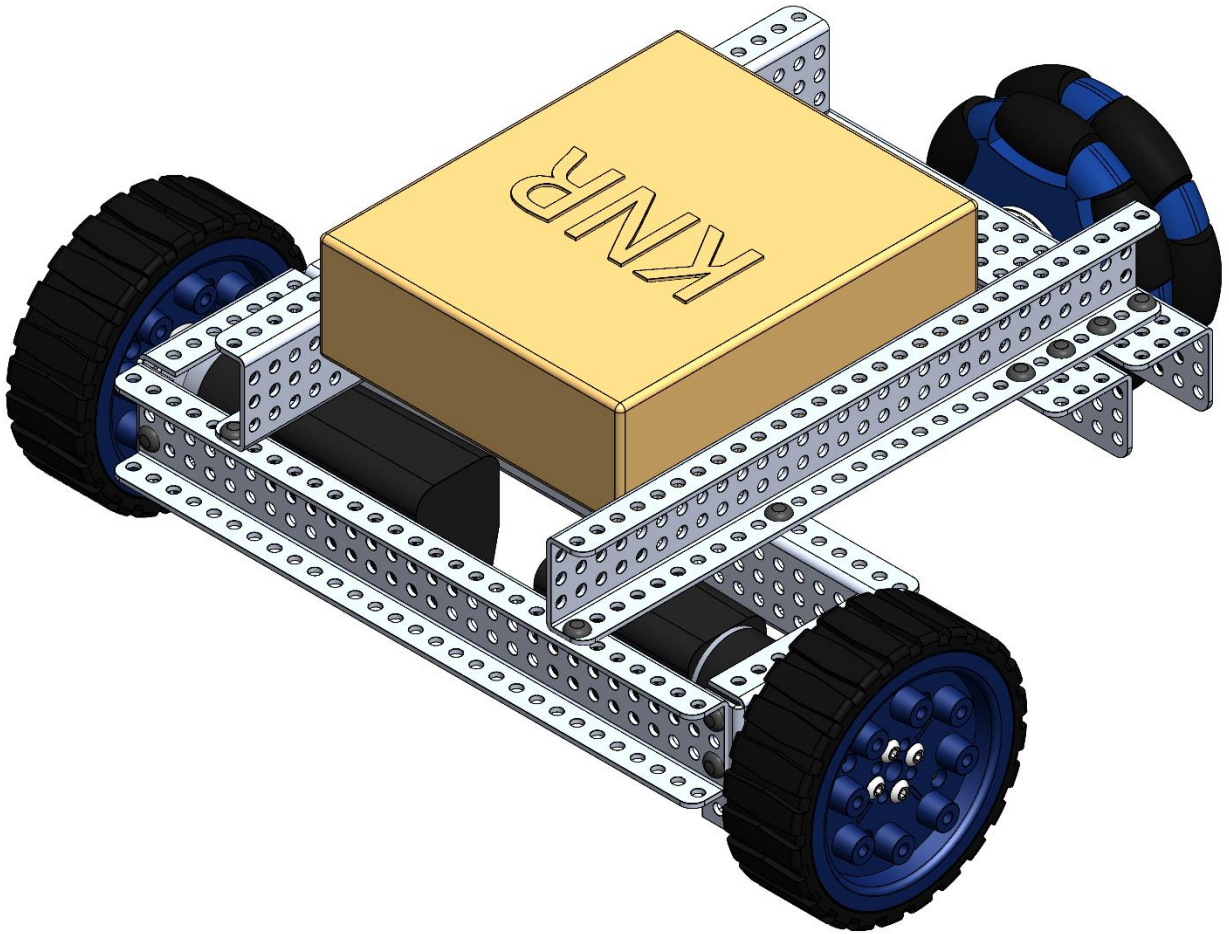
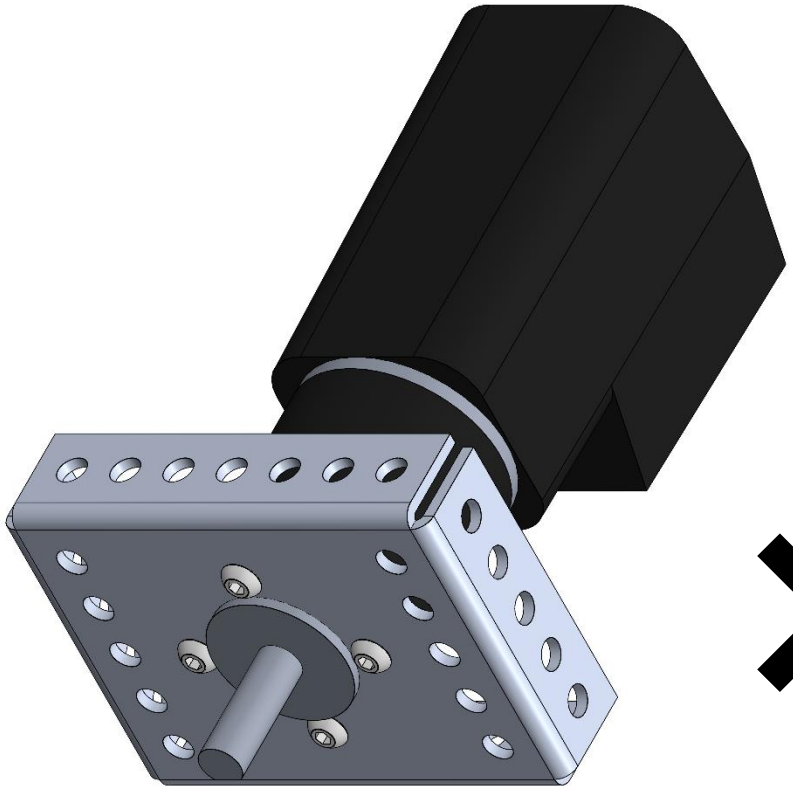
基本車組裝步驟



步驟一



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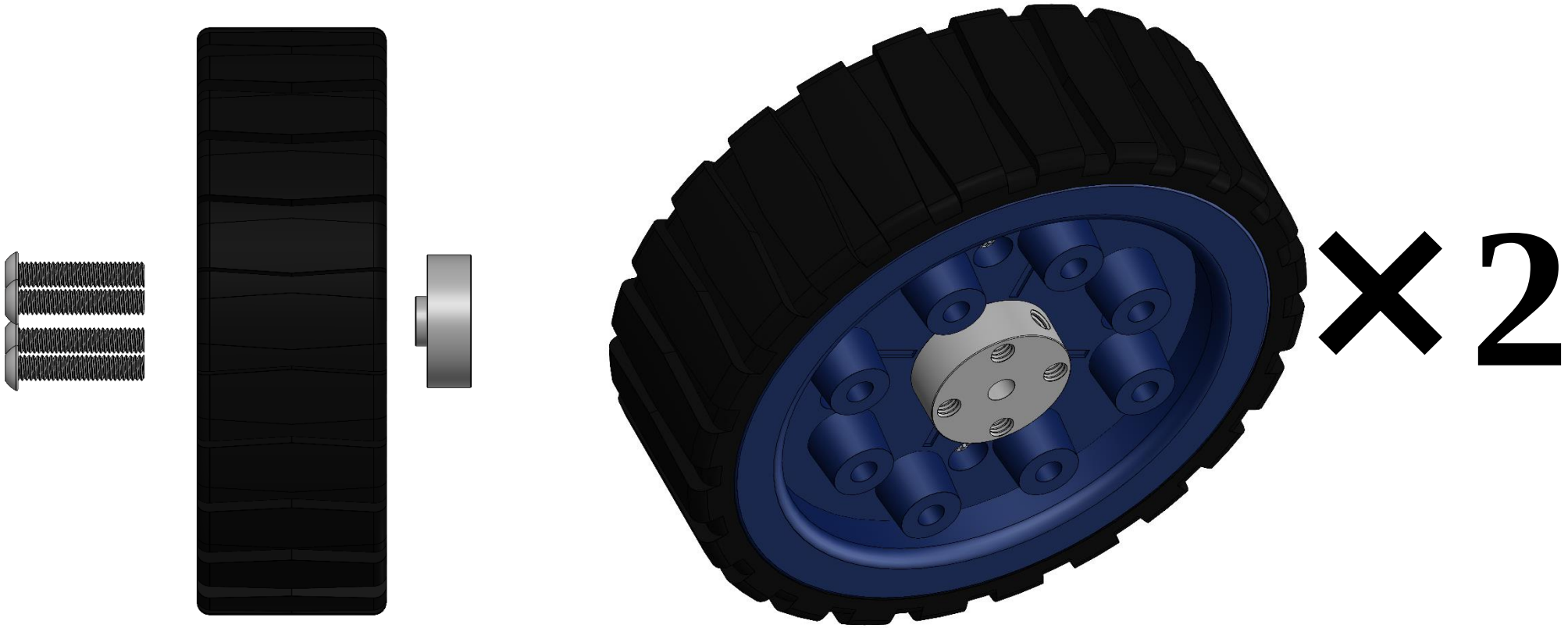
步驟二



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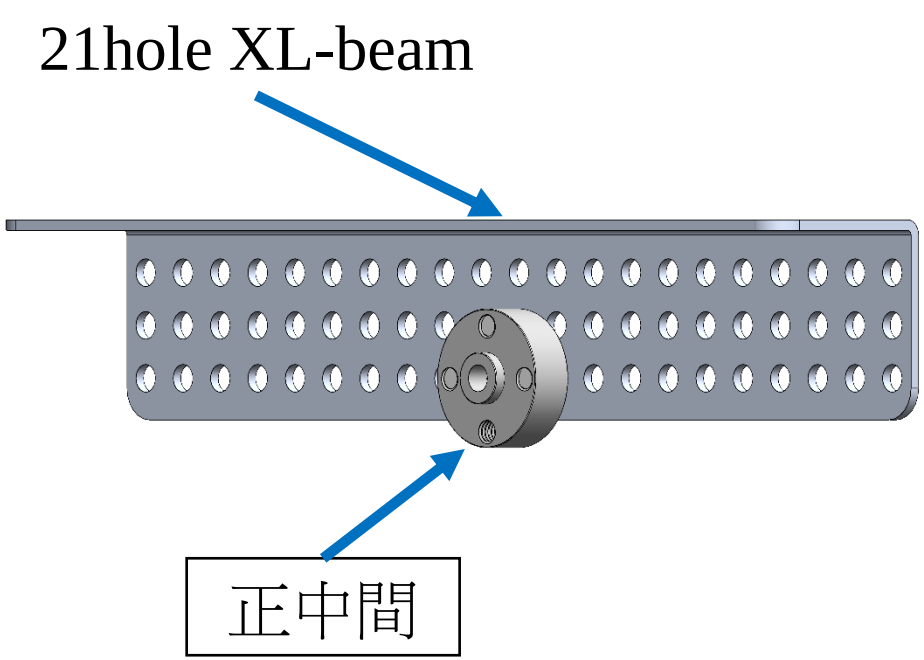
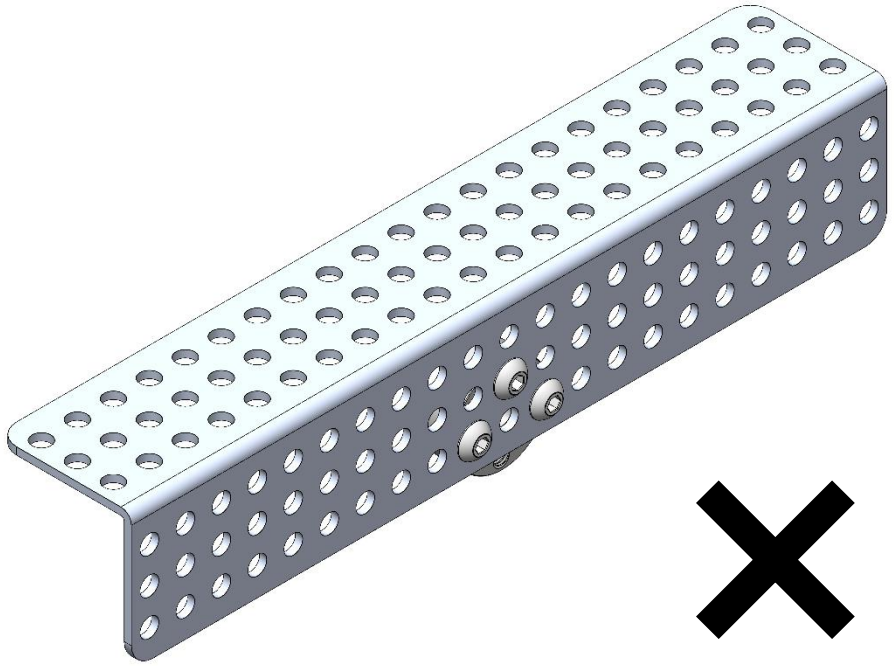
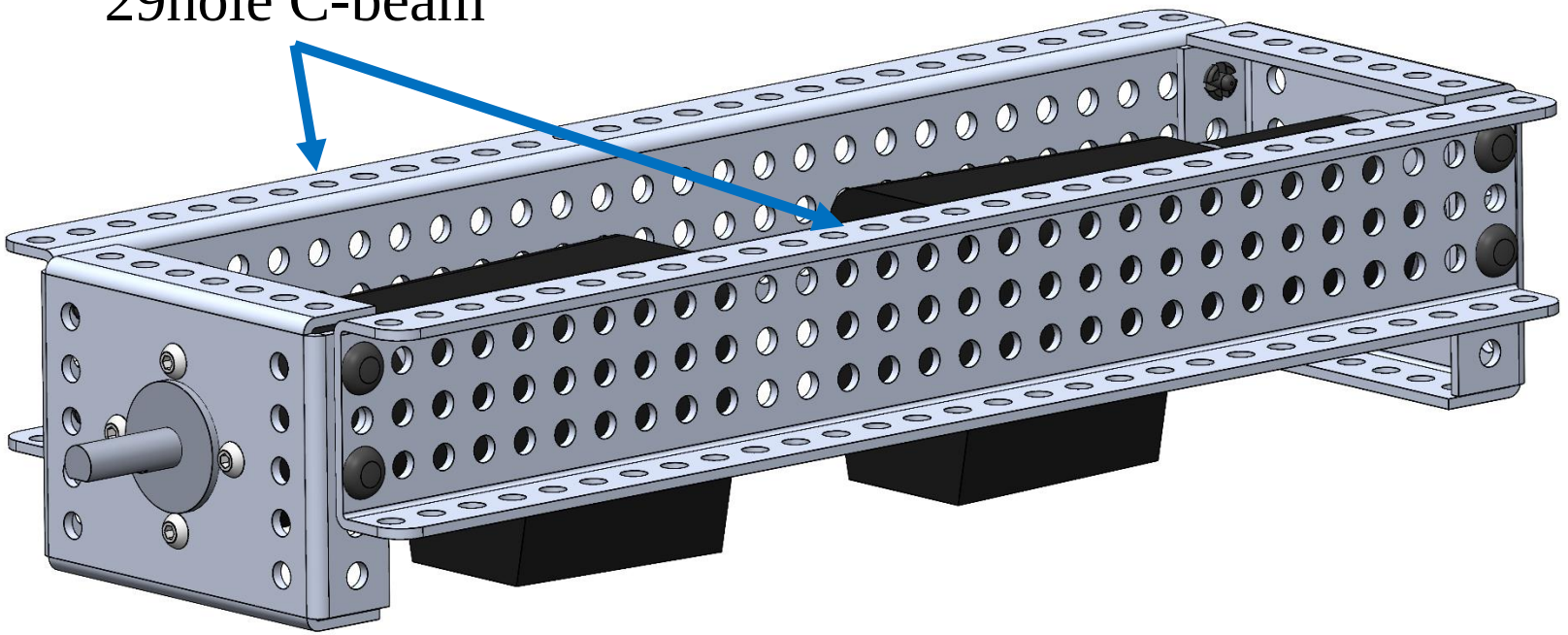




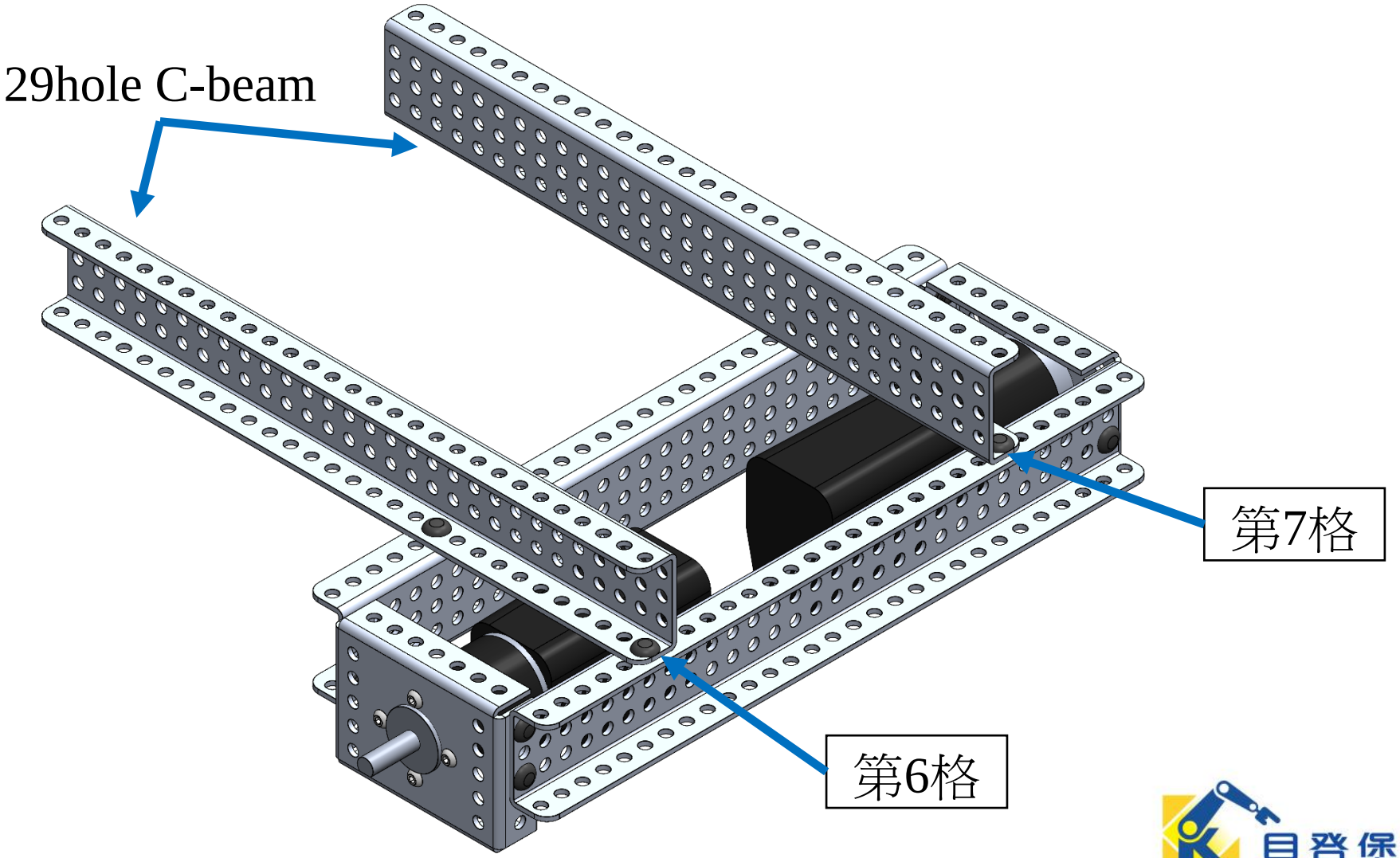
×2

步驟四

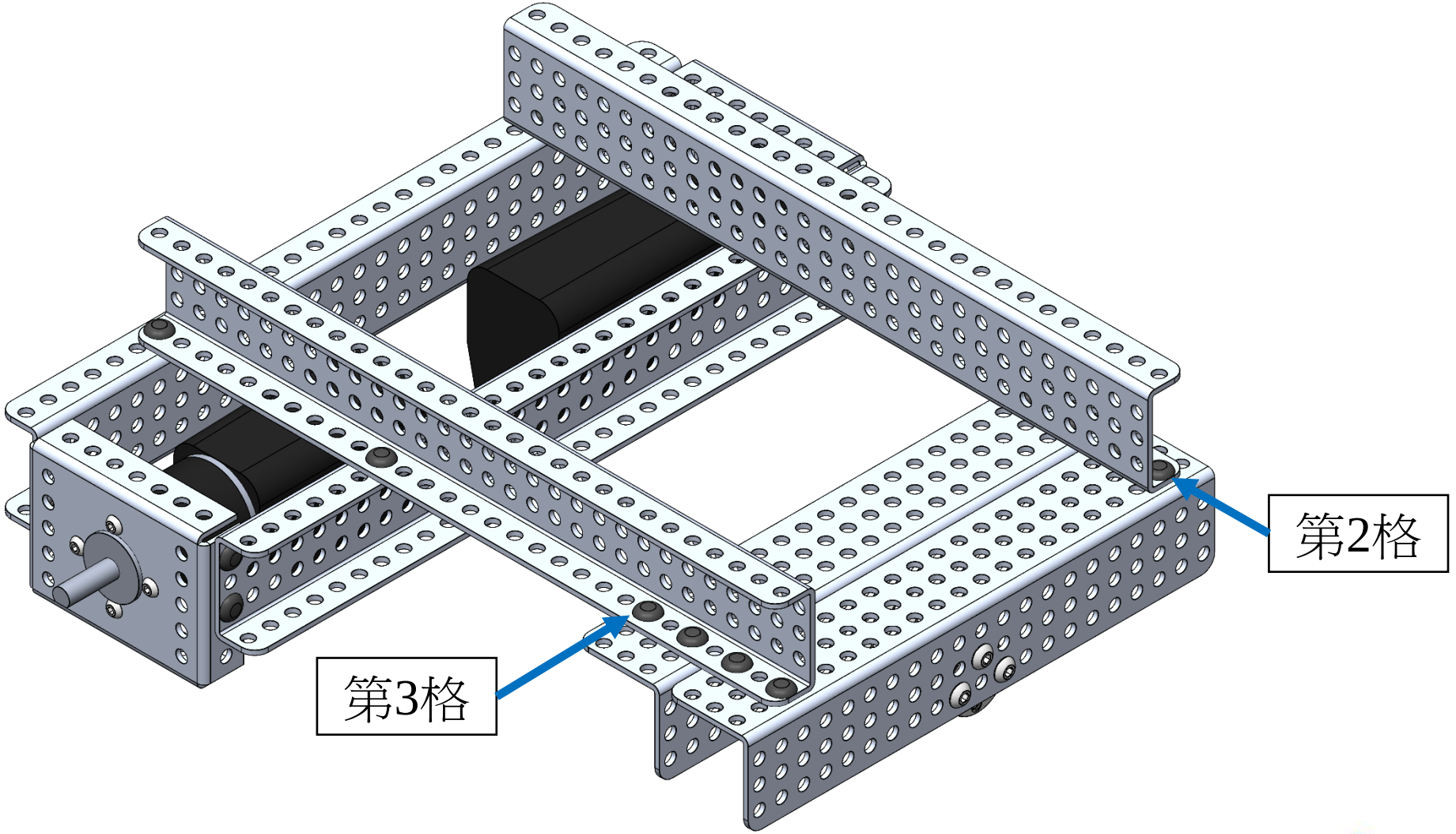
29hole C-beam



步驟五

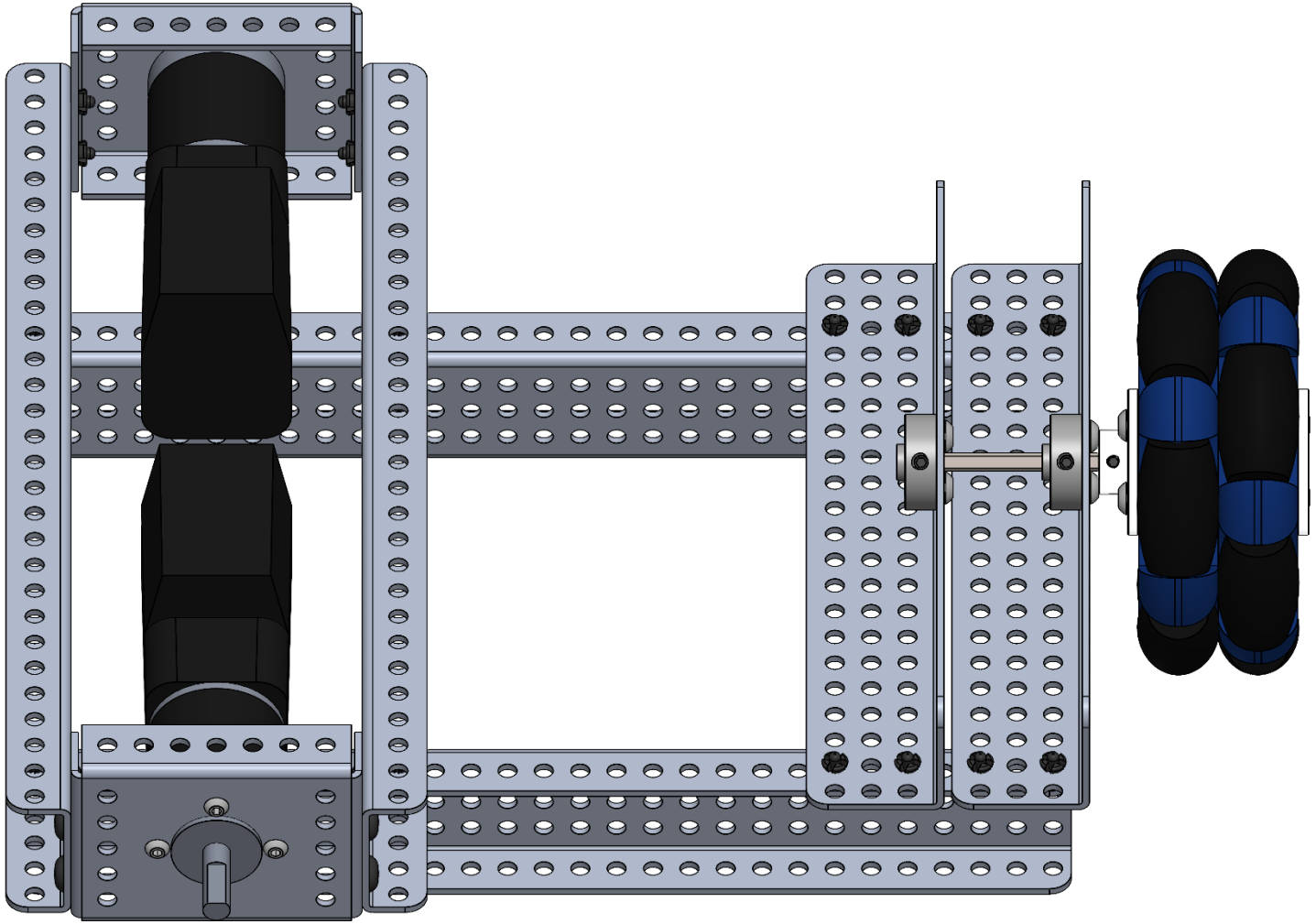


步驟六



步驟七

背面



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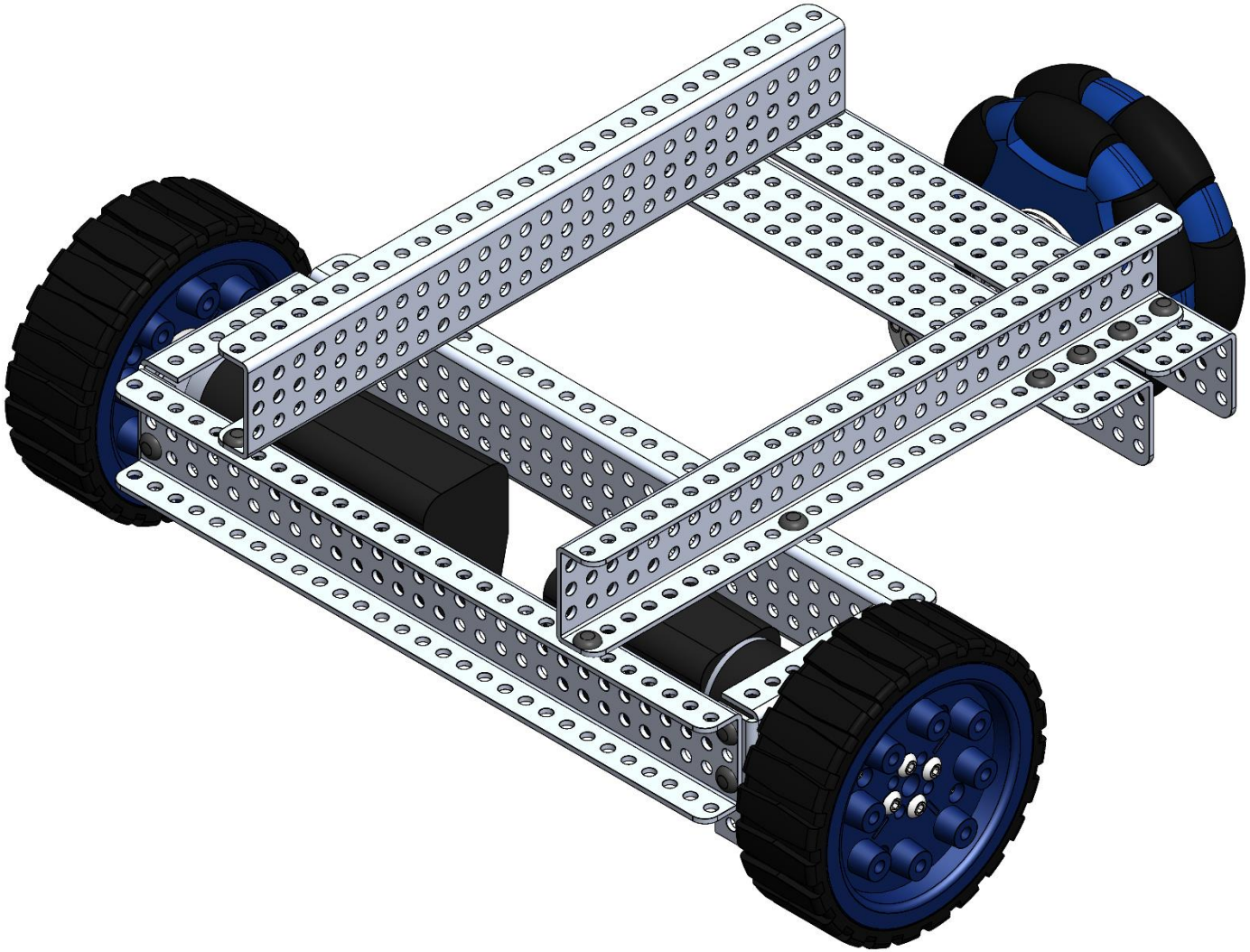
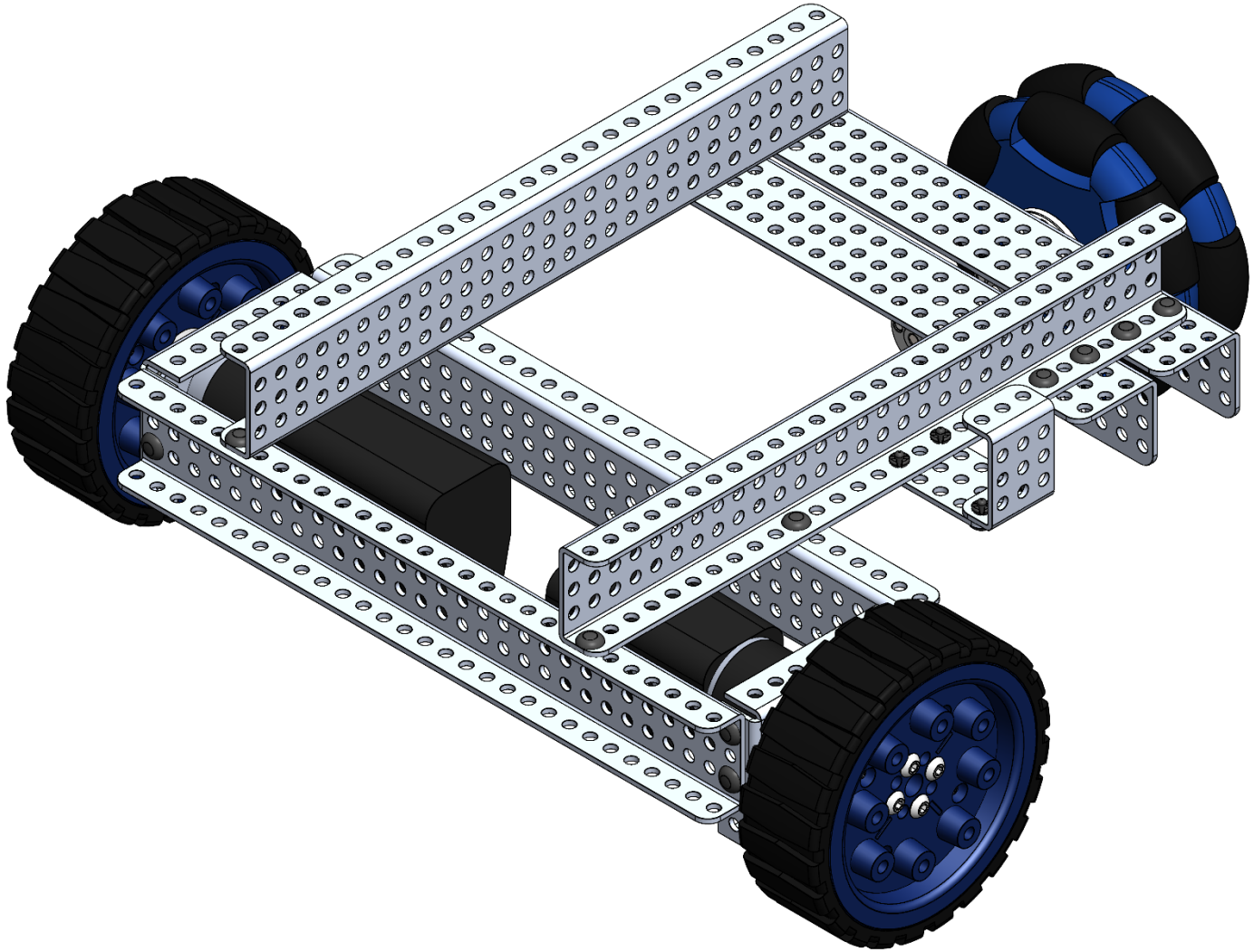


步驟九



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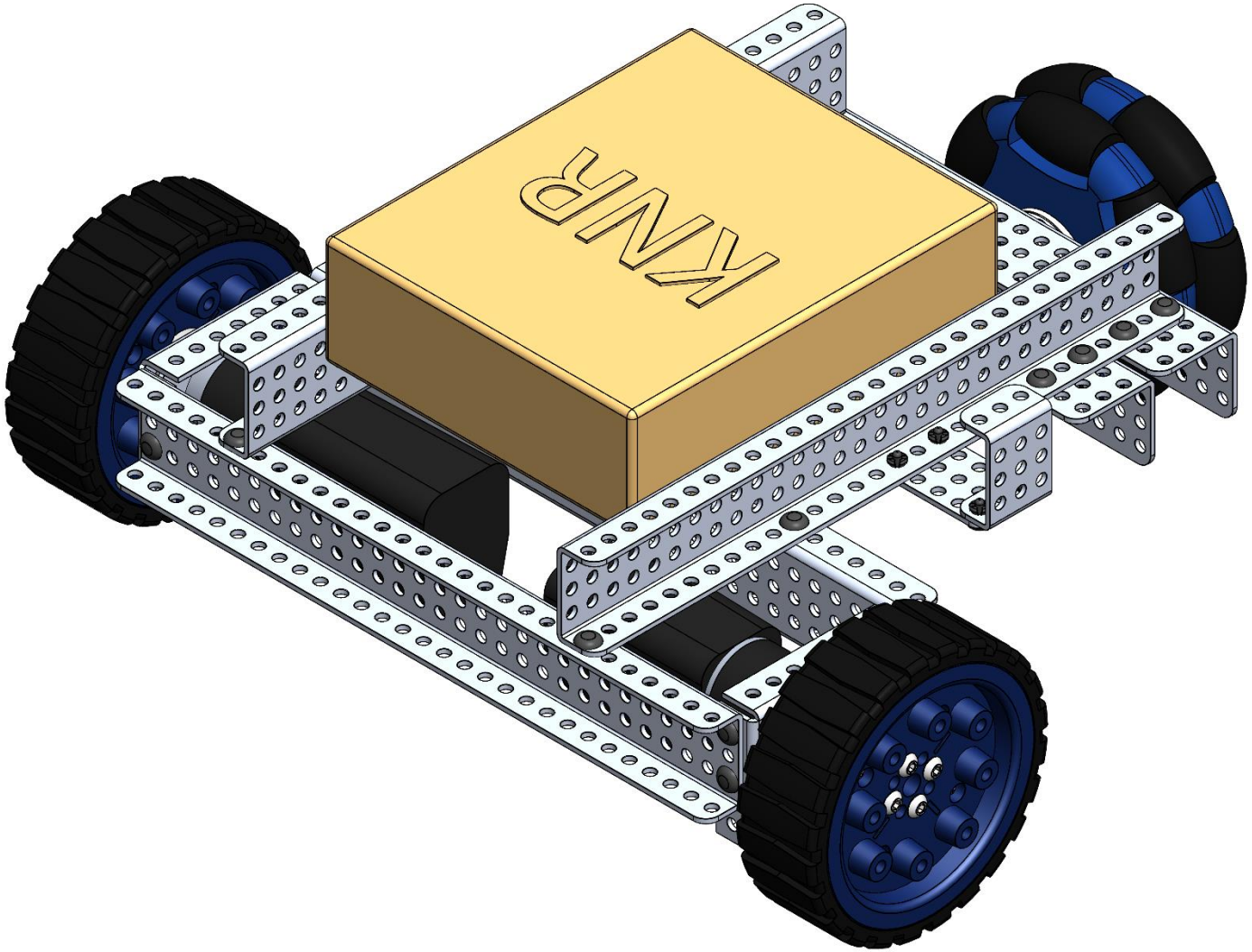
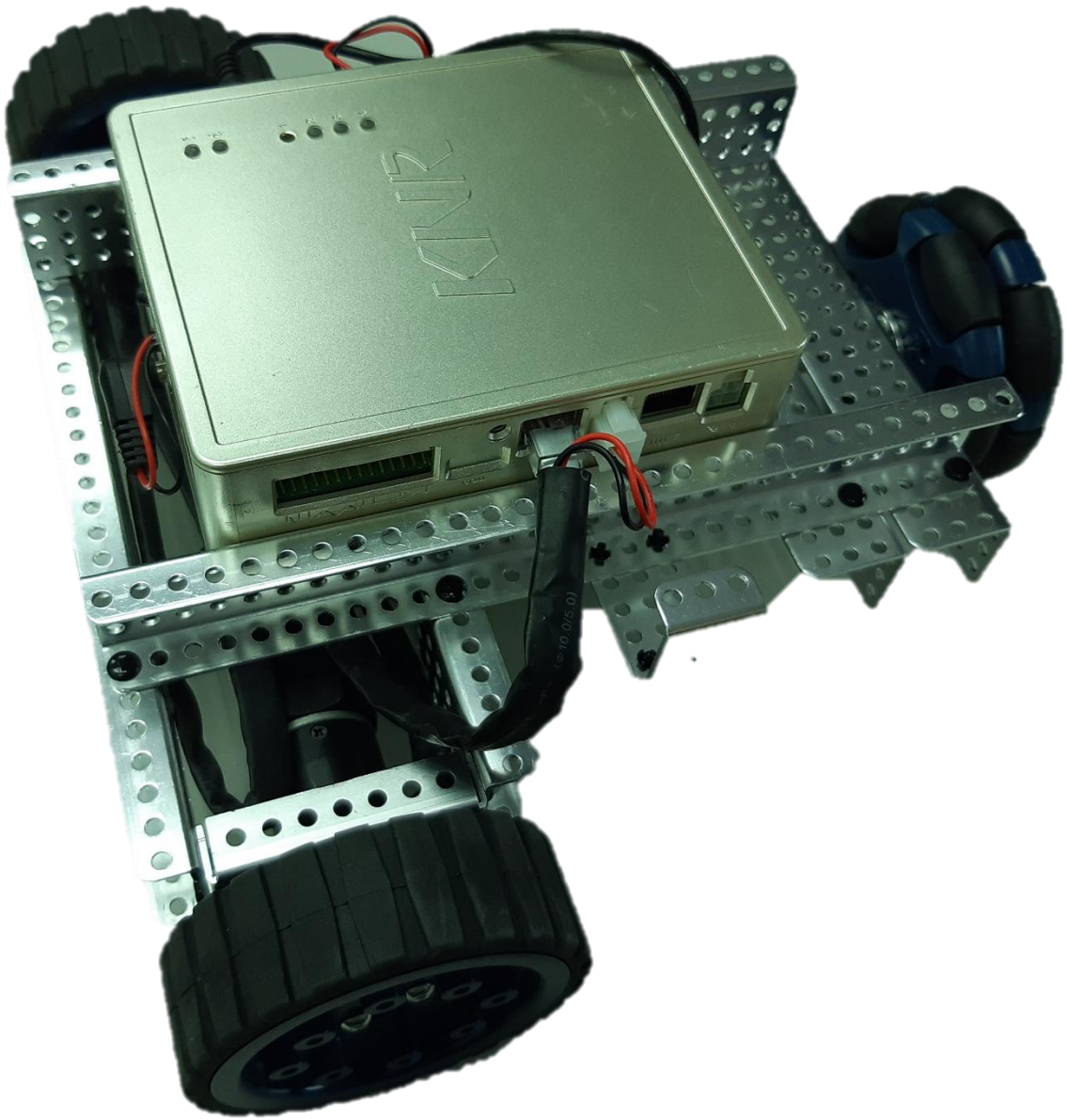


完成



課堂三 ：認識程式語言LabVIEW
（運算、迴圈、布林）

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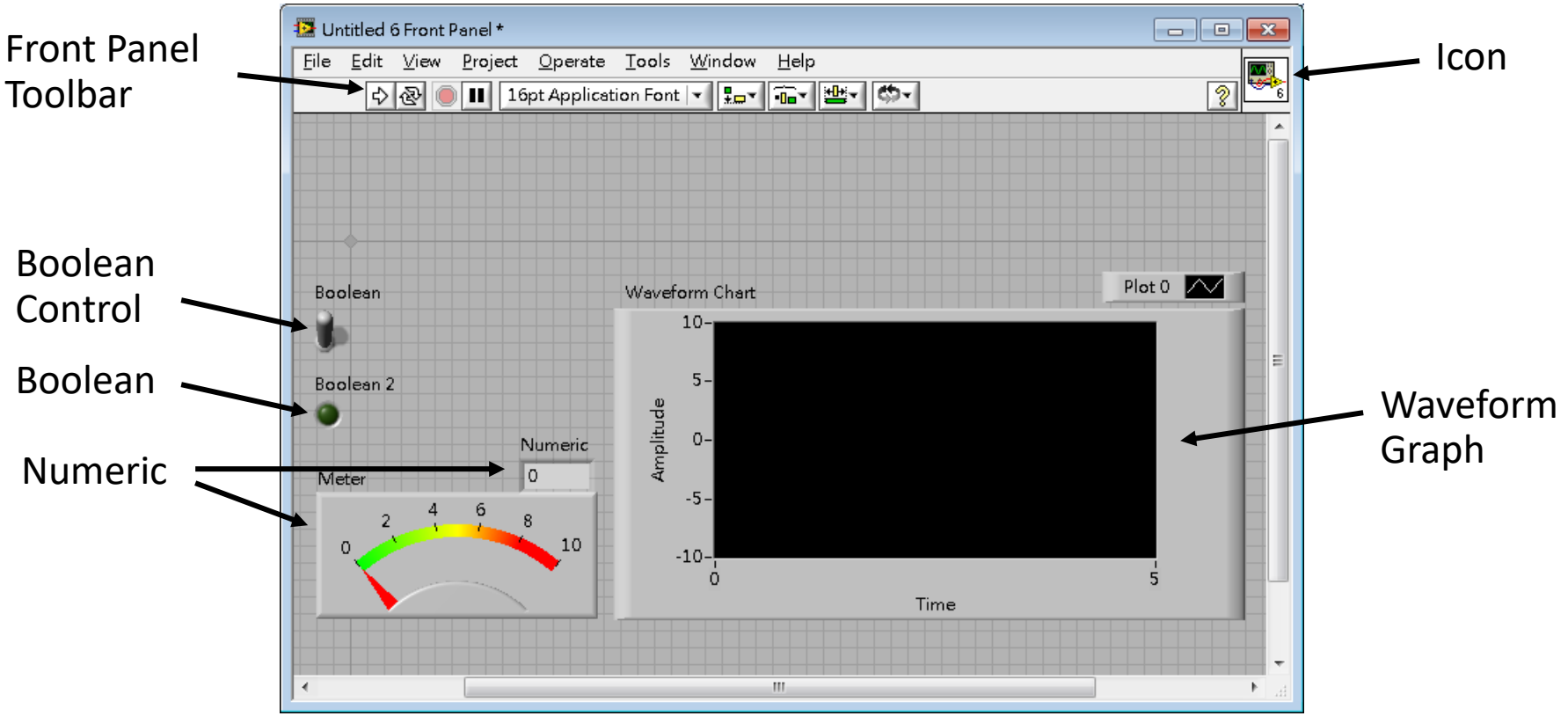
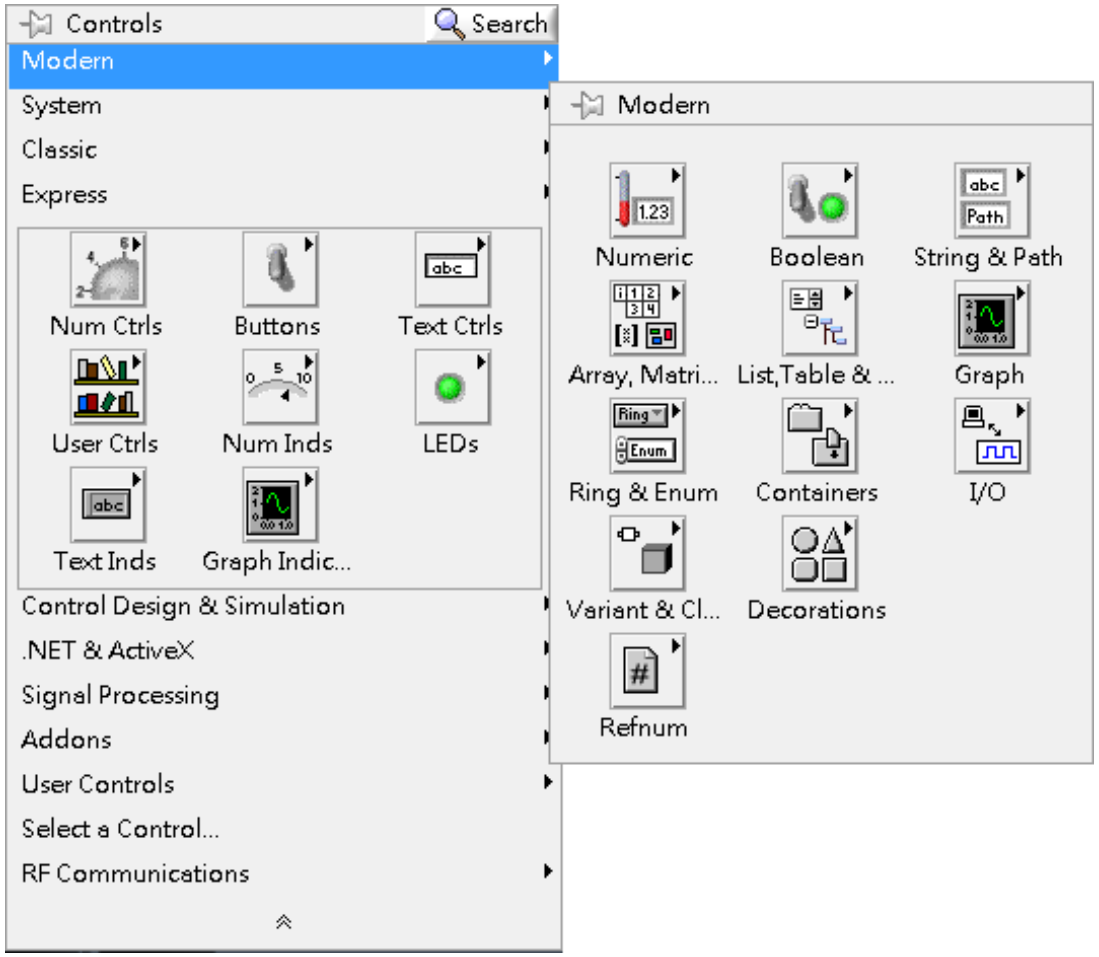
KK Intelligent Service,Inc.

Front Panel

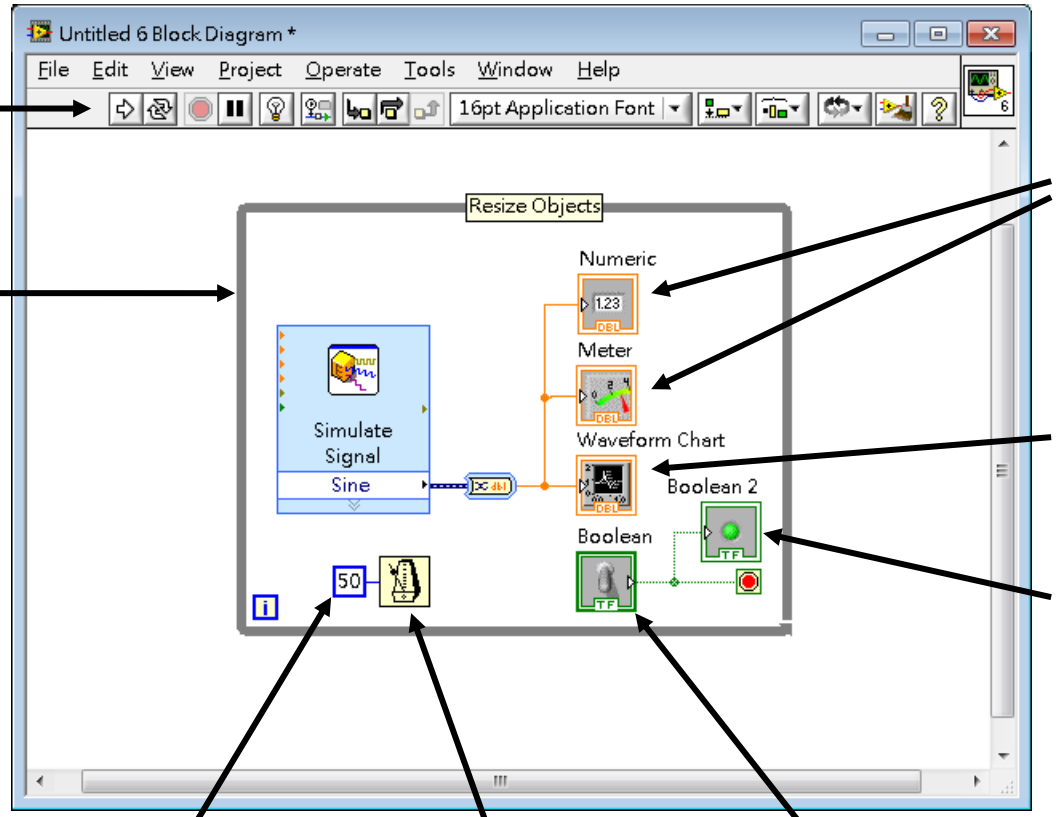

Front Panel Toolbar
Untitled 6 Front Panel *
File Edit View Project Operate Tools Window Help
16pt Application Font
Icon
Boolean Control
Boolean
Boolean 2
Numeric
Numeric
Meter
0
2
4
6
8
10
Waveform Chart
Plot 0
Amplitude
10
5
0
-5
-10
0
5
Time
Waveform Graph

Front Panel--控制選單



Modern
- --Numeric
- --Boolean
- --String
- --Array&Cluster
- --Graph
- --Enum
- --I/O

Block Diagram



Block Diagram Toolbar

While Loop Structure

Numeric Indicator

Graph Terminal

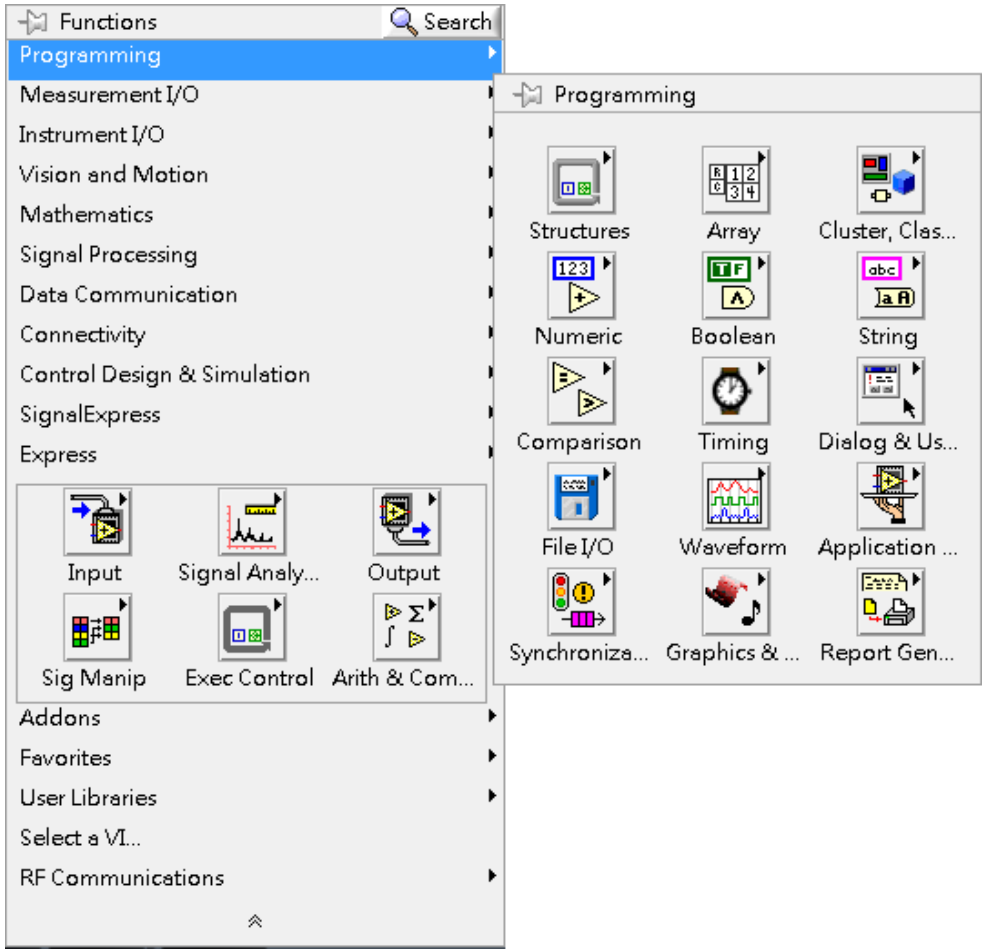
Boolean

Numeric Constant

Timing Function

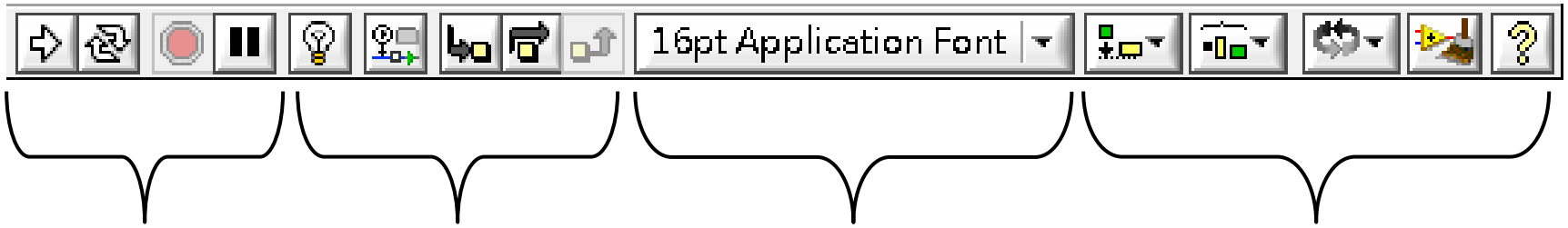
Boolean Control

Block Diagram--控制選單



Programming
- --Structures
- --Array
- --Cluster
- --Numeric
- --Boolean
- --String
- --Comparision
- --Timing
- --File I/O

Toolbar



執行

連續執行

中止程式

暫停/繼續

執行細流

測值探針

字體設定

調準、對準

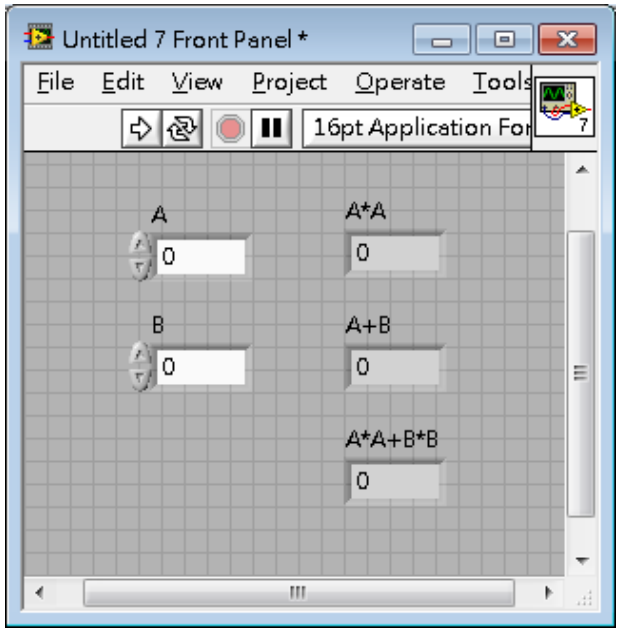
分佈

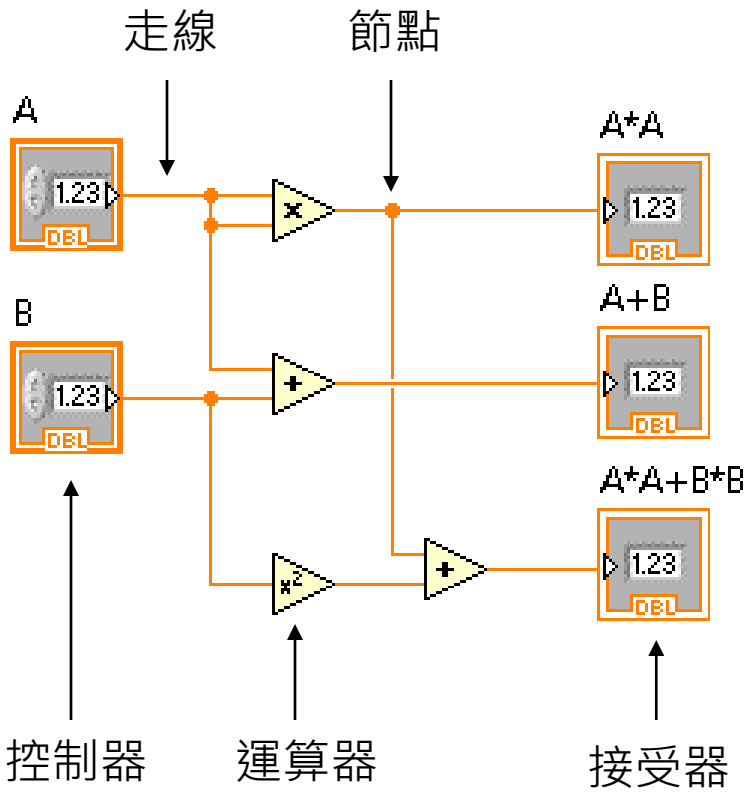
Resize ring

自動整理

Context Help

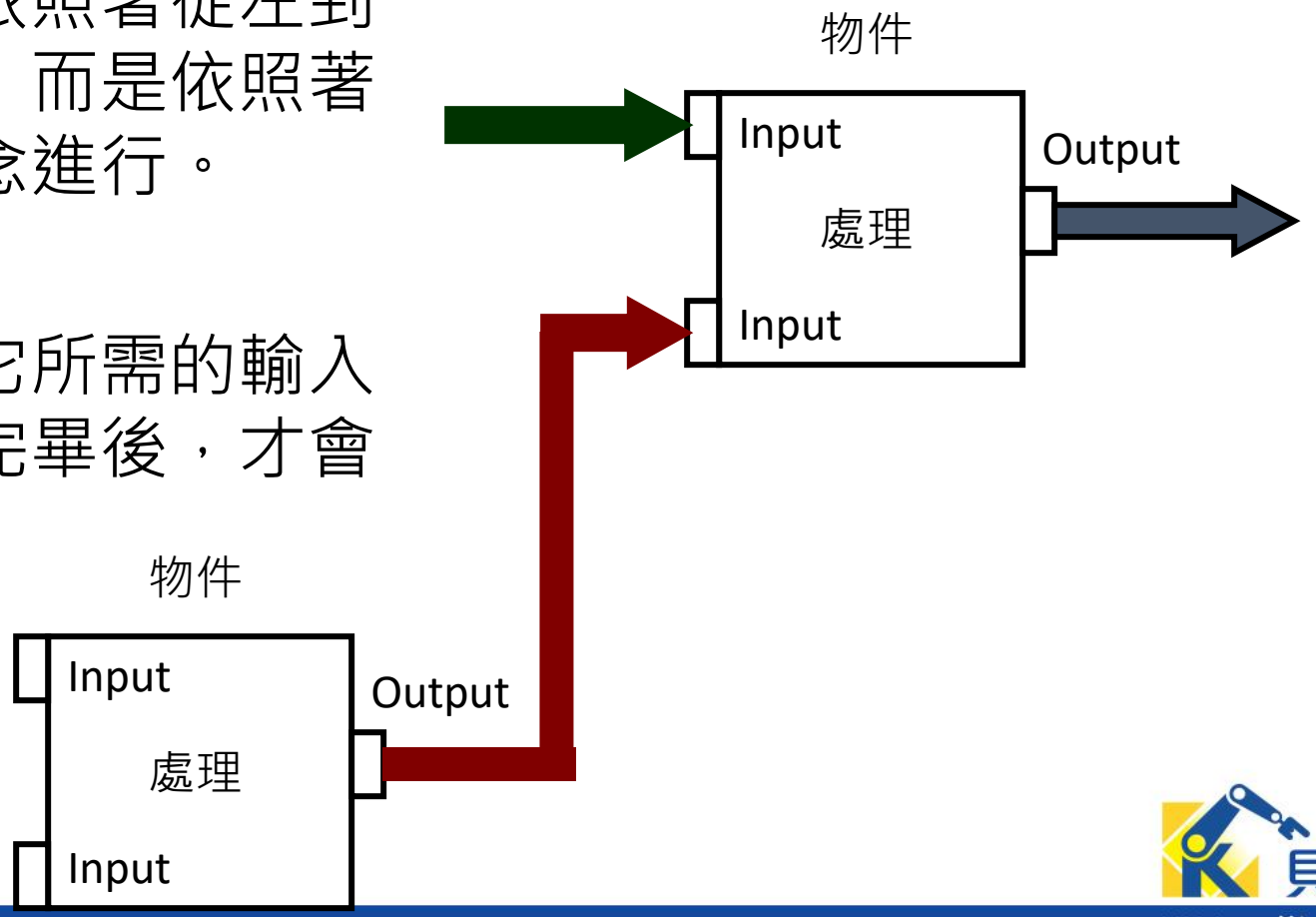
建立一個VI


Untitled 7 Front Panel *
File Edit View Project Operate Tools
16pt Application For
A
0
A*A
0
B
0
A+B
0
A*A+B*B
0


走線
節點
A
1.23
DBL
B
1.23
DBL
A*A
1.23
DBL
A+B
1.23
DBL
A*A+B*B
1.23
DBL
控制器
運算器
接受器

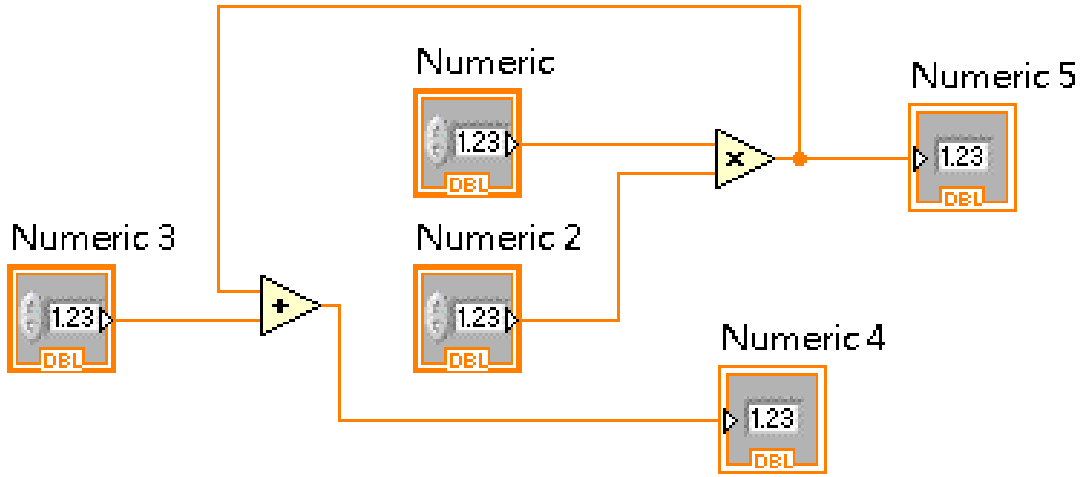
資料流程式設計

- 在線上流程圖中，程式的執行並不是依照著從左到右的順序走，而是依照著資料流的概念進行。
- 節點要等到它所需的輸入端全部運行完畢後，才會接著運作。

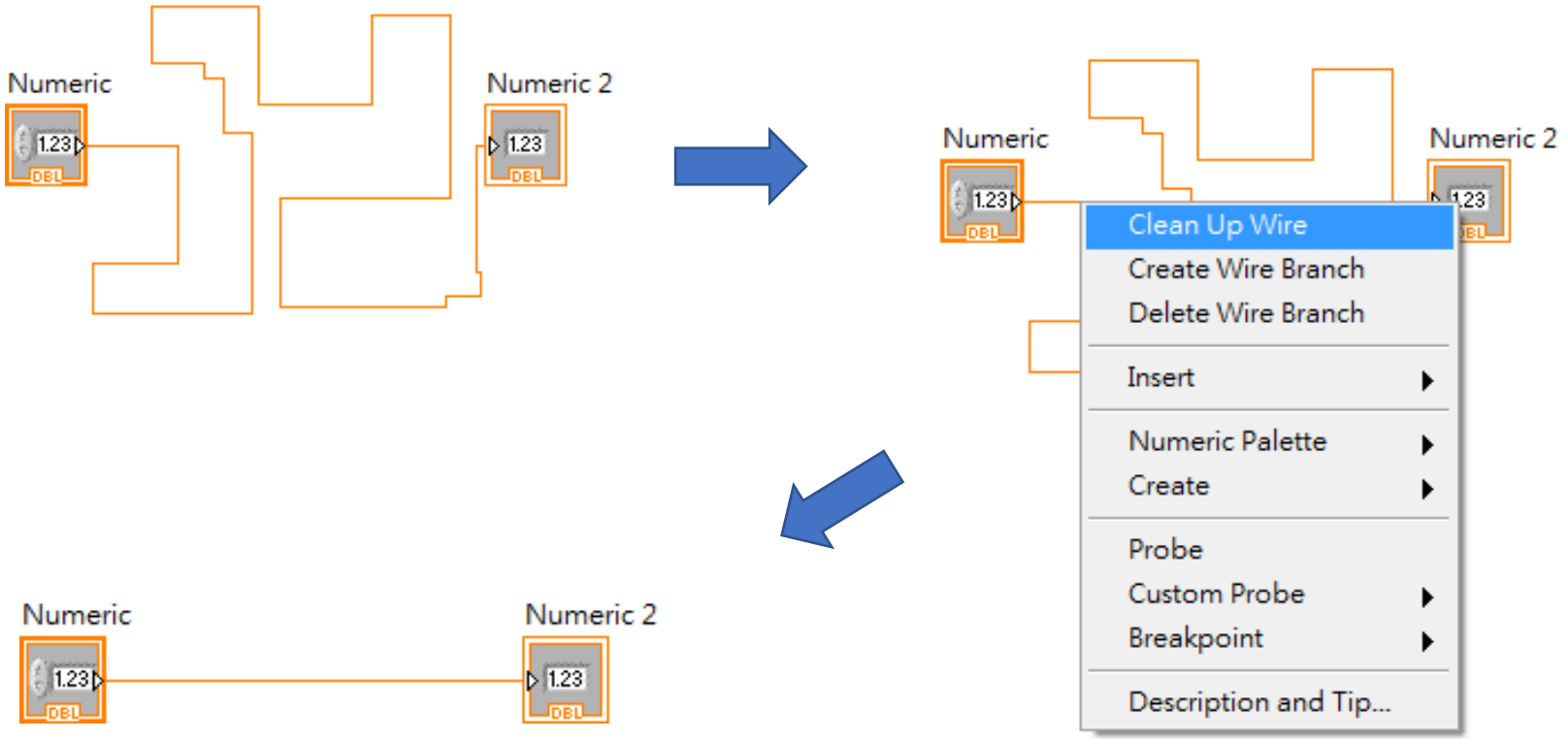


範例

- 請解說以下的程式流程。

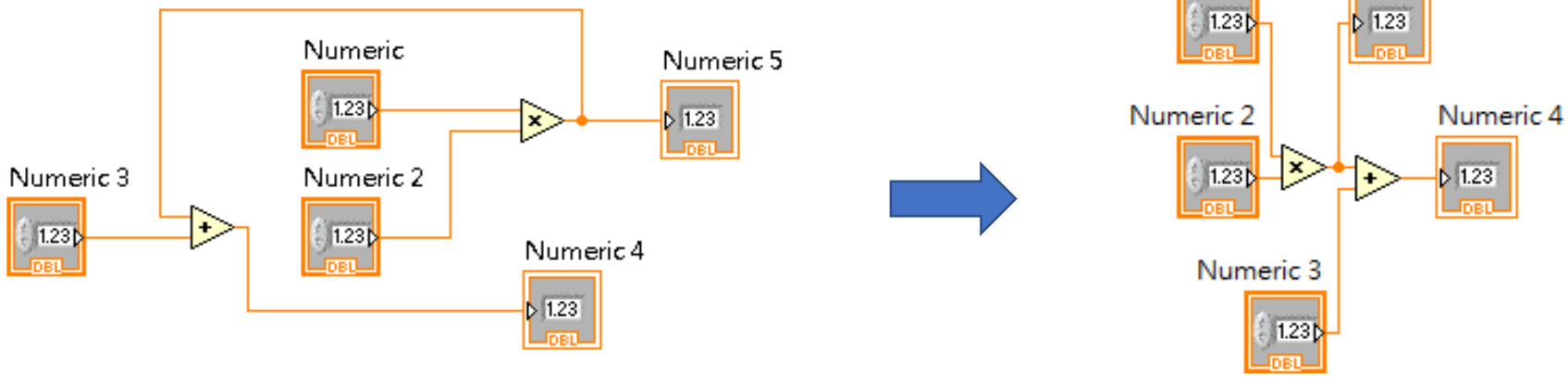


整理走線

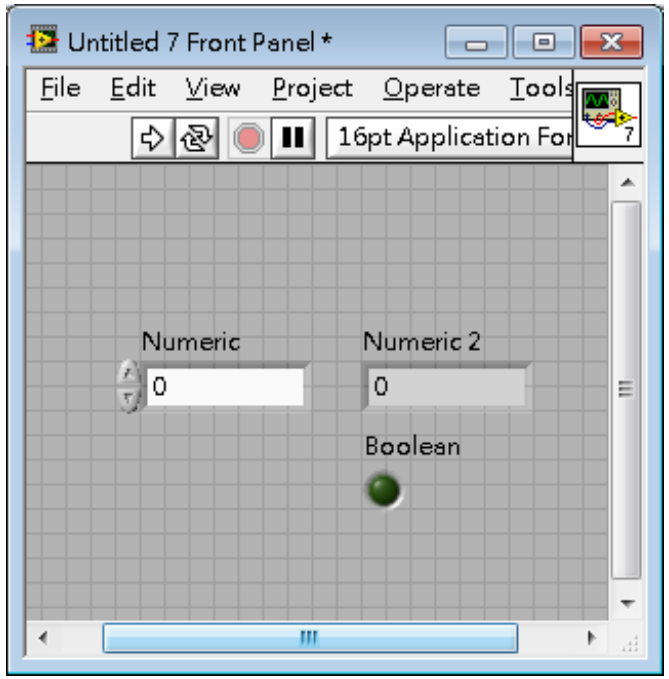

Numeric
Numeric 2
Clean Up Wire
Create Wire Branch
Delete Wire Branch
Insert
Numeric Palette
Create
Probe
Custom Probe
Breakpoint
Description and Tip...
Numeric
Numeric 2

整理走線

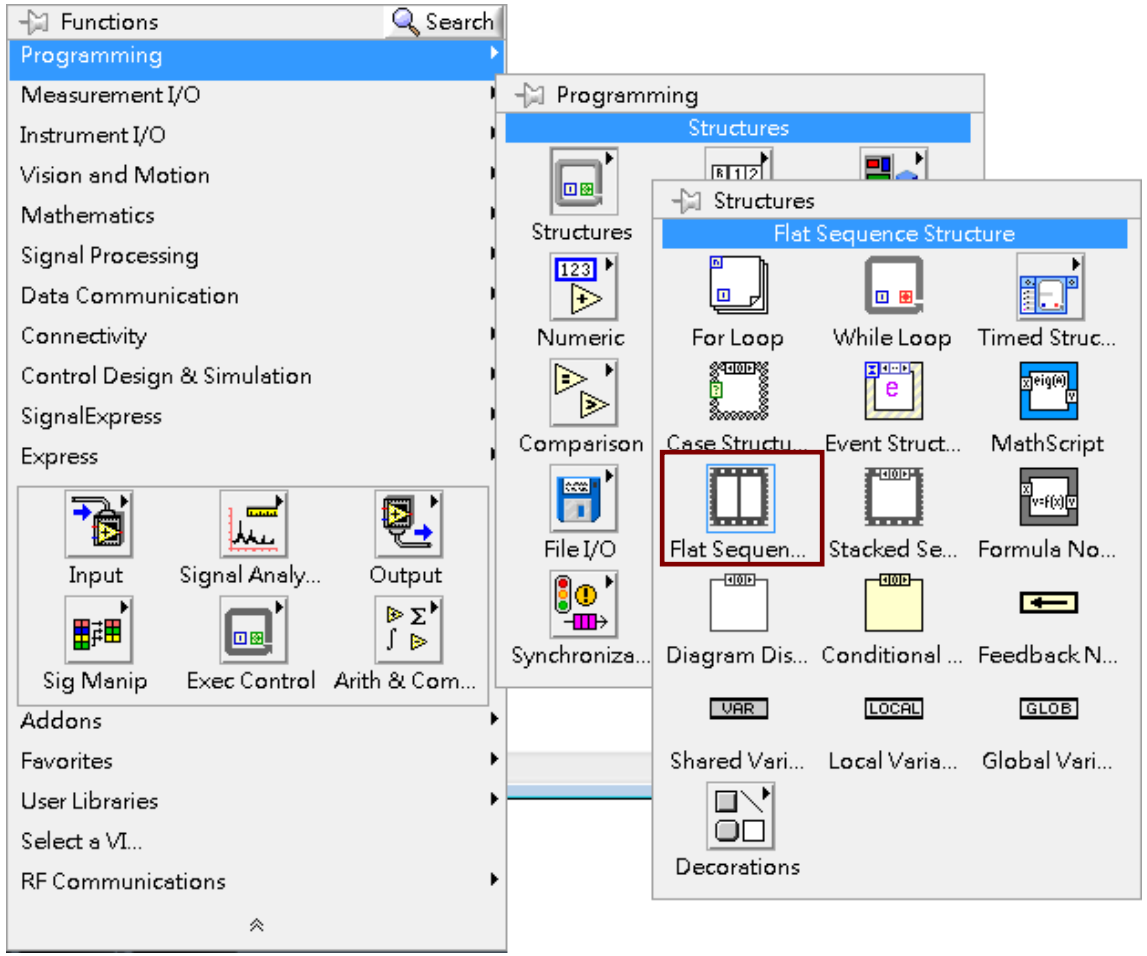

16pt Application Font


Numeric
Numeric 5
Numeric 3
Numeric 2
Numeric 4
Numeric
Numeric 5
Numeric 2
Numeric 4
Numeric 3

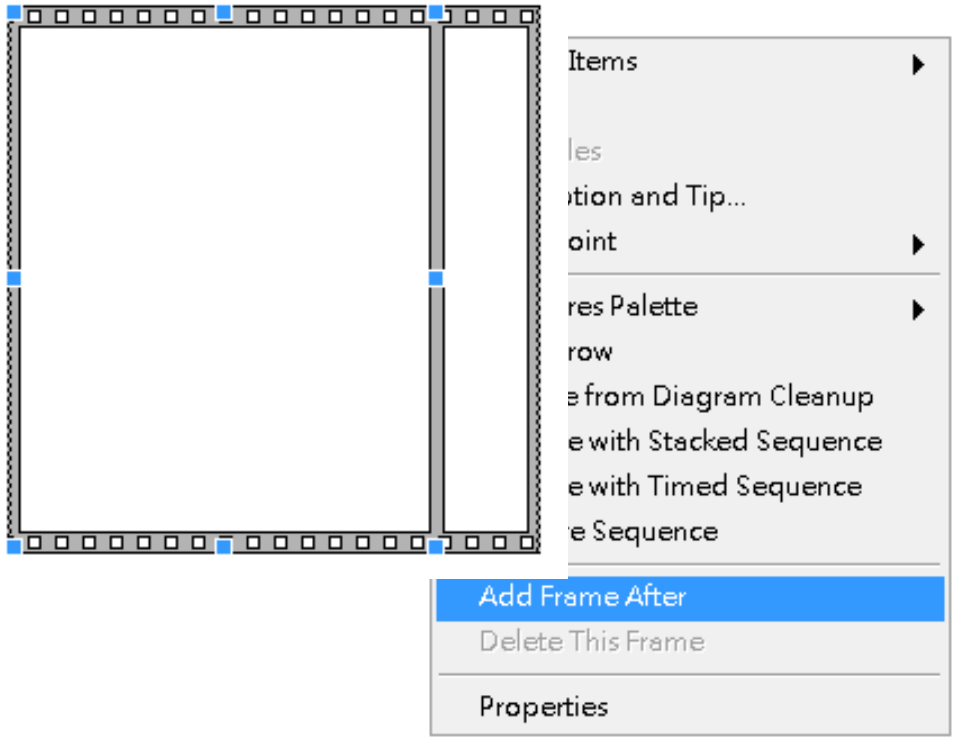
沒有接腳該如何達到資料流??

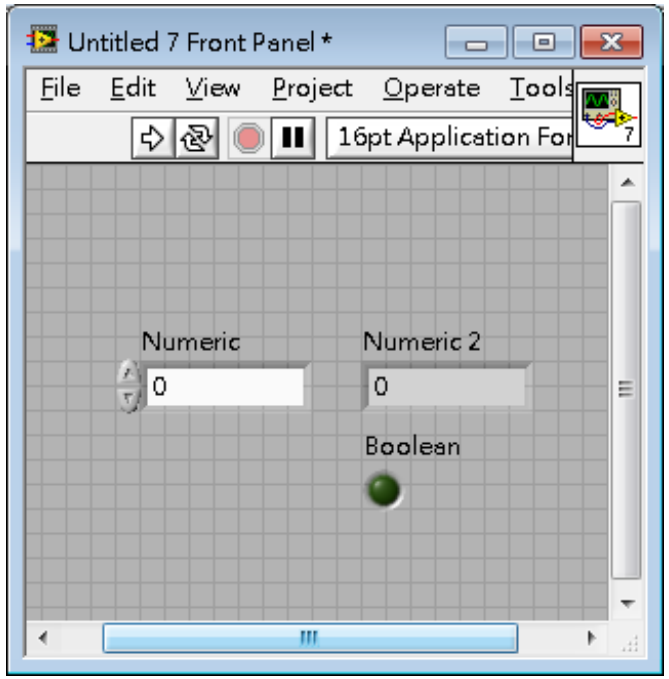


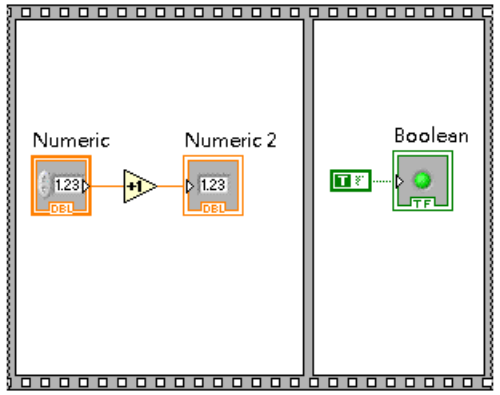
建立Sequence Structure



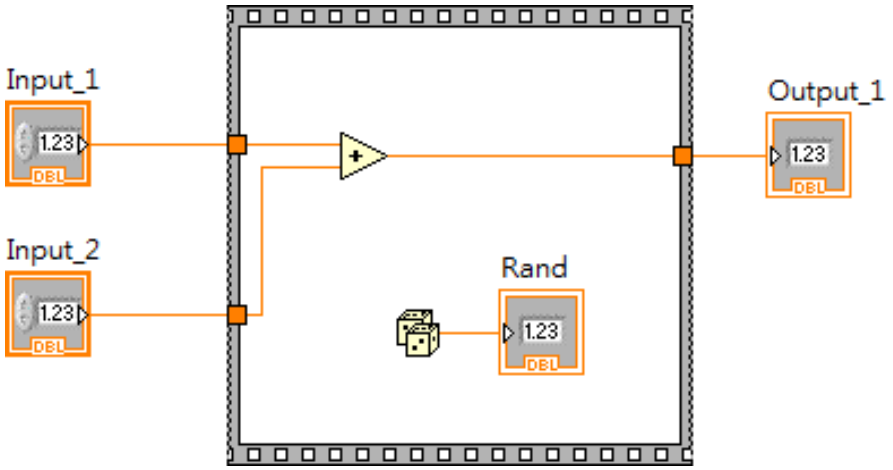
Add Sequence Frame



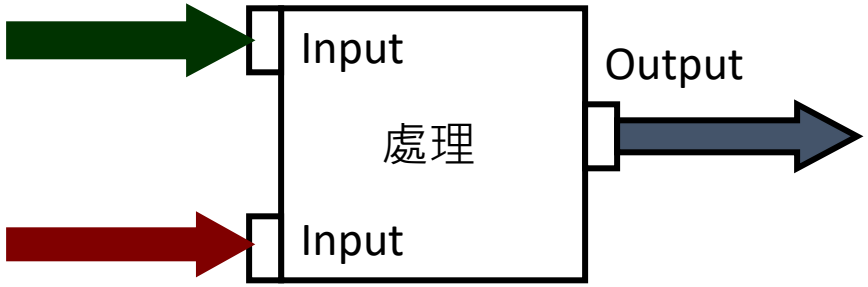

Untitled 7 Front Panel *
File Edit View Project Operate Tools
16pt Application Fo
Numeric
0
Numeric 2
0
Boolean


Numeric
1.23
DBL
Numeric 2
1.23
DBL
Boolean
TF

Structure遵守資料流程式設計



物件

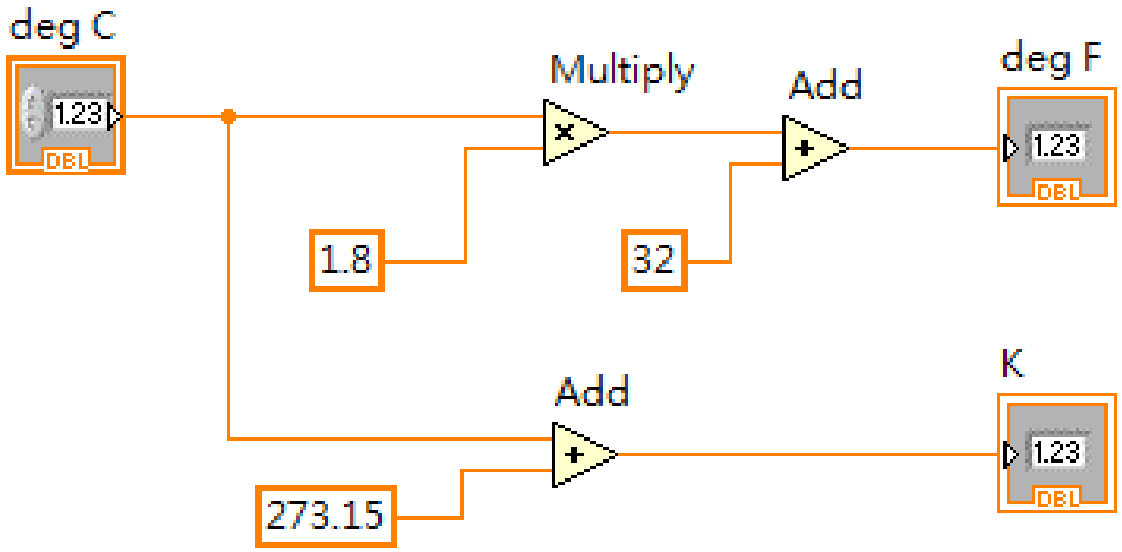


練習一

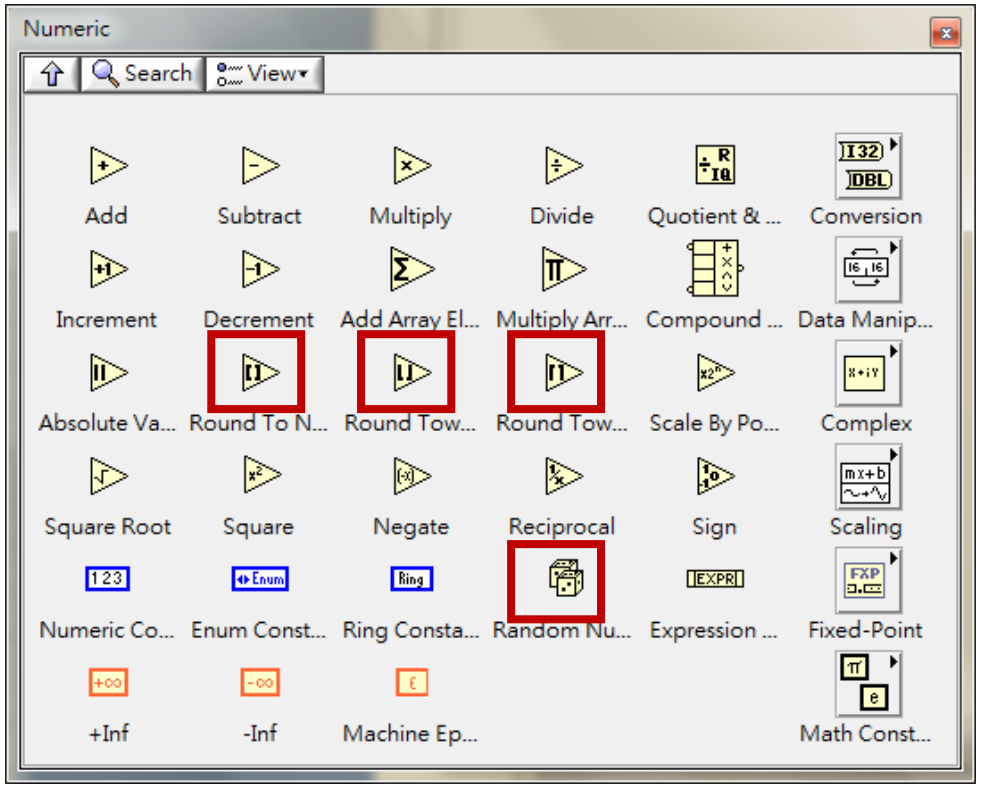
- 在前列面板輸入攝氏溫度值，輸出華氏溫度、與卡氏溫度值。

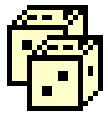
  華氏溫度=攝氏溫度*(9/5)+32
  卡氏溫度=攝氏溫度+273.15

練習一的Block Diagram



Function介紹





產生0-1之間的亂數

四捨五入

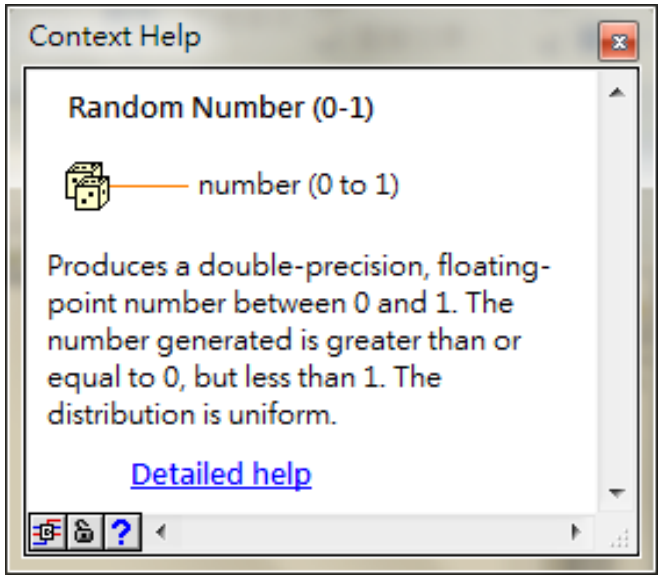
無條件捨去

無條件進位

Context Help Window

- 在使用各種不同的Function時，若不清楚其Function的功能或是使用設定，可以叫出Context Help Window，叫出的方法為按下Ctrl+H或是點選Tool Bar最右側

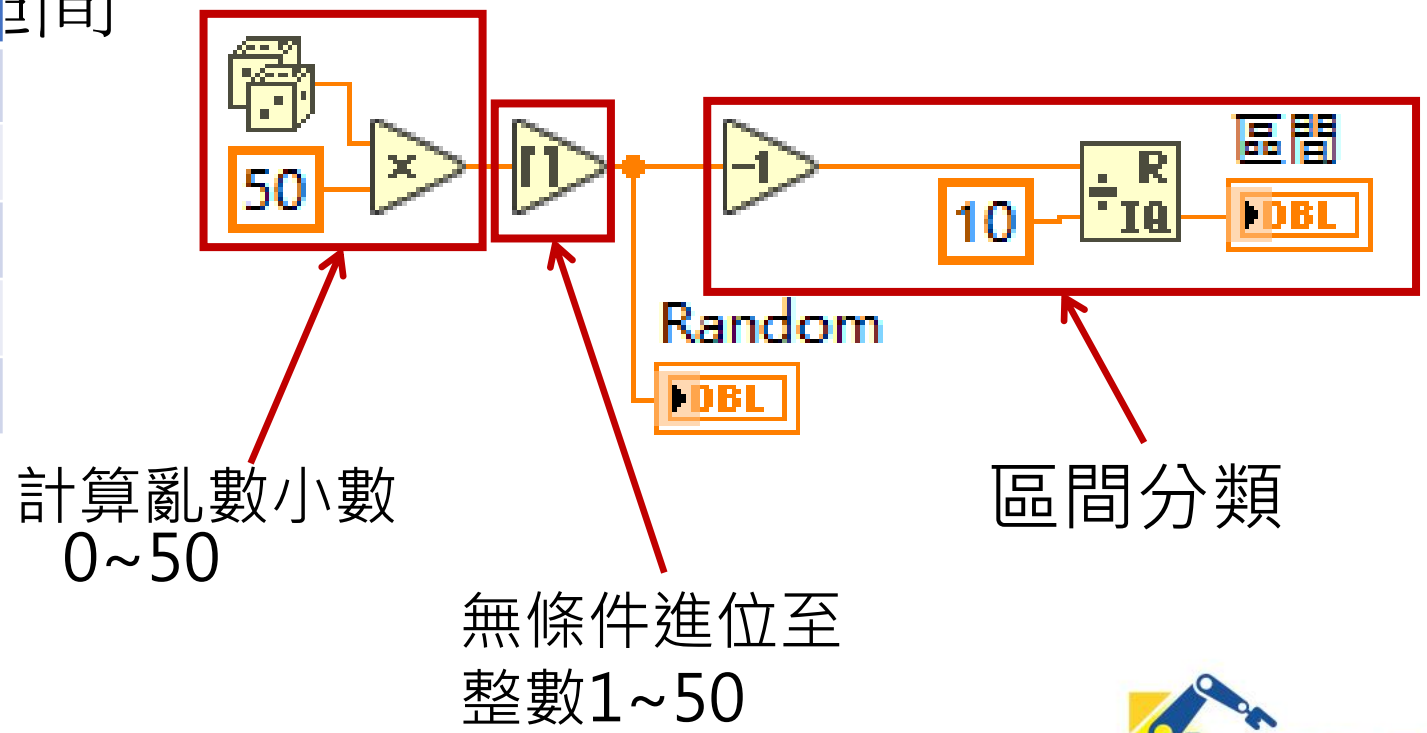
- 當滑鼠移動到Function上時，Context Help Window會自動顯示出該物件的簡略說明，若有需求可點選Detailed Help來查詢詳細說明。



練習二 亂數區間

隨機產生一個1~50的數字

範圍	區間
1~10	0
11~20	1
21~30	2
31~40	3
41~50	4



SubVI

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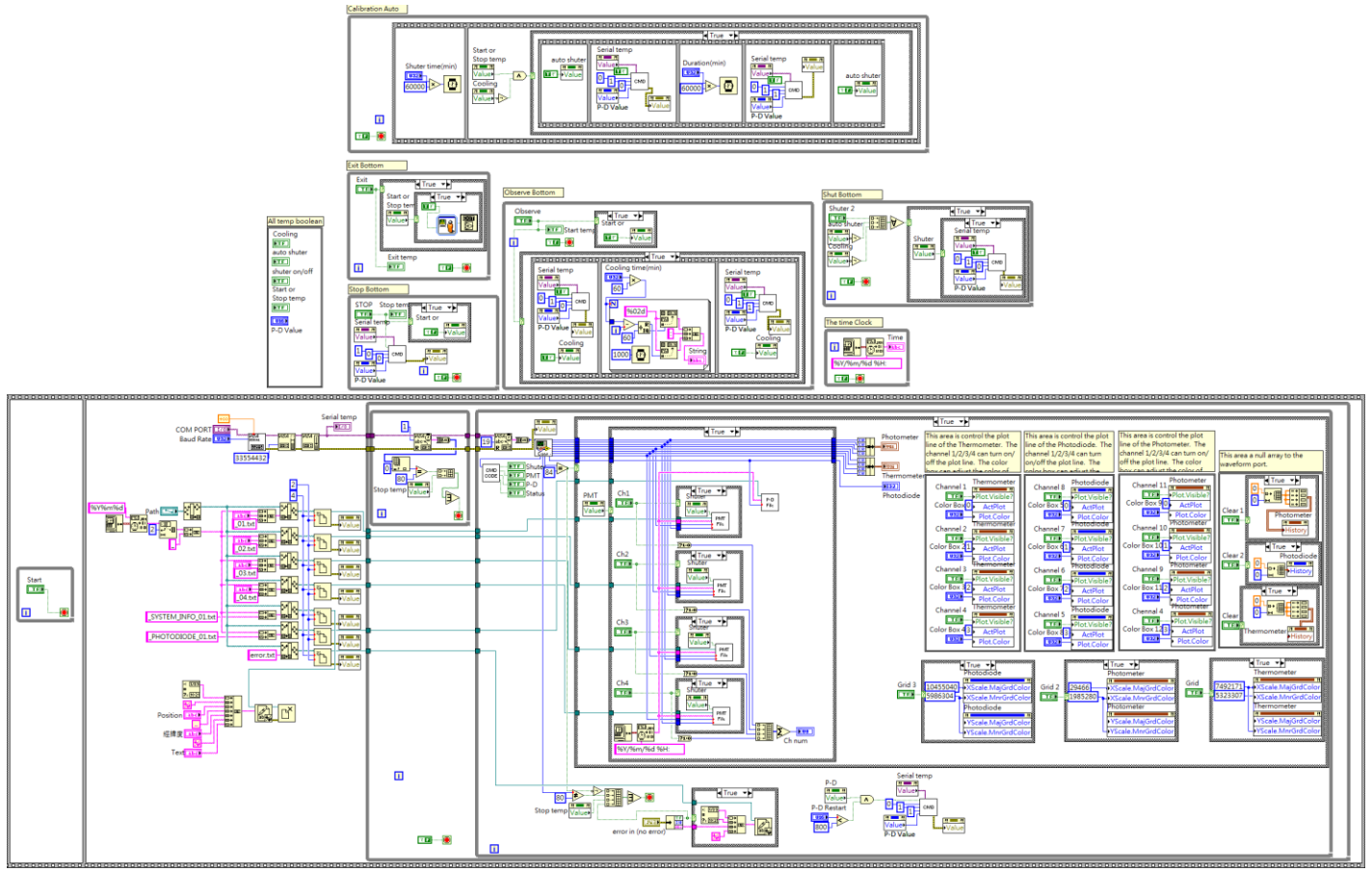
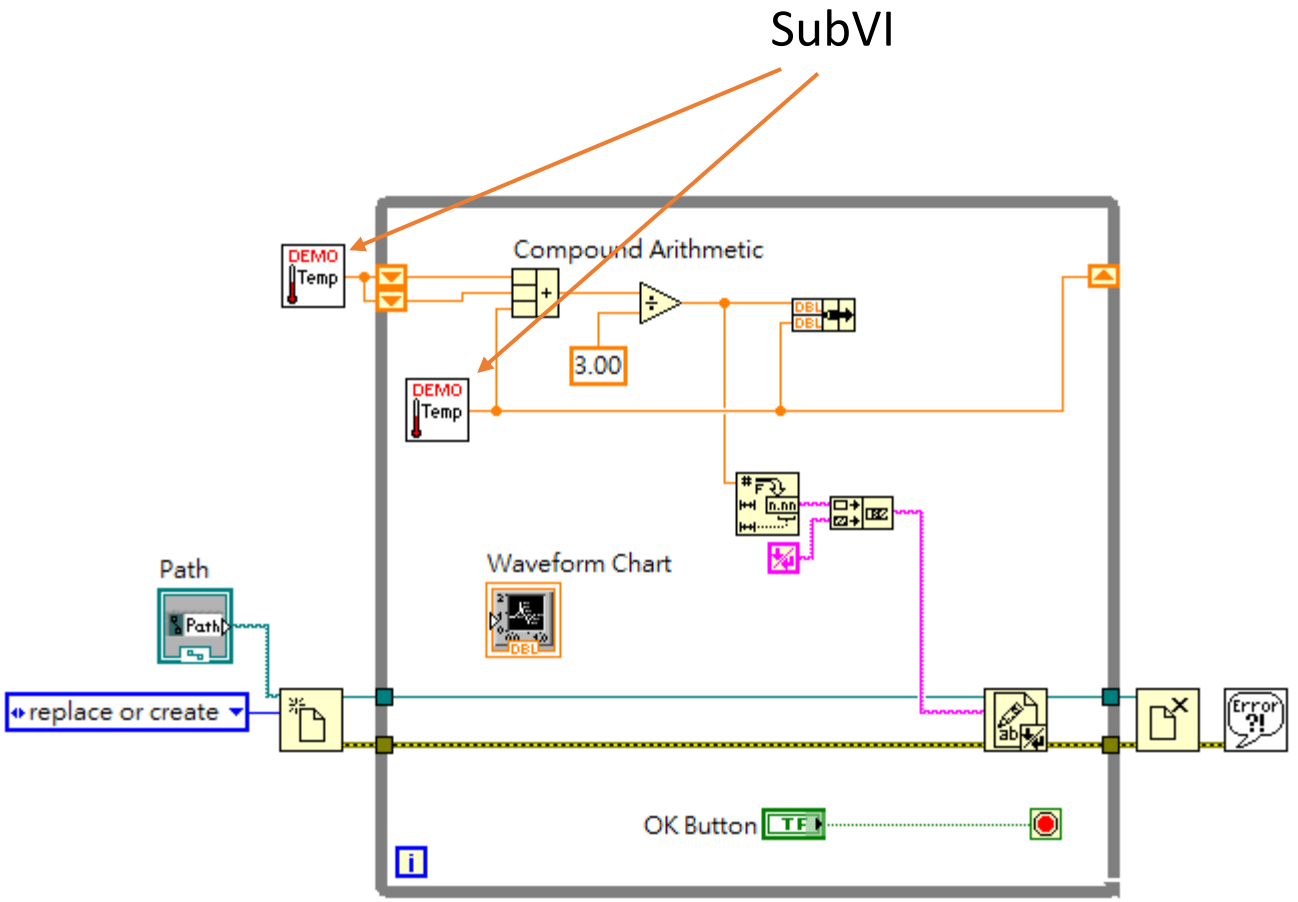
糟糕的程式



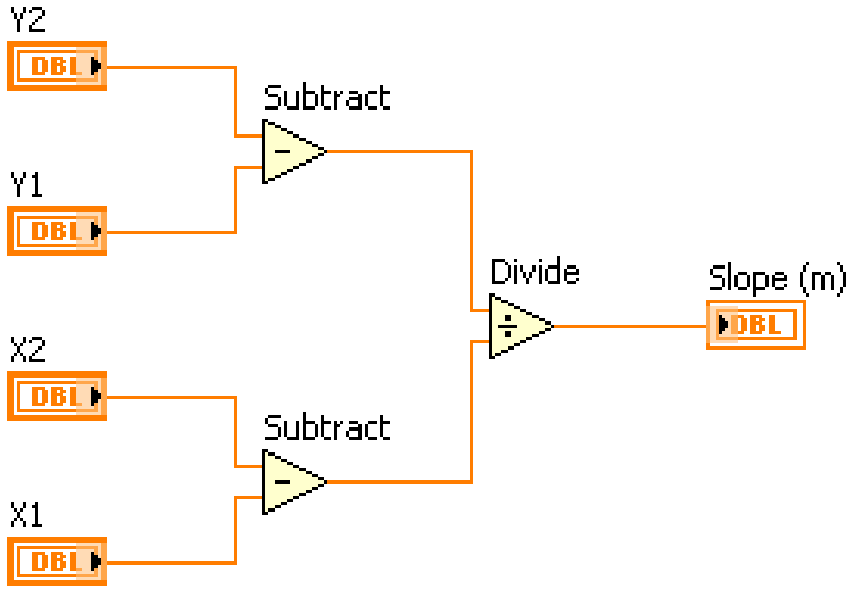
為什麼要使用SubVI

- 某部分的程式常常重複出現
- 將程式模組化，增加可讀性

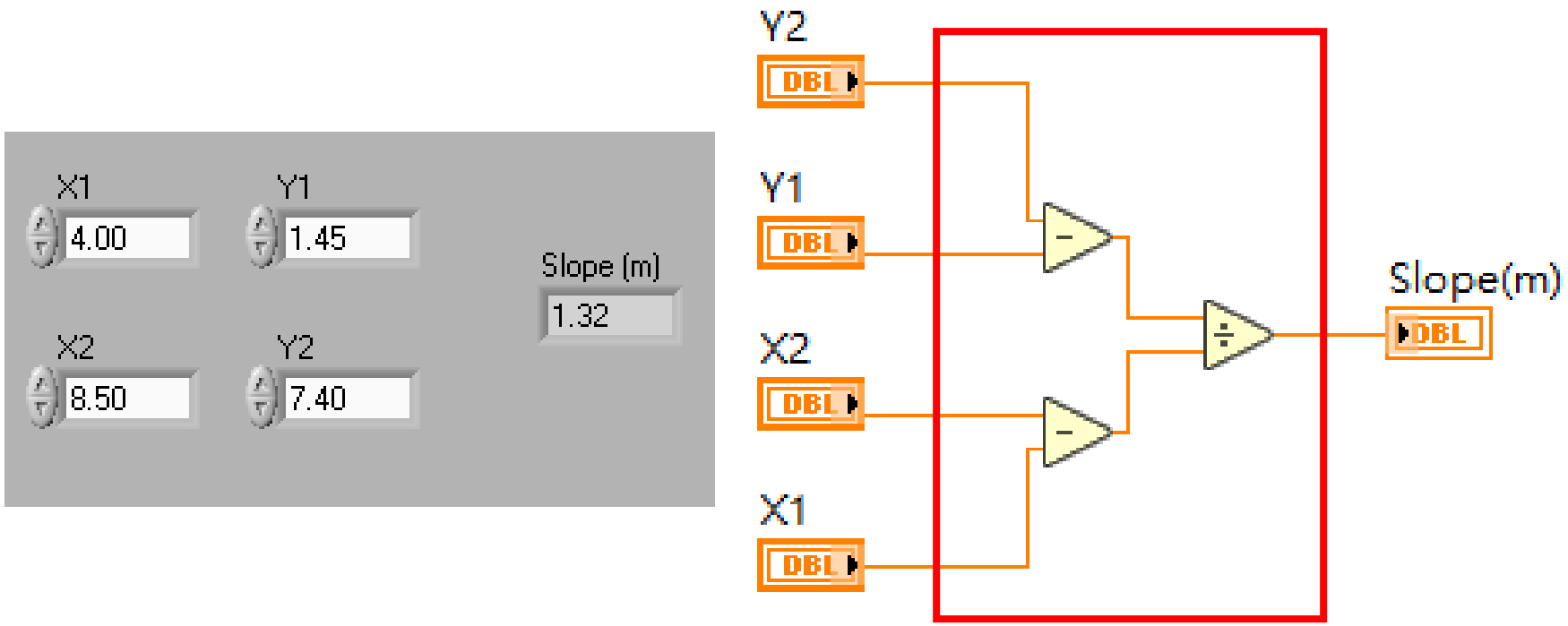
Use SubVI


SubVI
DEMO
Temp
Compound Arithmetic
3.00
DEMO
Temp
Path
Waveform Chart
Path
replace or create
OK Button
TF
Error

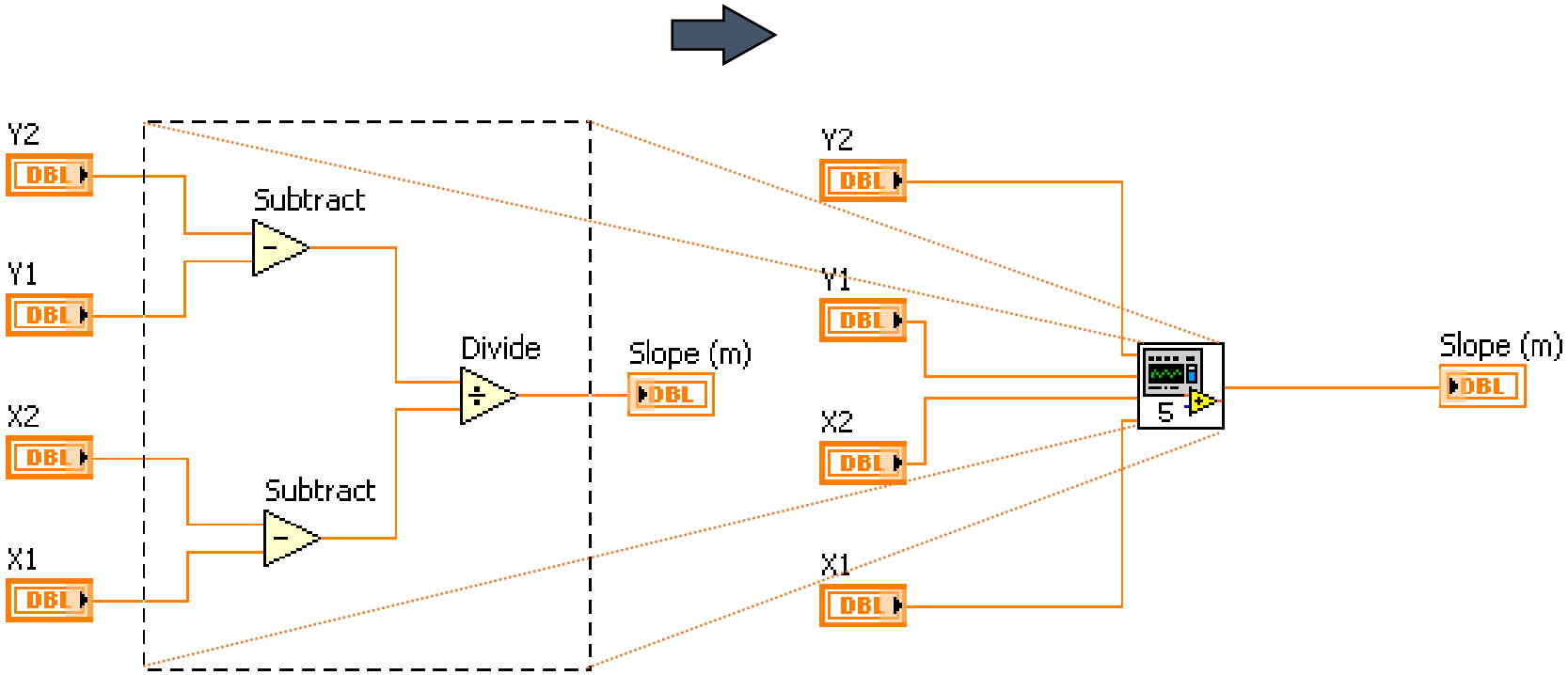
SubVI Example

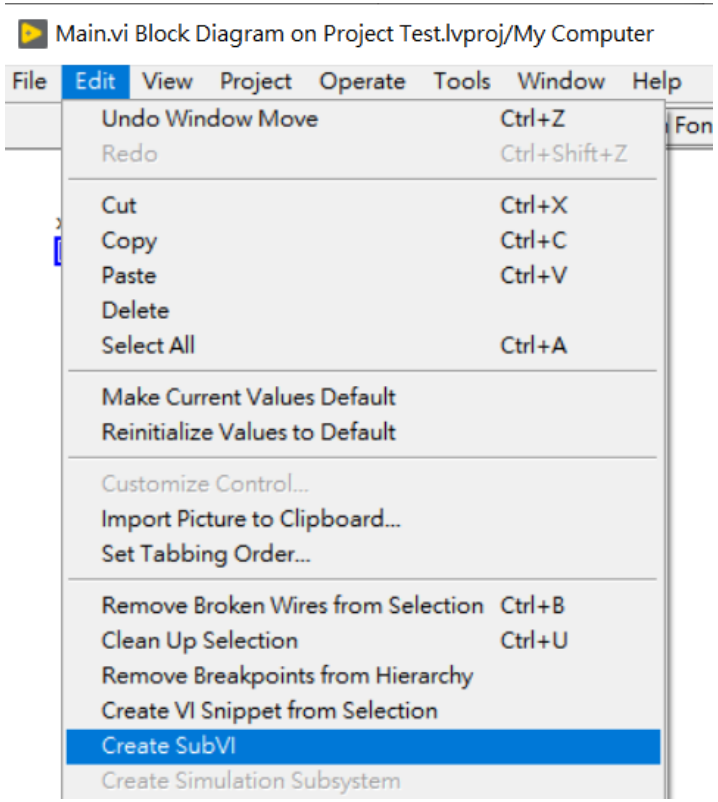


SubVI Example



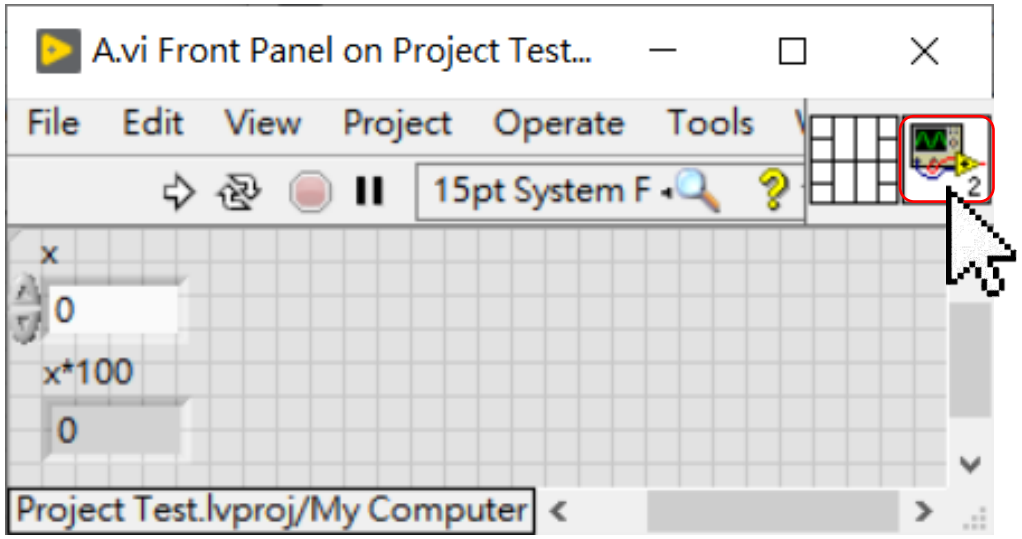
Create SubVI



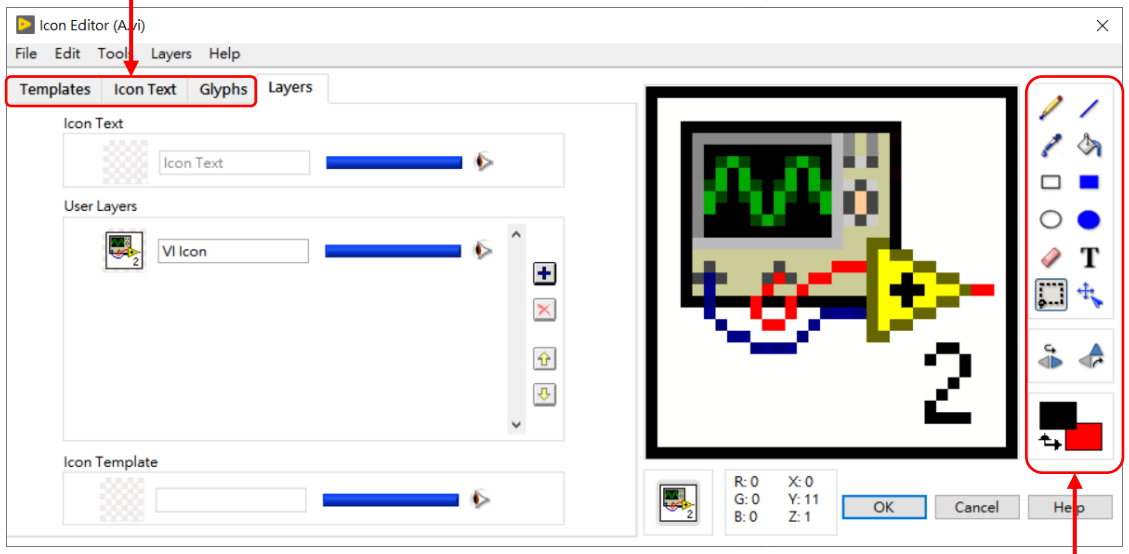


Edit Icon

雙擊Icon即可編輯Icon



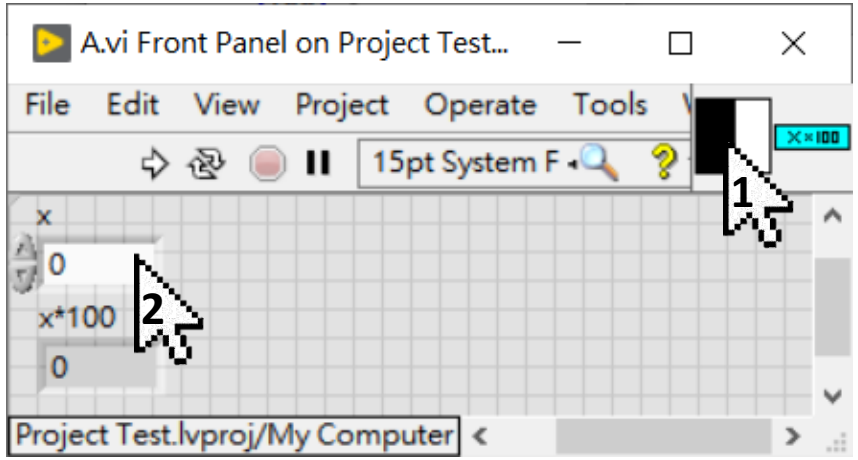
有內建的模板可以使用

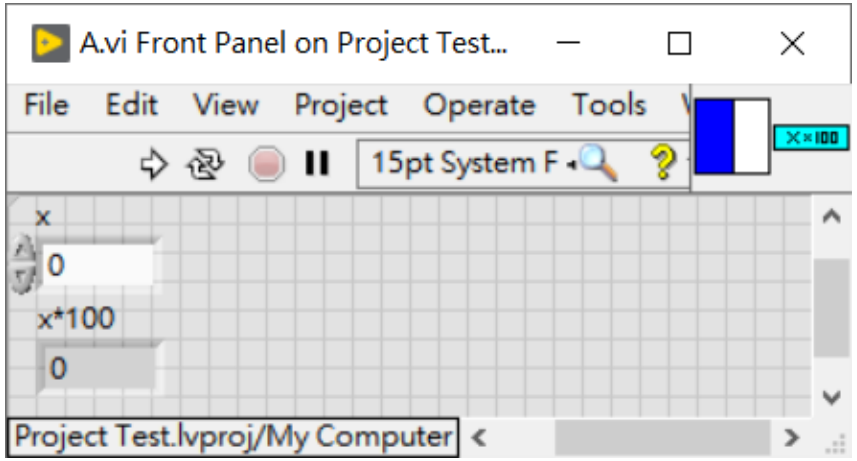


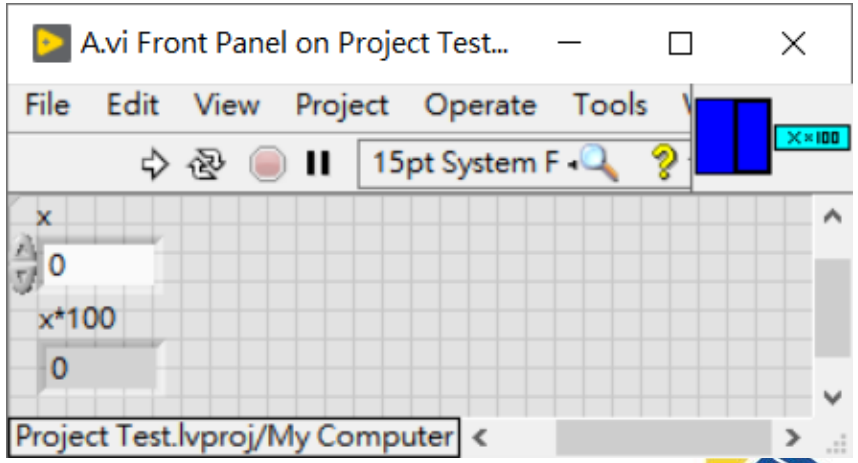
繪圖工具可自行繪製

Terminal 連接

1.單擊接腳(接腳呈黑色)
2.單擊要連接的輸入或輸出







範例

- 試著將之前的練習題改成SubVI。

迴圈Loop

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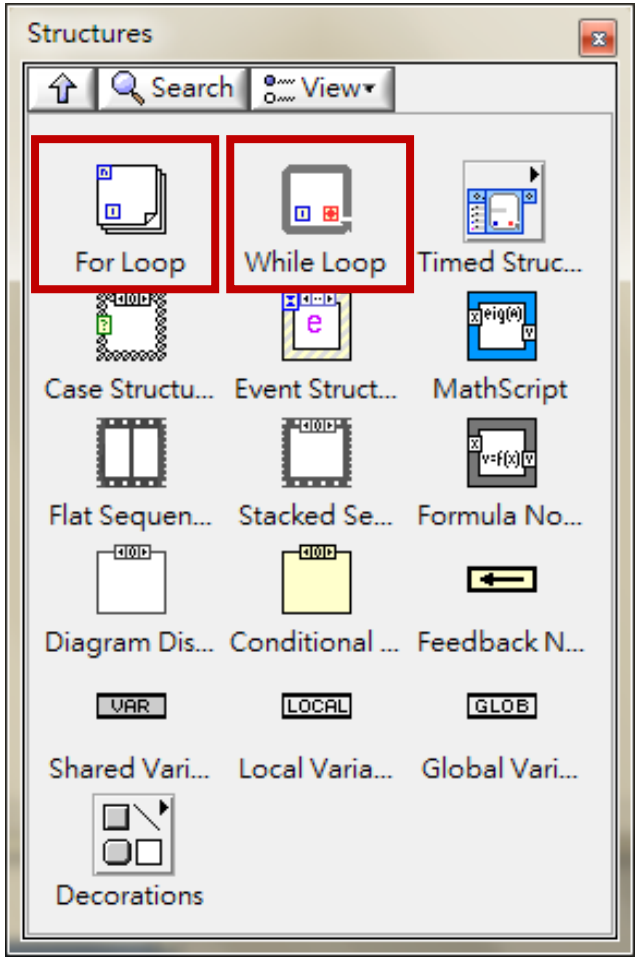
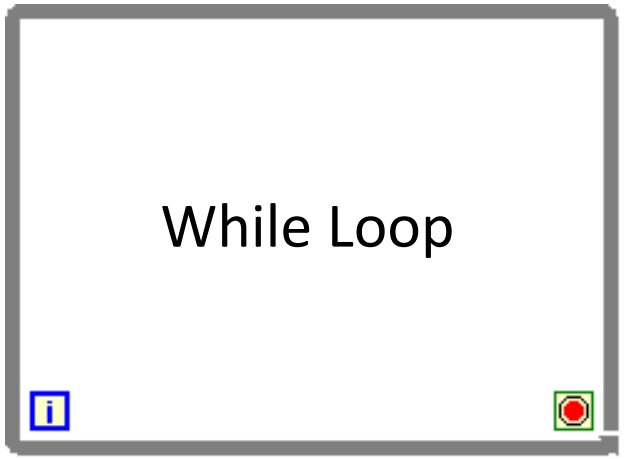
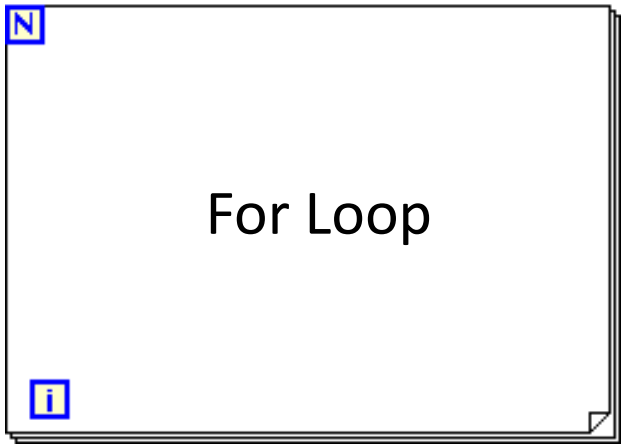
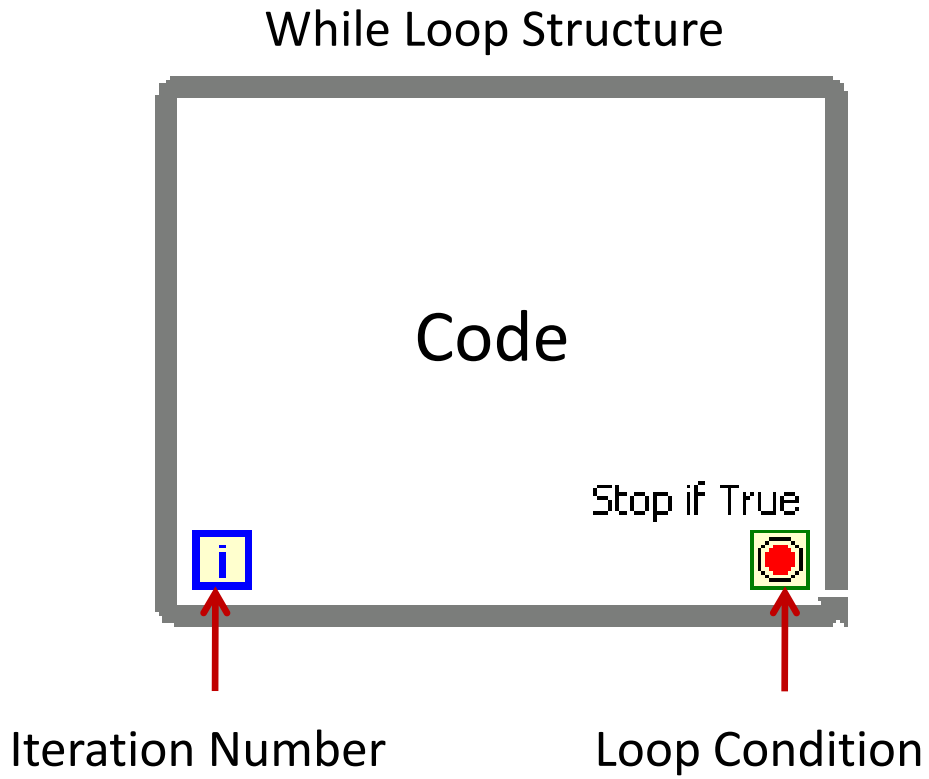
Loop Structure

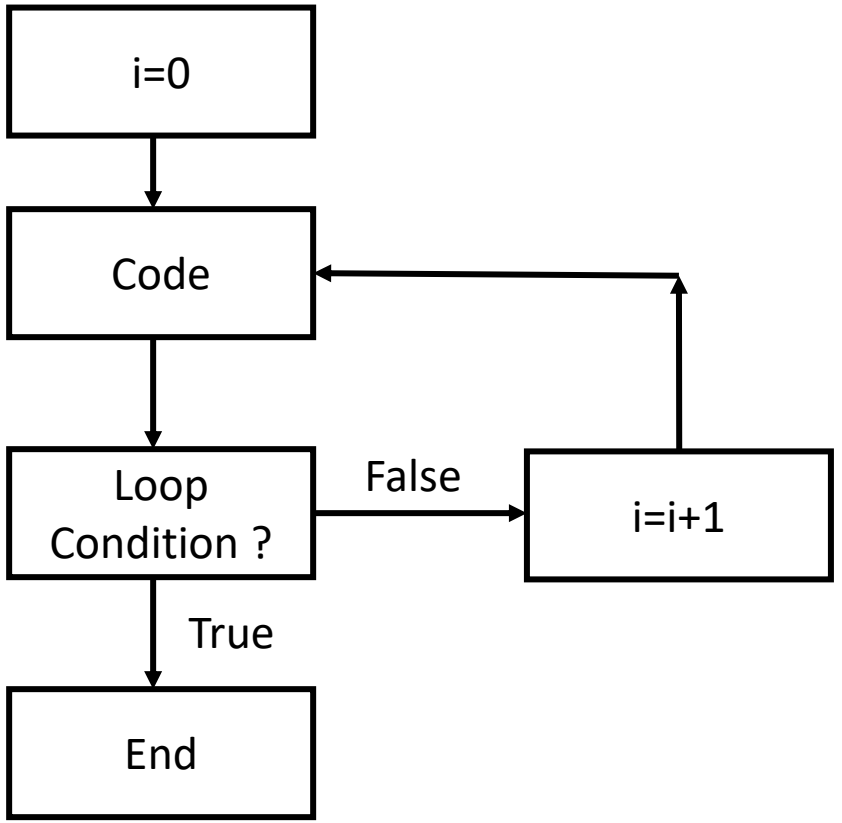




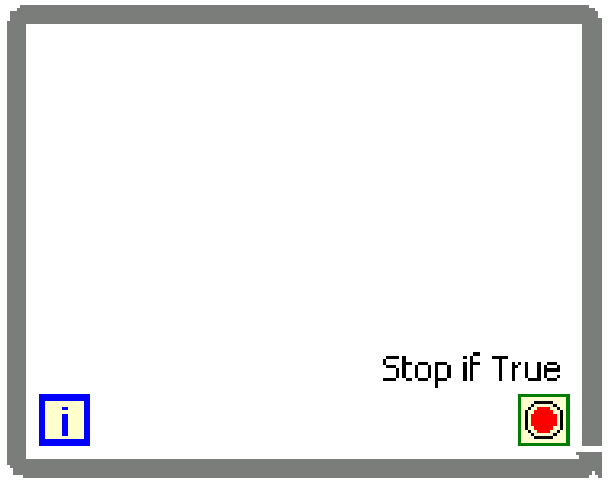


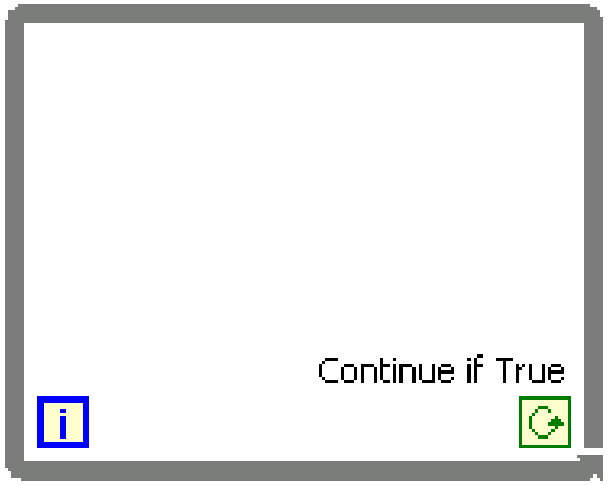
While Loop


While Loop Structure
Code
Stop if True
i
Iteration Number
Loop Condition

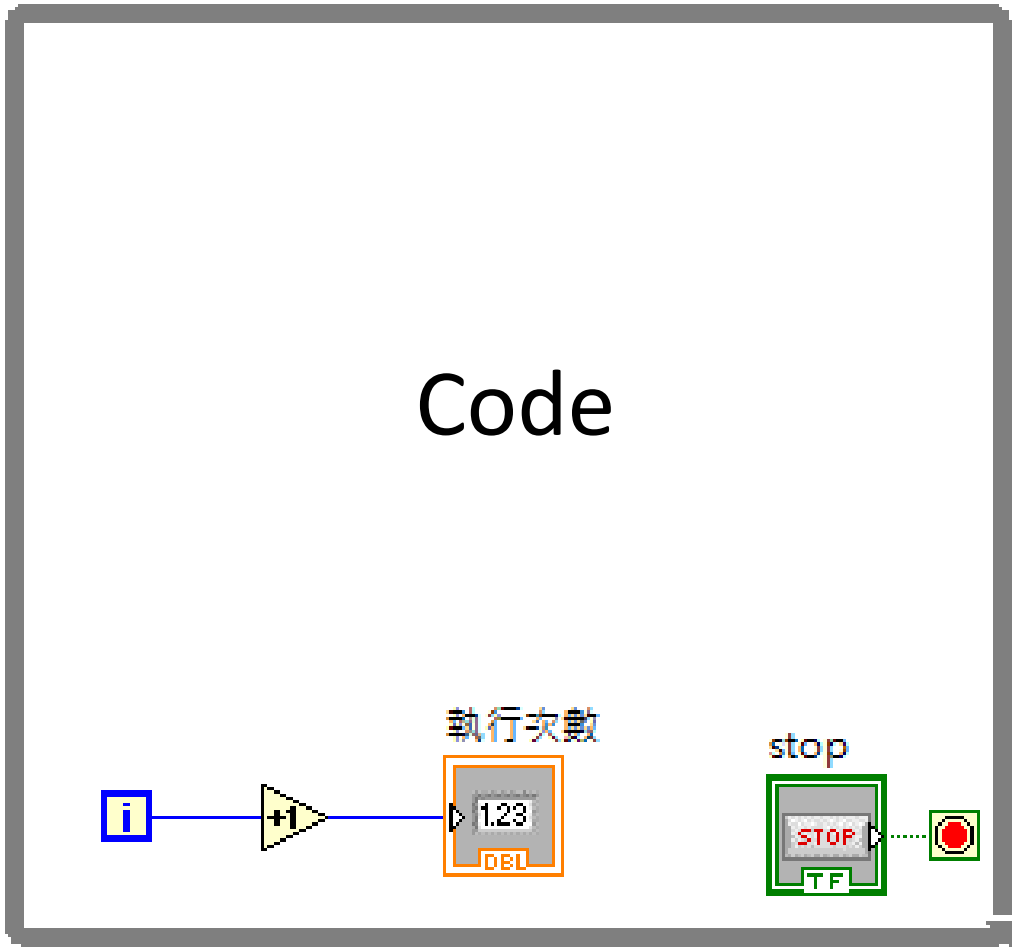

i=0
Code
Loop Condition ?
False
i=i+1
True
End

停止條件設定

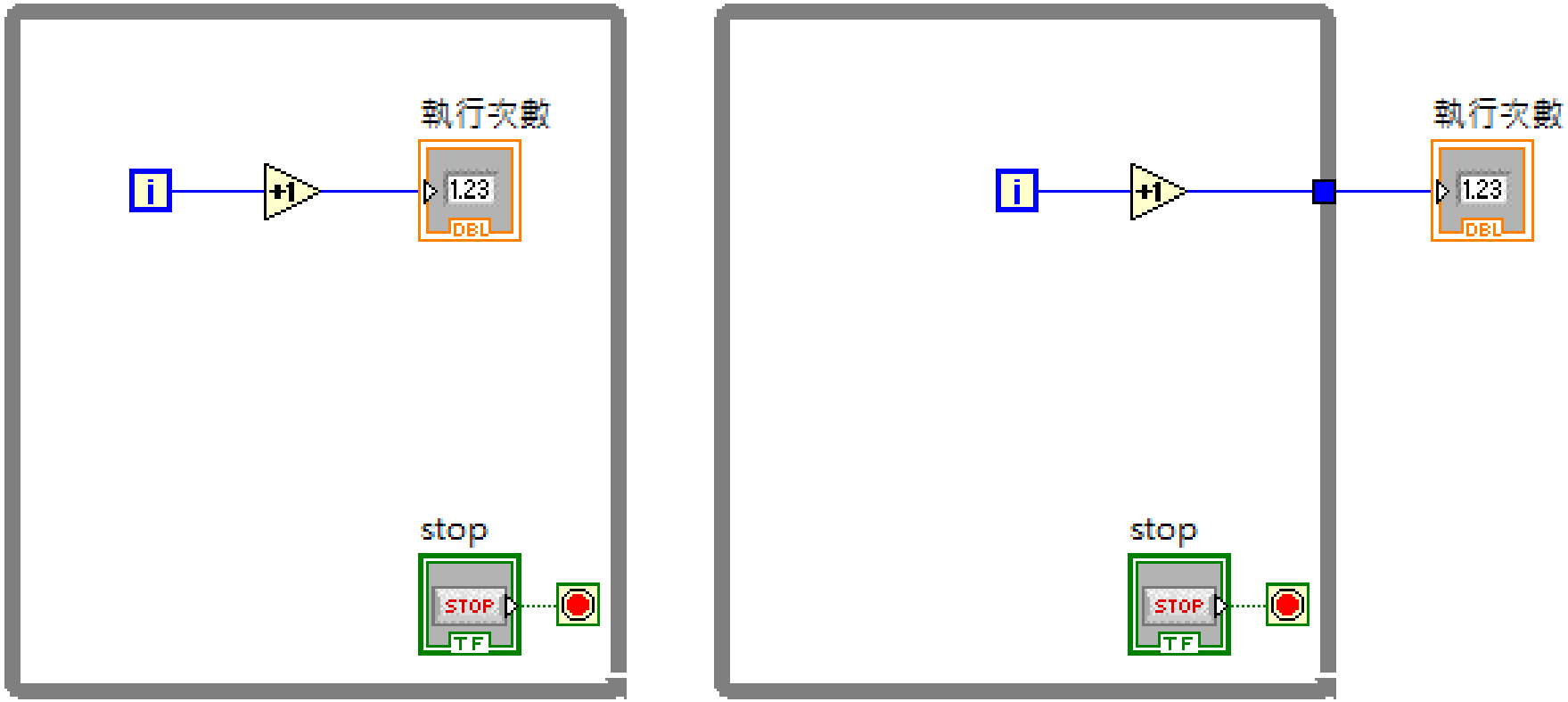




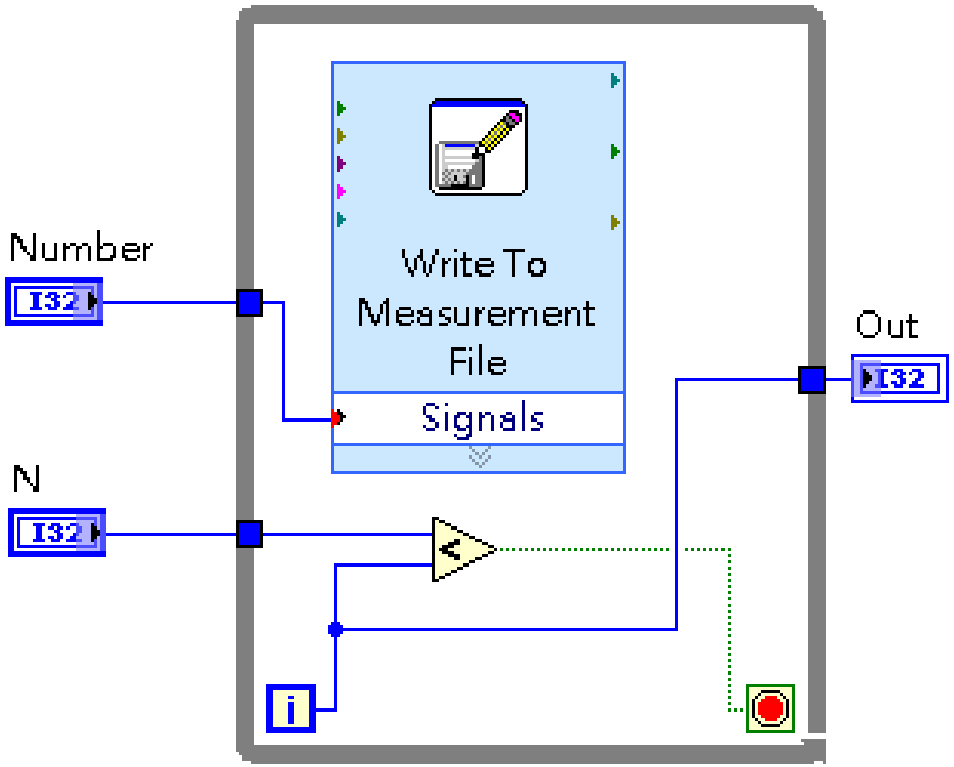
查看迴圈執行次數

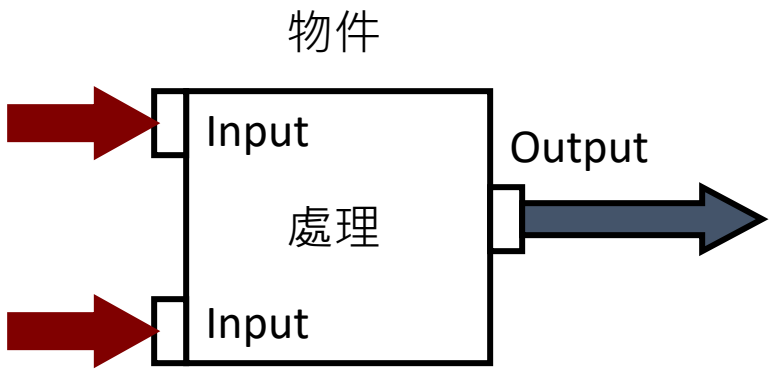


What is the Difference?

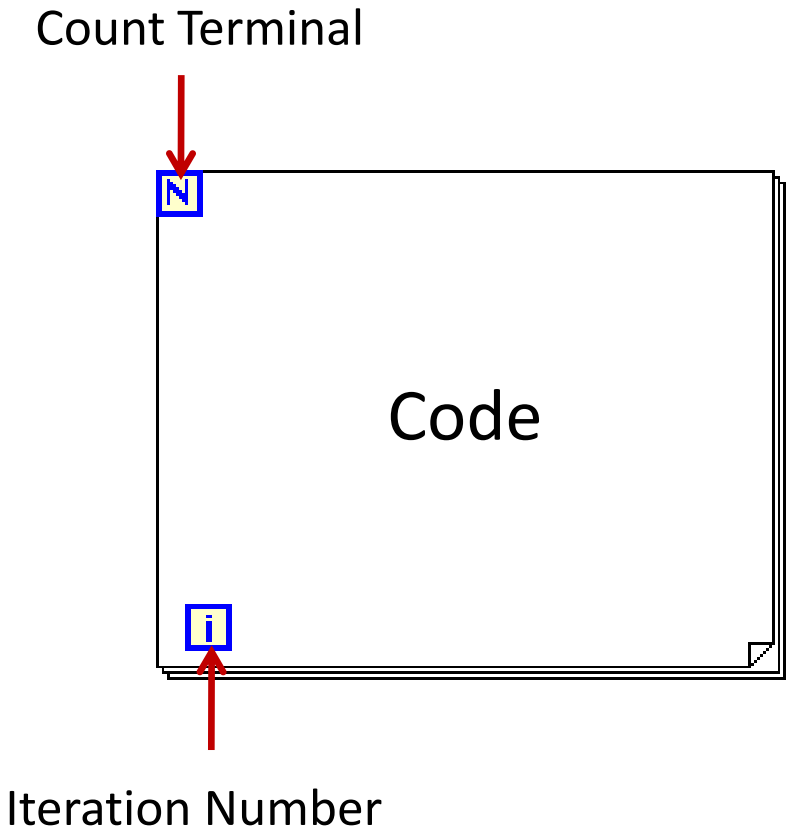


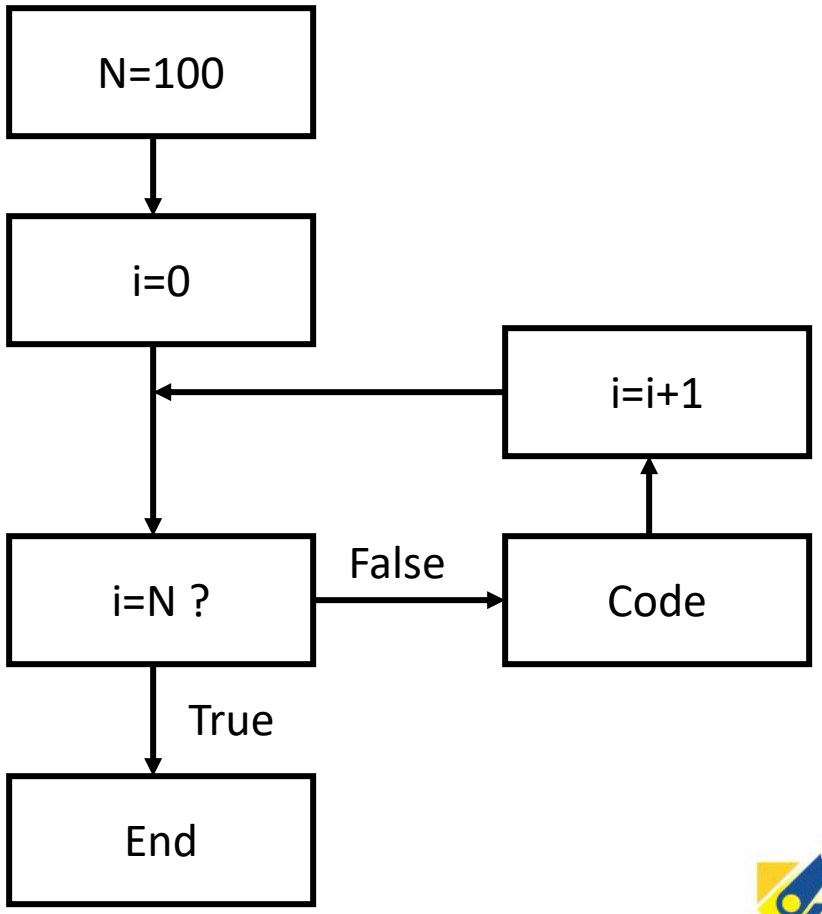
Structure Data Flow



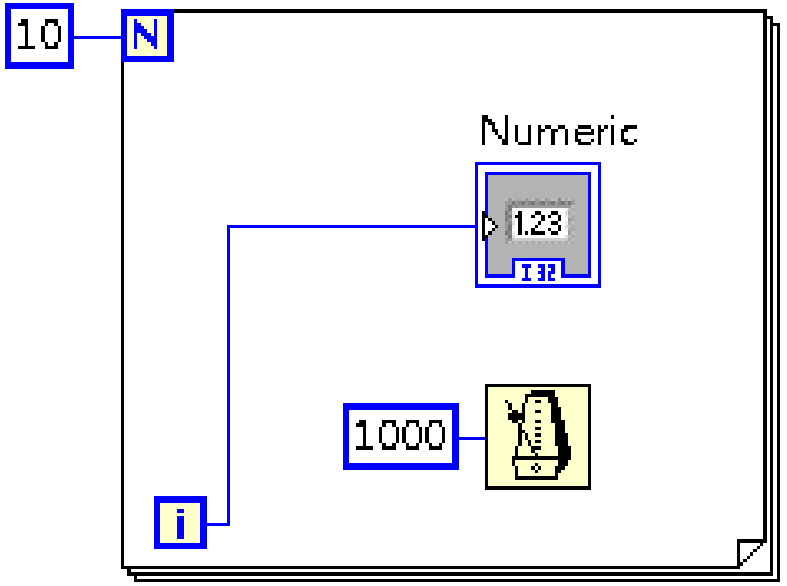


For Loop

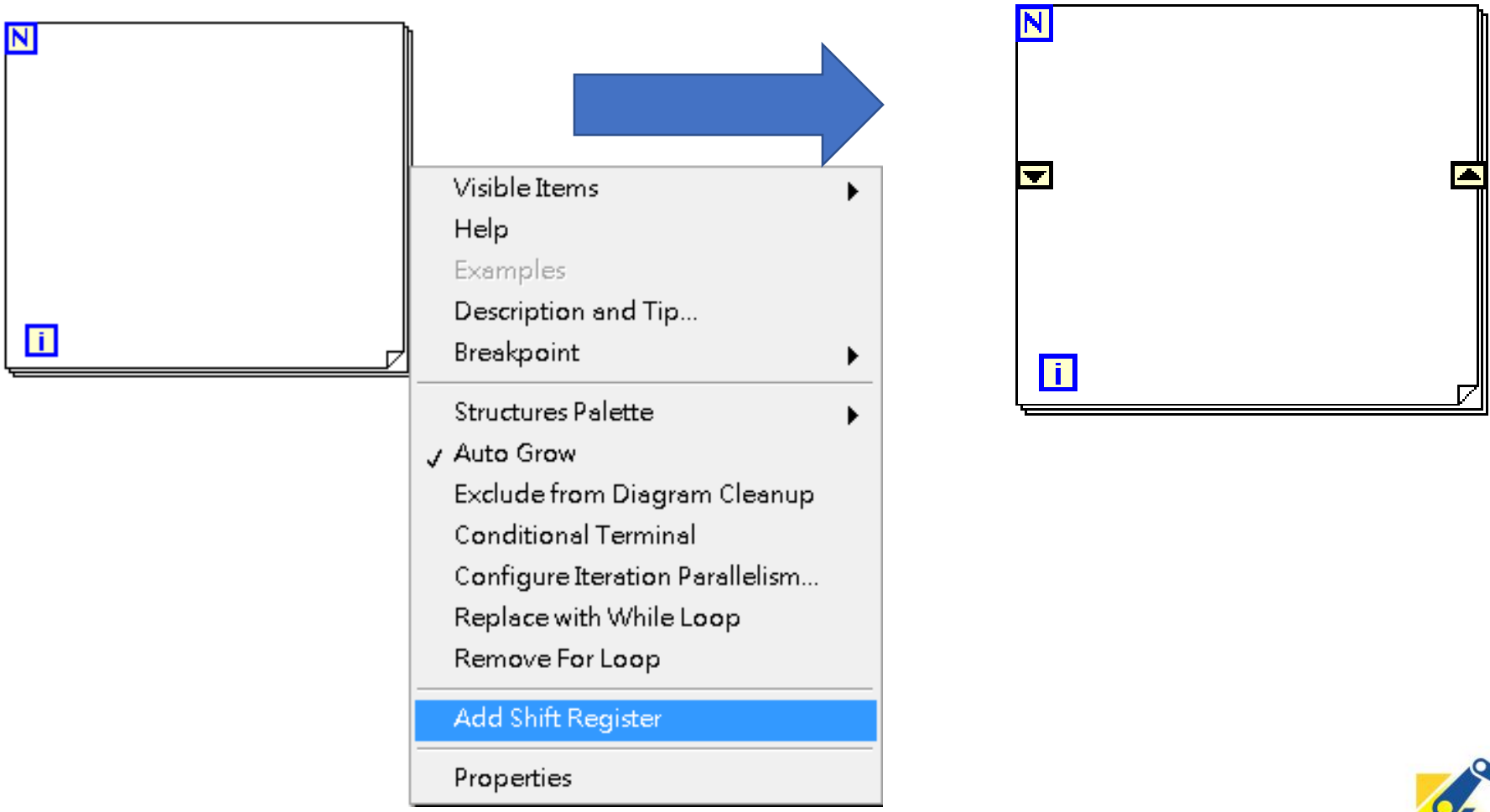

Count Terminal
N
Code
i
Iteration Number


N=100
i=0
i=i+1
i=N ?
False
Code
True
End

範例

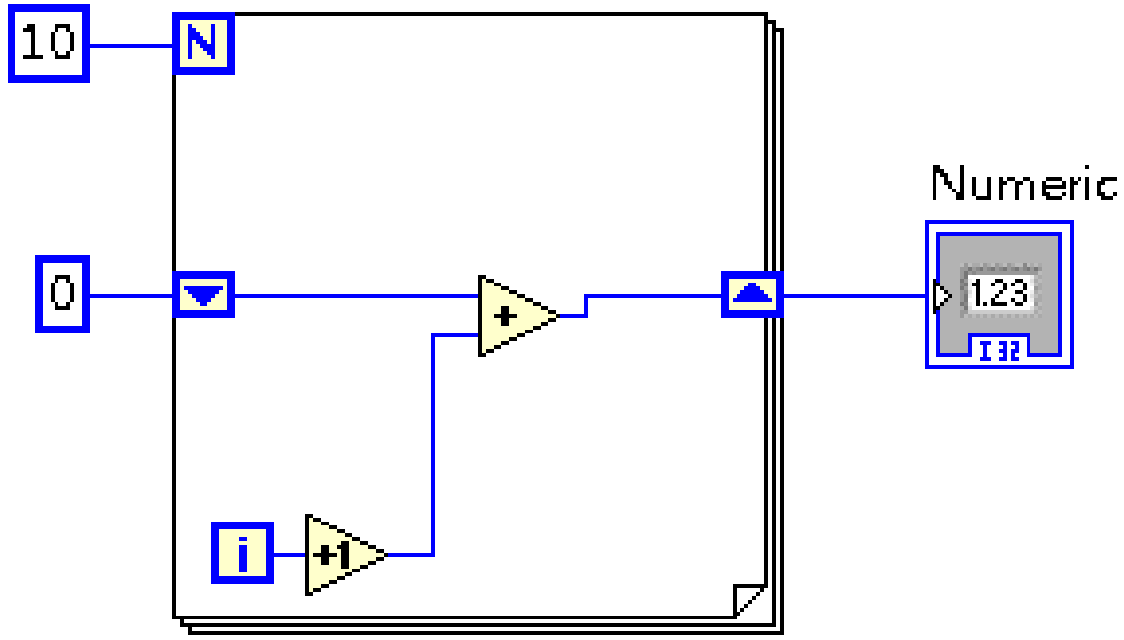


Shift register



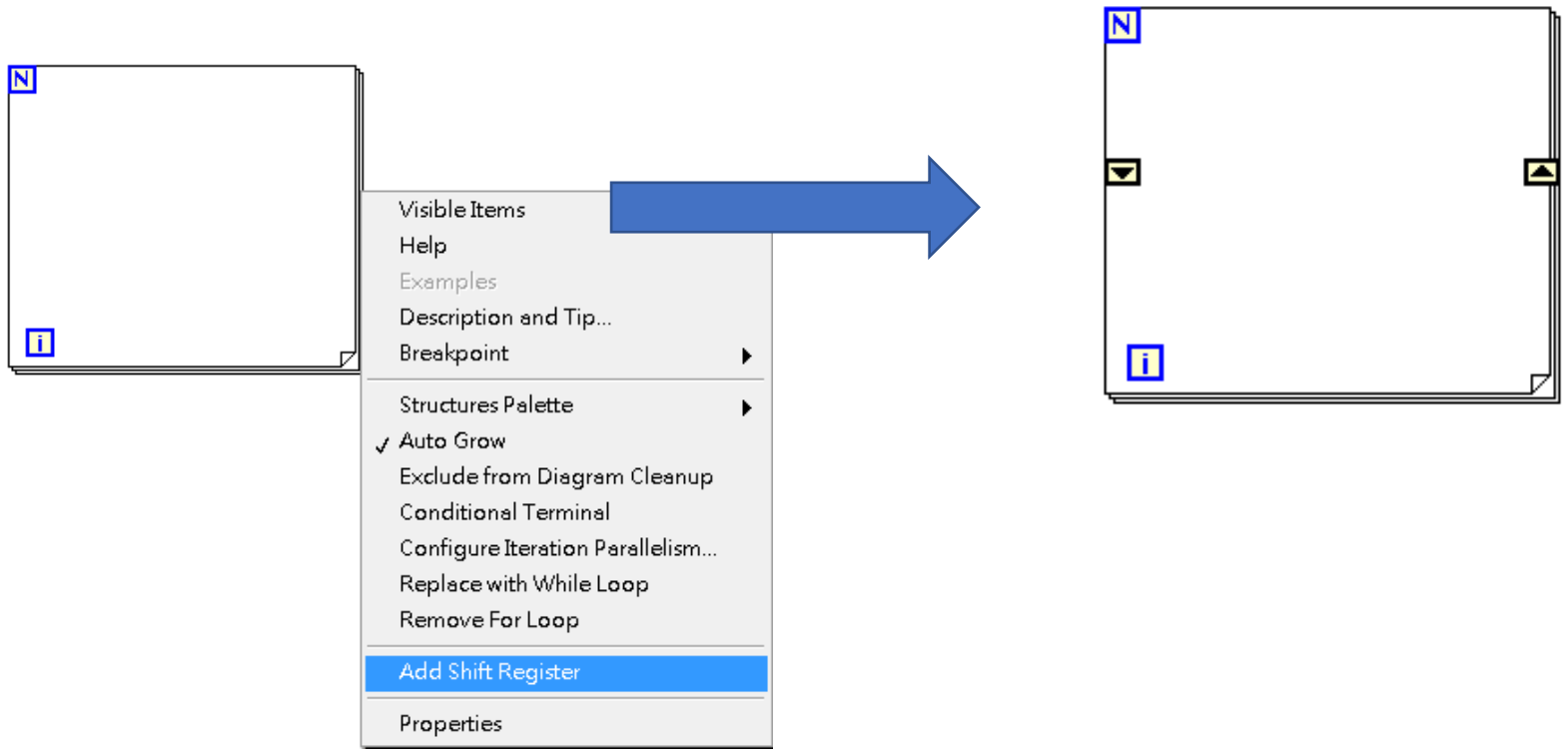
範例

解出1 + 2 + 3 + 4 + ... + 9 + 10 = ?

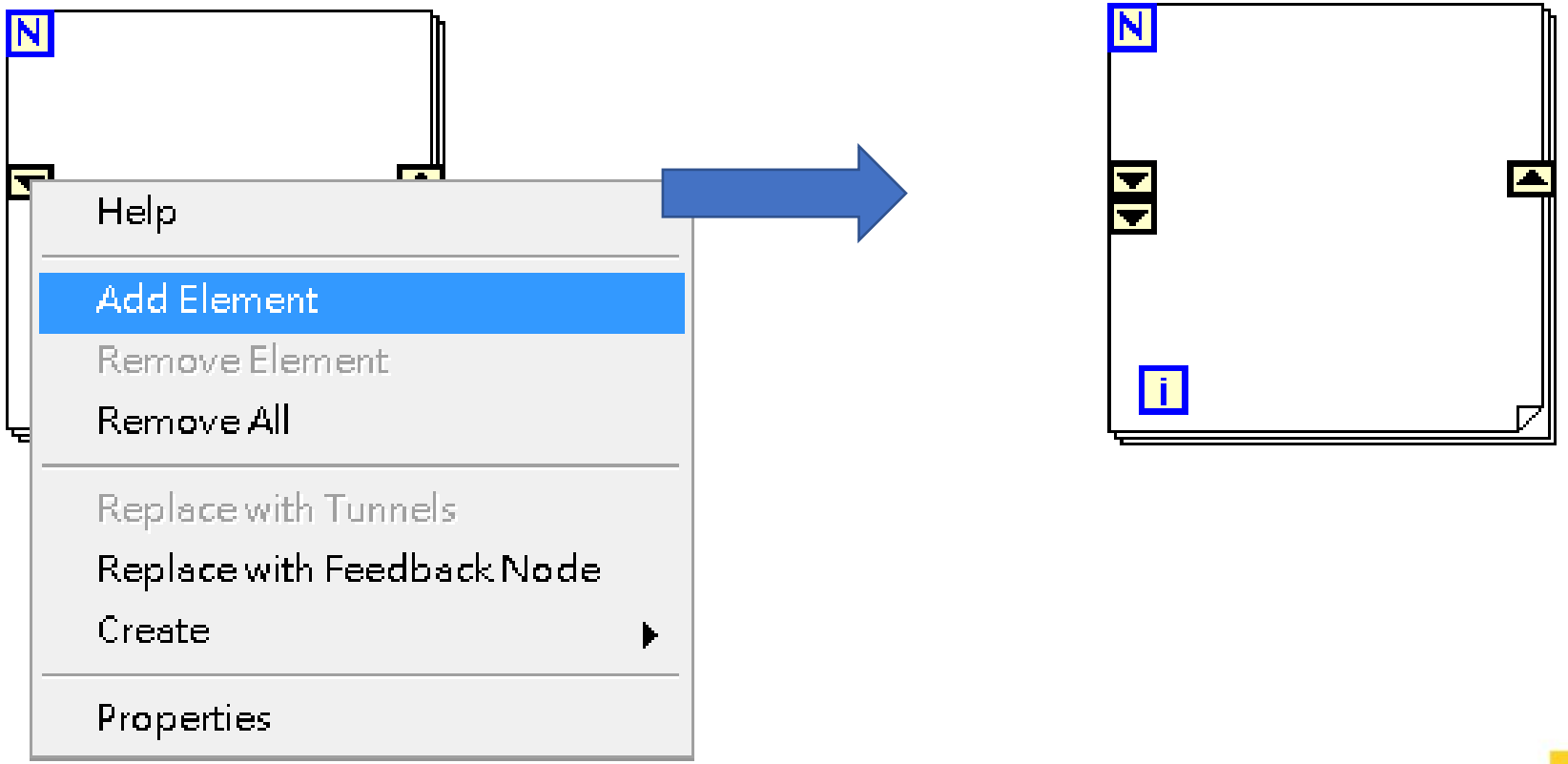


練習

- 使用前列面板輸入變數x，利用For Loop計算x!並輸出至前列面板。



Shift register

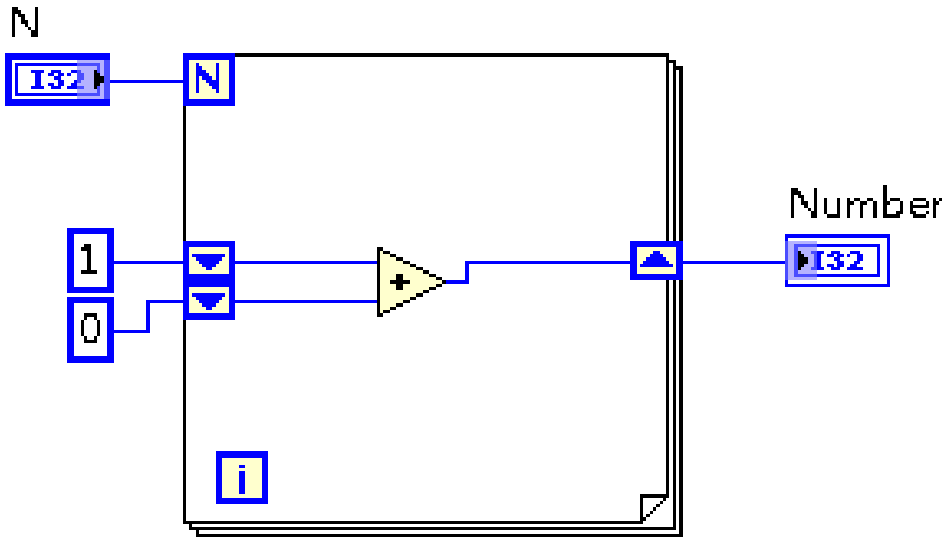


範例

Fibonacci number:

0 1 1 2 3 5 8 13 21 34 55 ....

F(n)=F(n-1)+F(n-2)



For Loop與While Loop比較

處理重復的問題

內部程式最少執行0次

已知執行次數

處理重復的問題

內部程式最少執行1次

已知停止條件

範例問題

以下問題適合使用For Loop還是While Loop

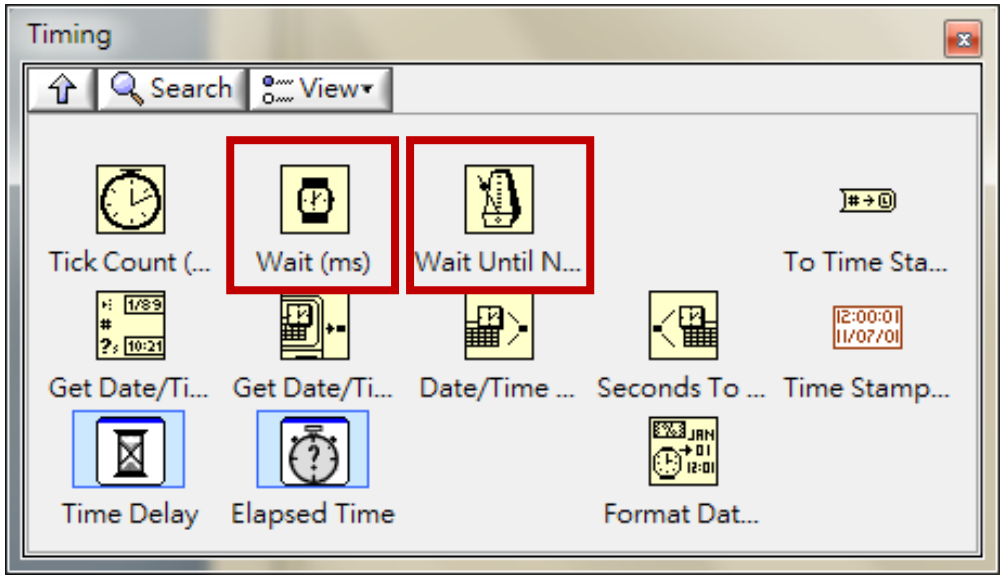
1. 每秒量測一次壓力值，量測一小時

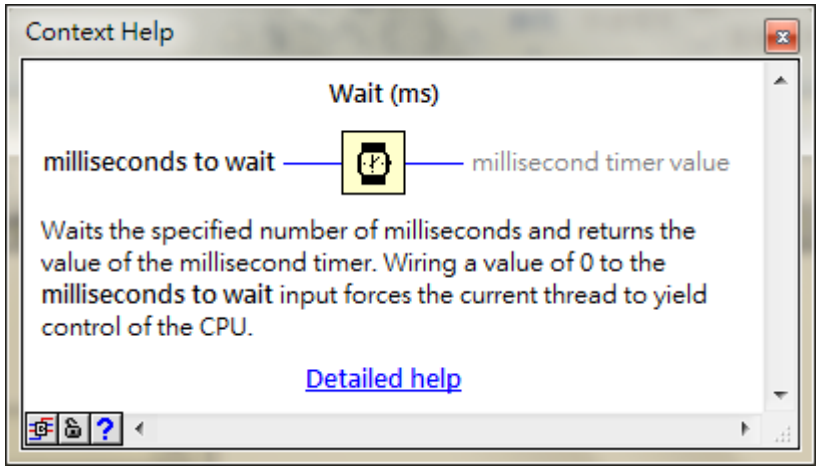
2. 每秒量測一次壓力值，直到壓力>1000psi

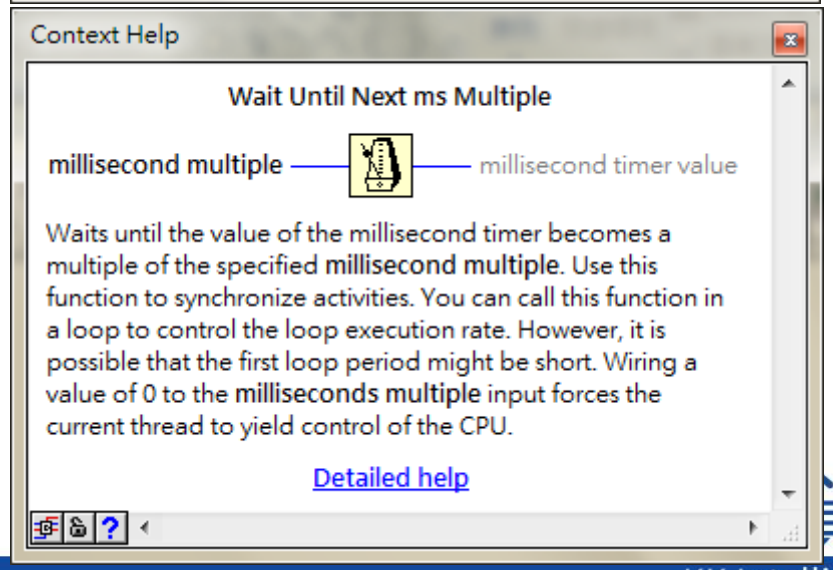
3. 量測溫度，直到溫度達到定值(保持1 min)

4. 輸出電壓值，從0V開始，每秒增加0.5V，直到電壓達到5V

Wait Function

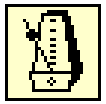




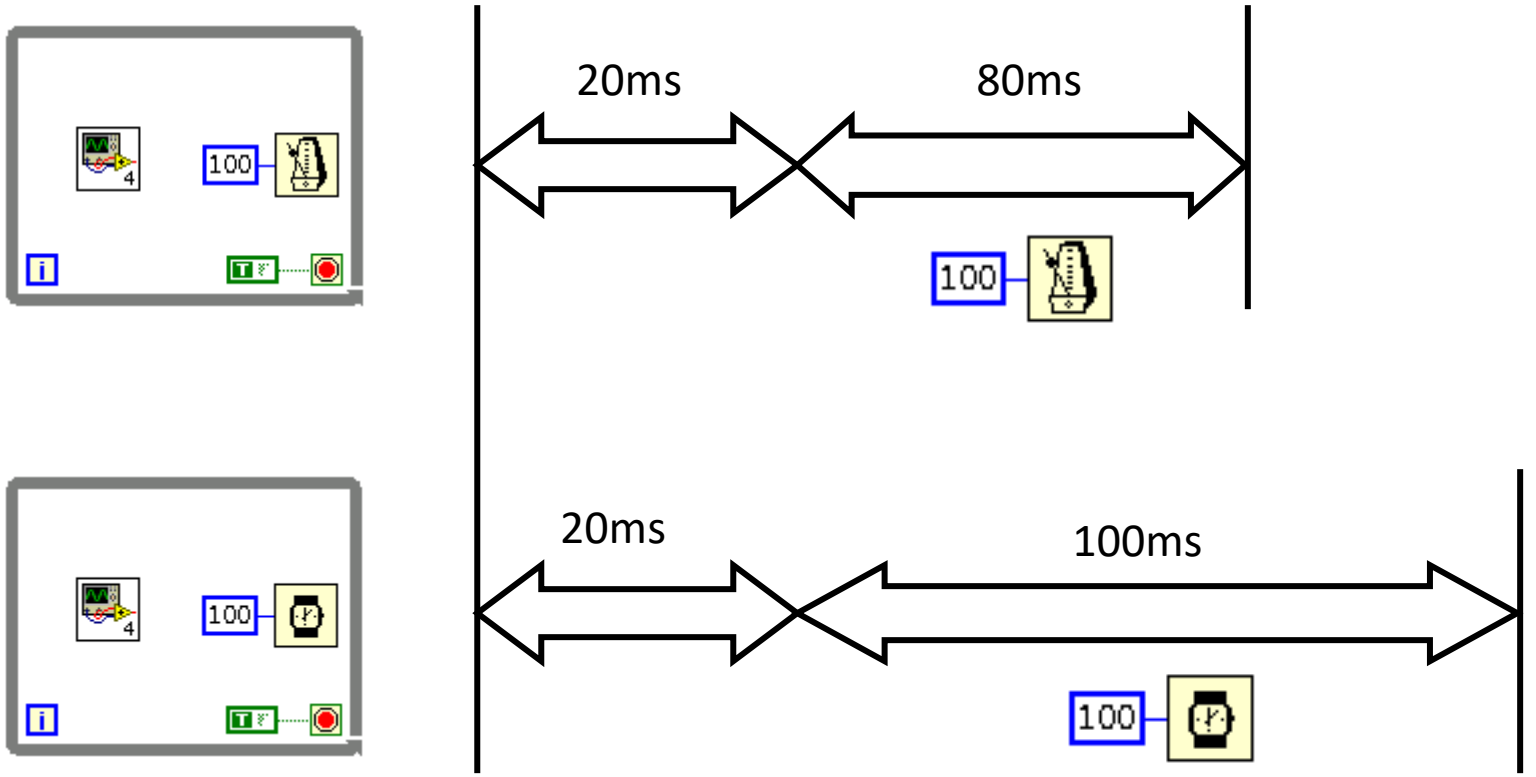


Wait (ms)

Wait Until Next ms Multiple



比較兩種Wait Function



條件判斷

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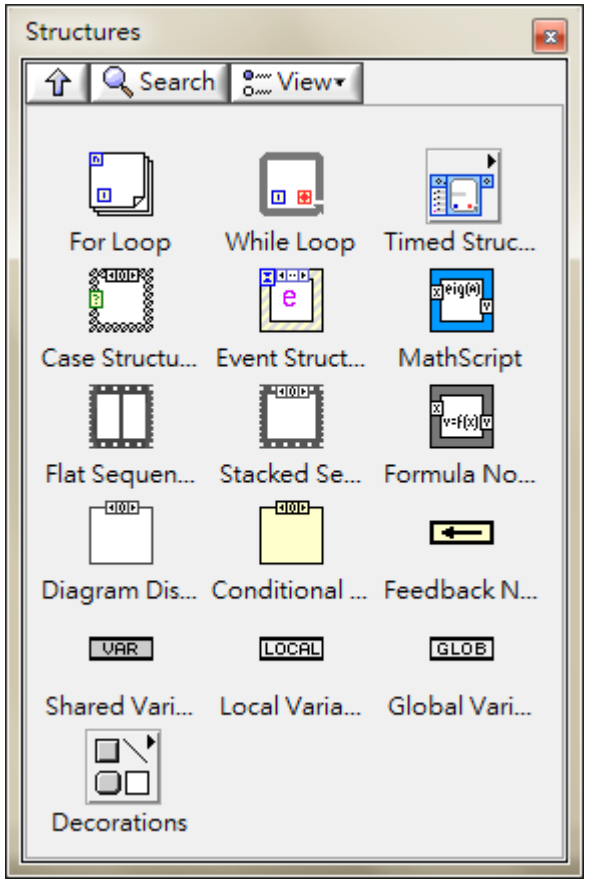
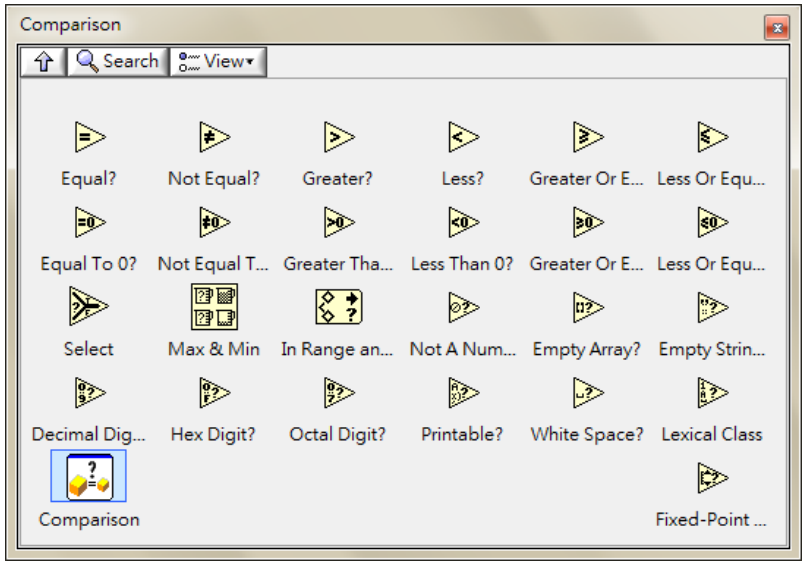
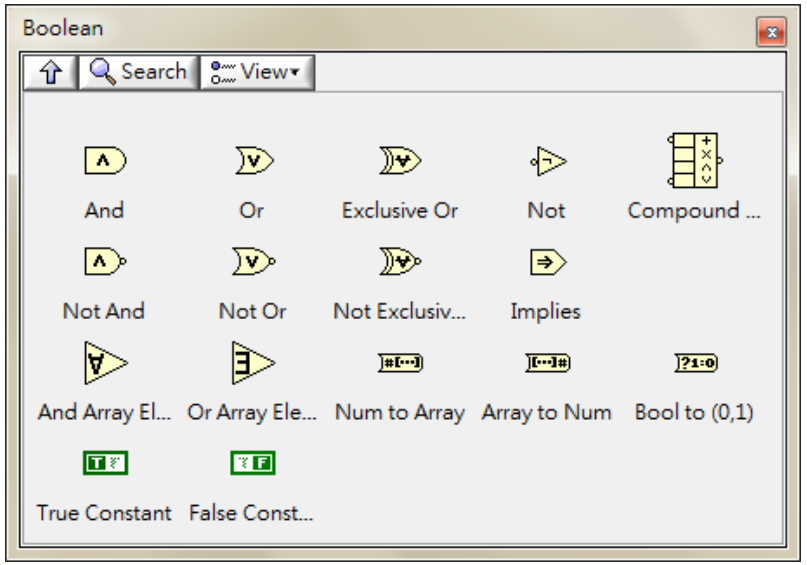
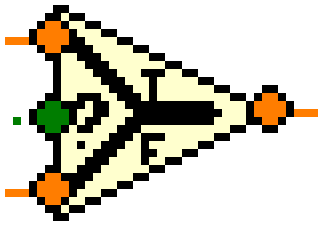

Structures
Search
View
For Loop
While Loop
Timed Struc...
Case Structu...
Event Struct...
MathScript
Flat Sequen...
Stacked Se...
Formula No...
Diagram Dis...
Conditional ...
Feedback N...
VAR
LOCAL
GLOB
Shared Vari...
Local Varia...
Global Vari...
Decorations

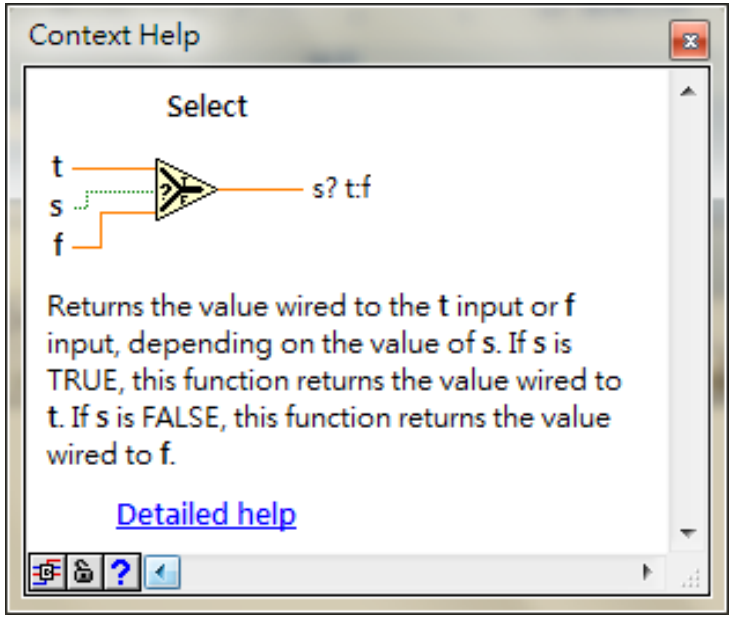

Comparison
Search
View
Equal?
Not Equal?
Greater?
Less?
Greater Or E...
Less Or Equ...
Equal To 0?
Not Equal T...
Greater Tha...
Less Than 0?
Greater Or E...
Less Or Equ...
Select
Max & Min
In Range an...
Not A Num...
Empty Array?
Empty Strin...
Decimal Dig...
Hex Digit?
Octal Digit?
Printable?
White Space?
Lexical Class
Comparison
Fixed-Point ...


Boolean
Search
View
And
Or
Exclusive Or
Not
Compound ...
Not And
Not Or
Not Exclusiv...
Implies
And Array El...
Or Array Ele...
Num to Array
Array to Num
Bool to (0,1)
True Constant
False Const...

Select Function

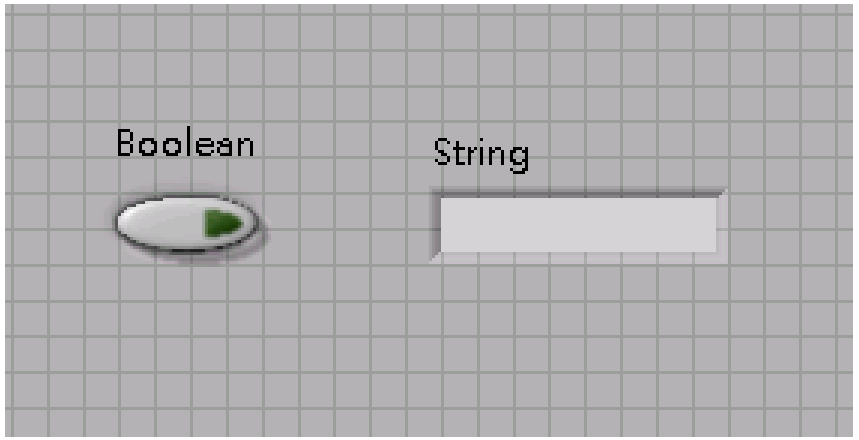
- Select Function是最簡單的條件式函式，應用層面卻非常廣，善用它可以用來簡化很多需要判斷的問題。



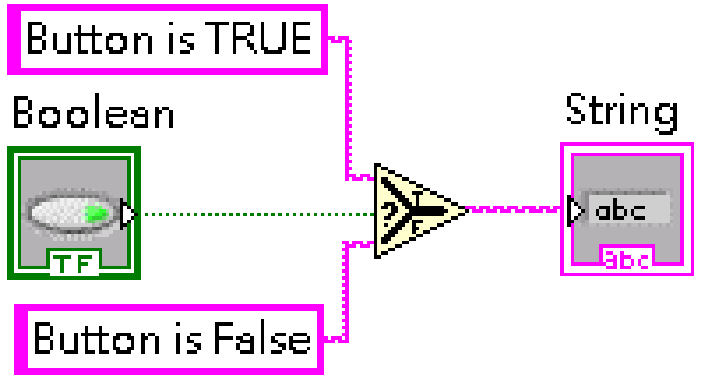


範例

Front Panel

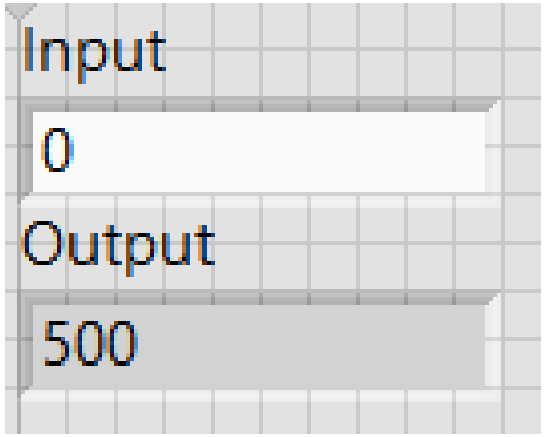


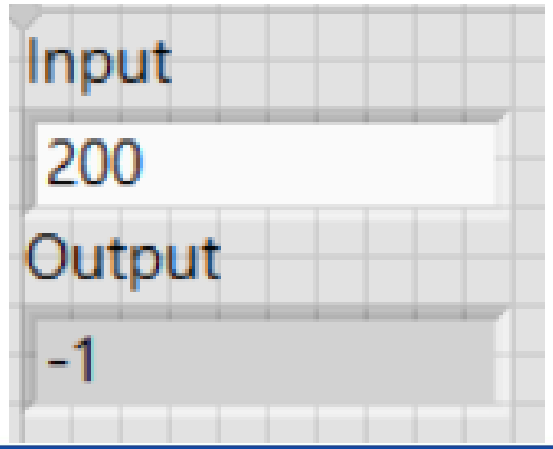
Block Diagram

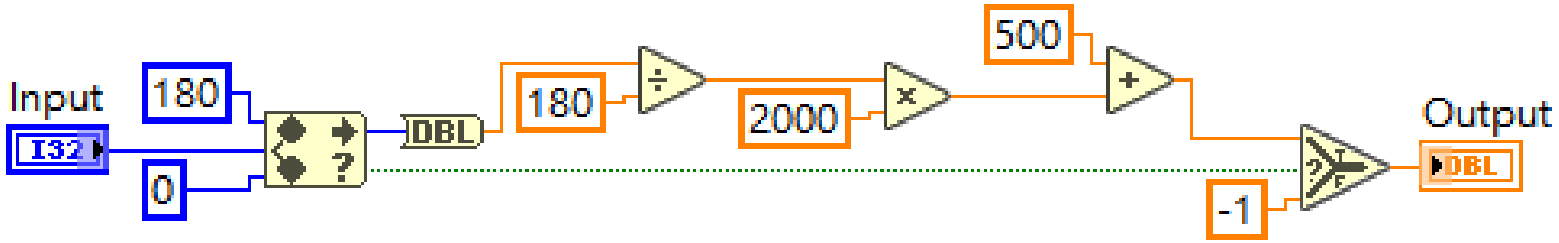


練習三

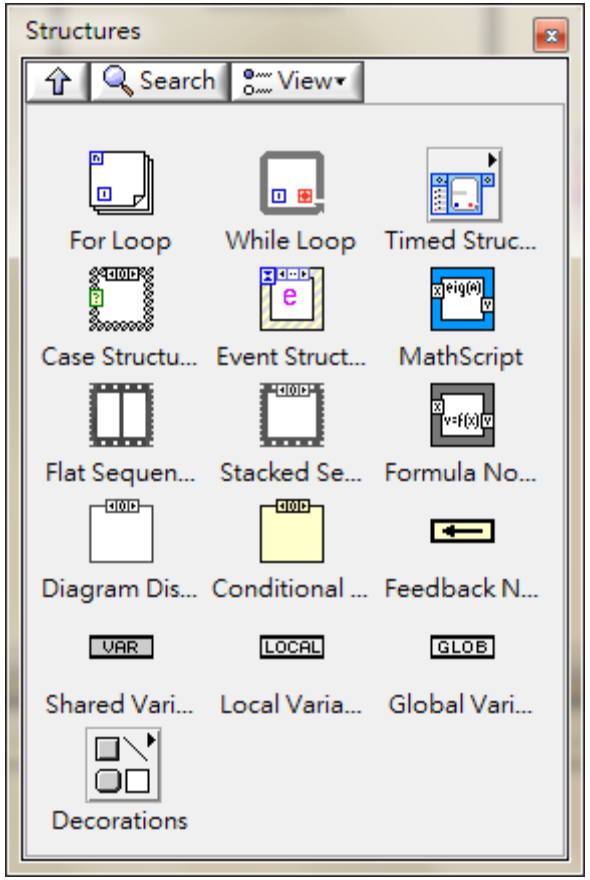
- 輸入0~180轉為500~2500
- 若輸入不在0~180則輸出-1

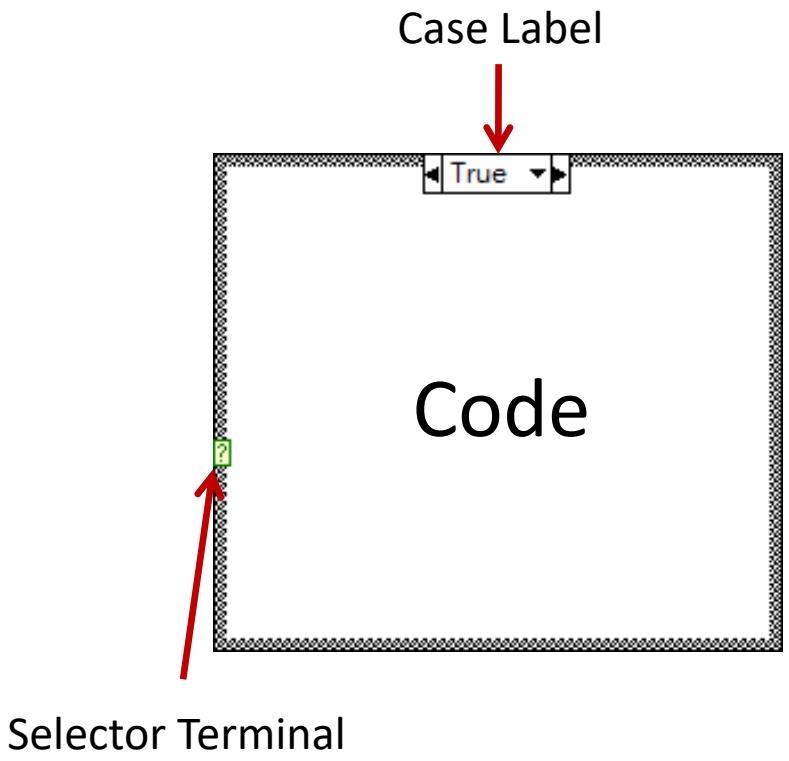






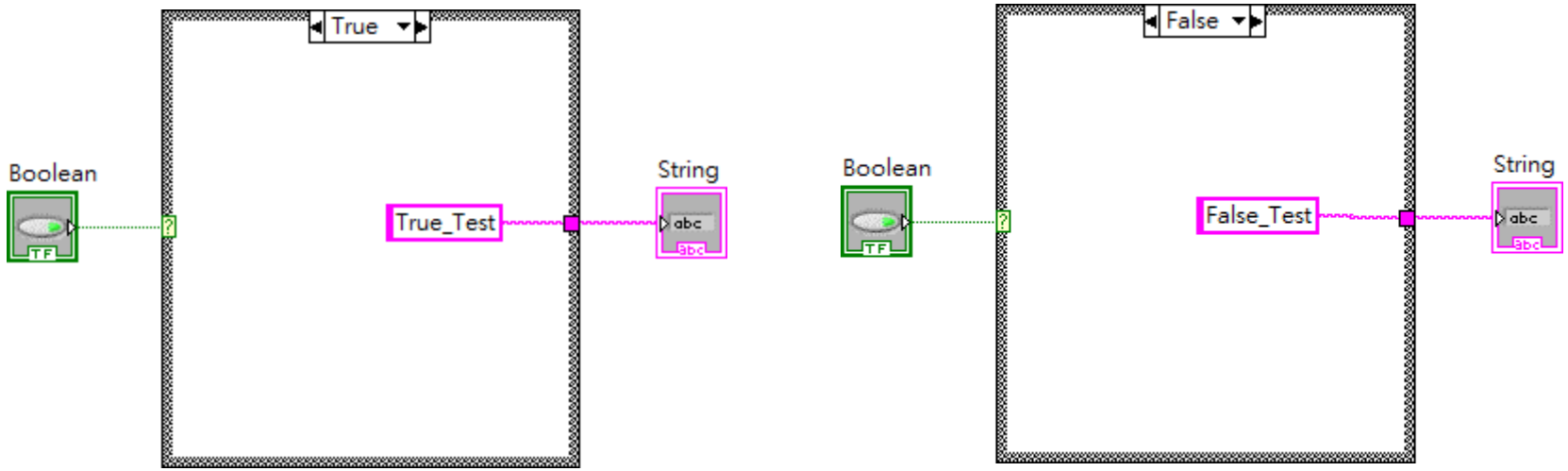
Case Structure





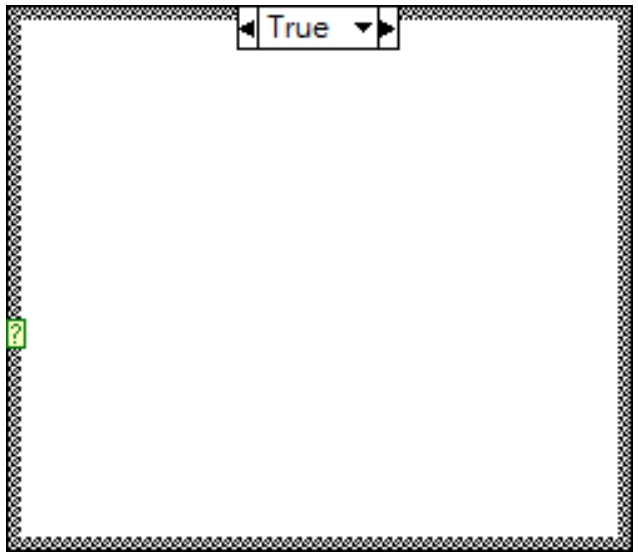
Boolean Case Structure

- 在Selector Terminal接上Boolean型態輸出，當輸出為True時，Case Structure會執行True的那一區塊，輸出為False執行False區塊程式。

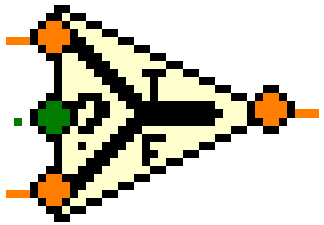


Boolean Case & Select

- 兩者皆可以處理相同問題

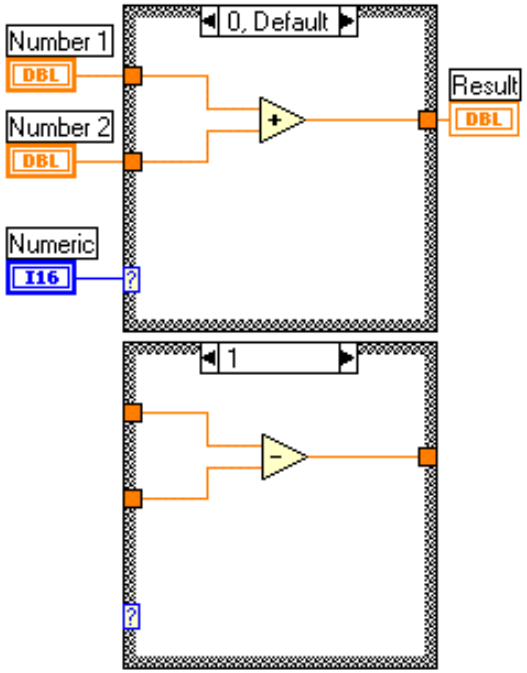


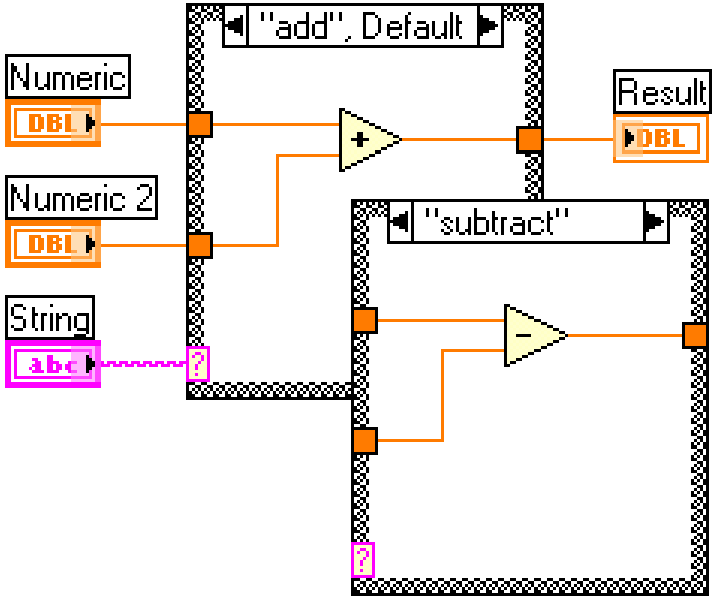
適合處理大型Code



適合處理簡單Code

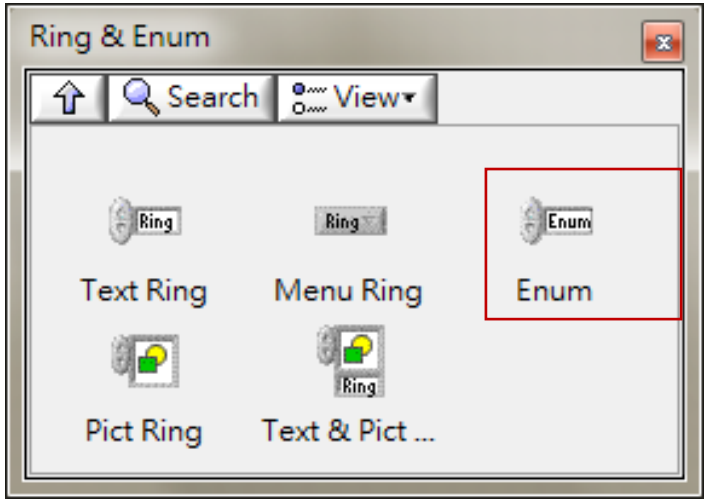
Numeric and String Cases

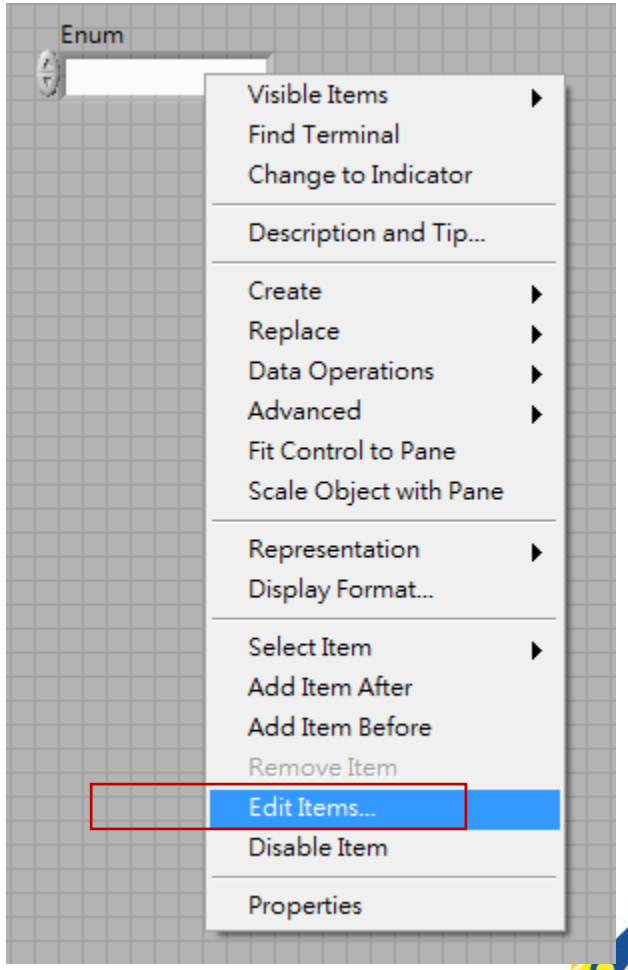


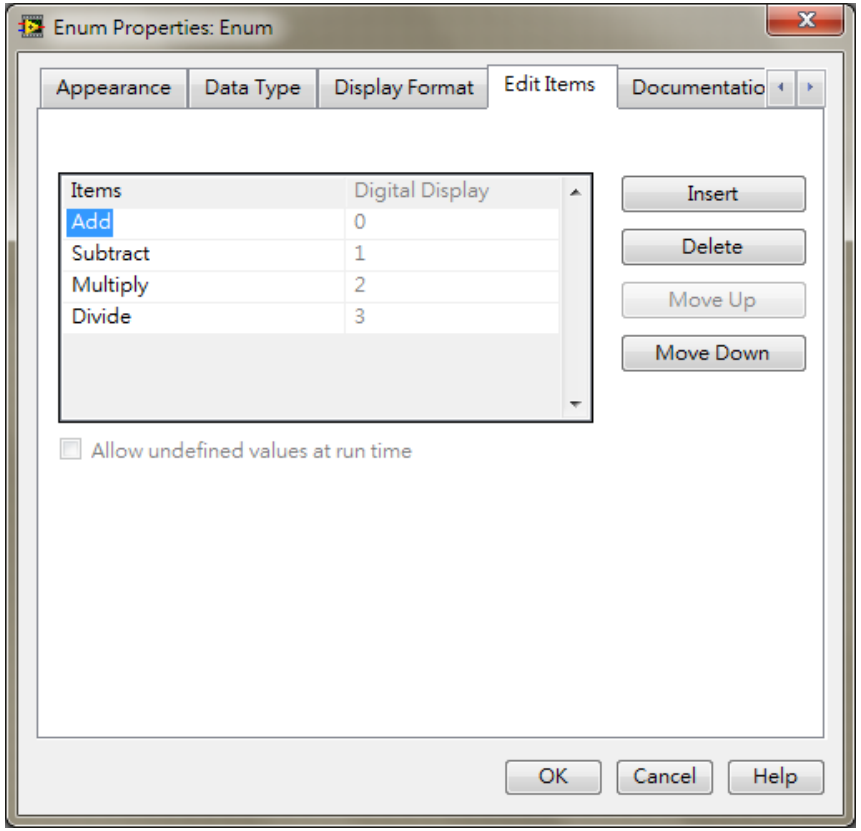


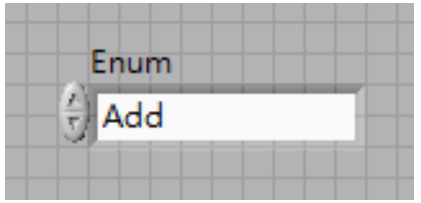
Enumerate

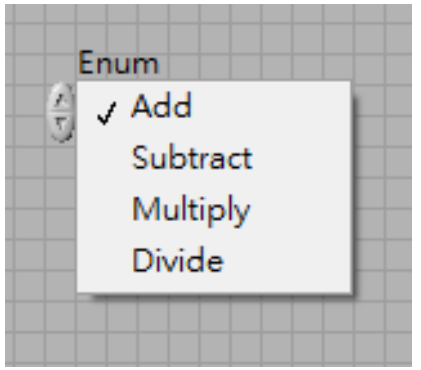
- Enumerate是包含字串與數值的型態，使用非常方便。



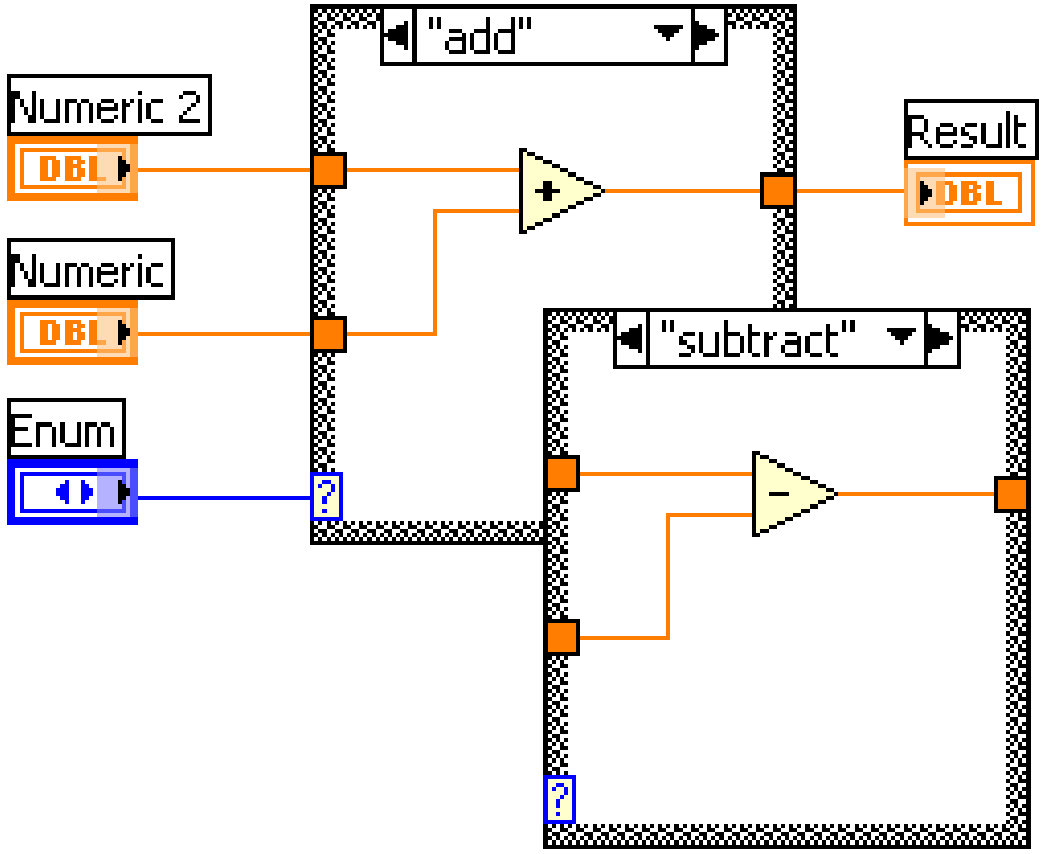


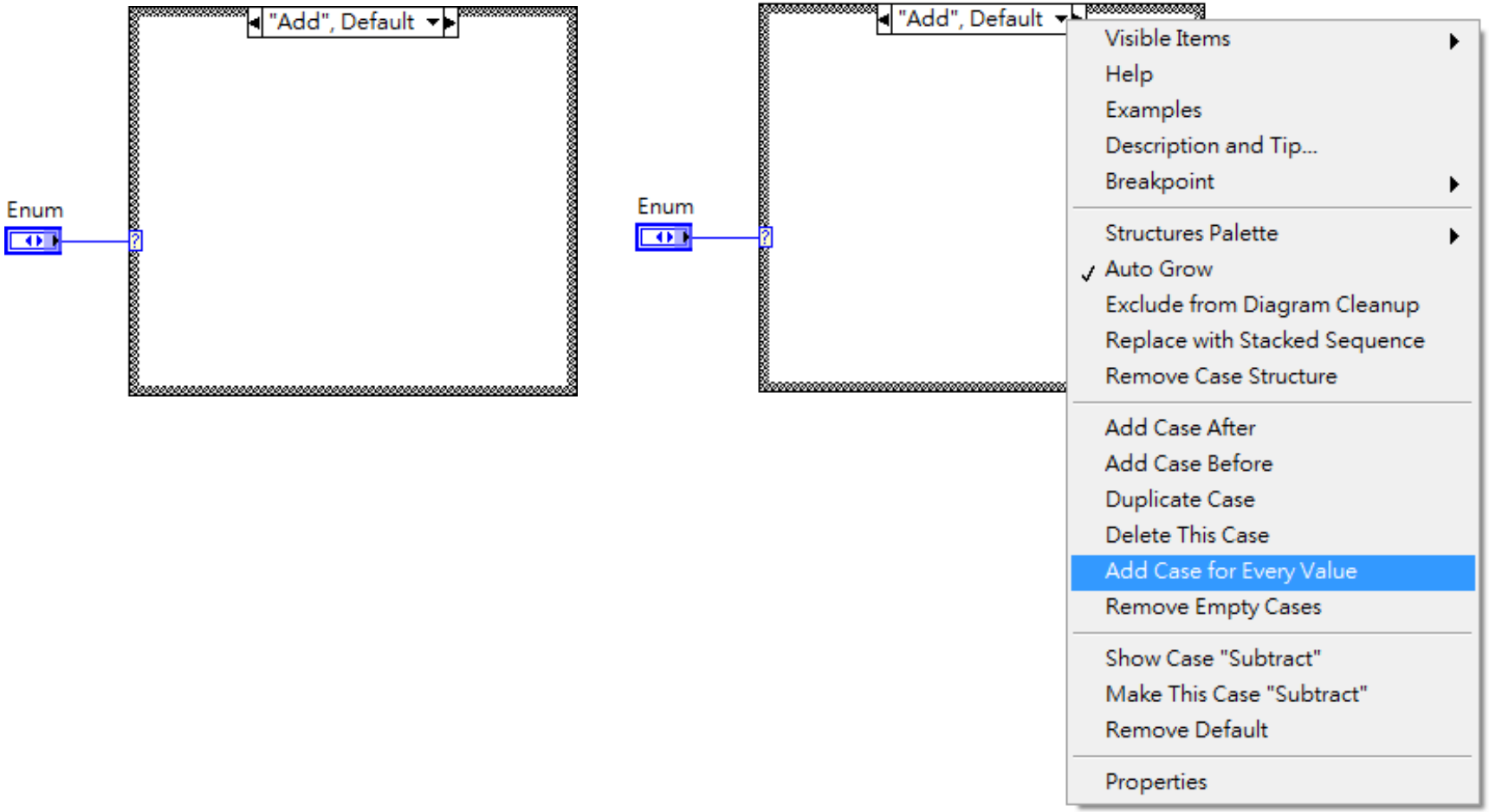

Enum Properties: Enum
Appearance
Data Type
Display Format
Edit Items
Documentatio
Items
Digital Display
Add
0
Subtract
1
Multiply
2
Divide
3
Insert
Delete
Move Up
Move Down
Allow undefined values at run time
OK
Cancel
Help


Enum
Add

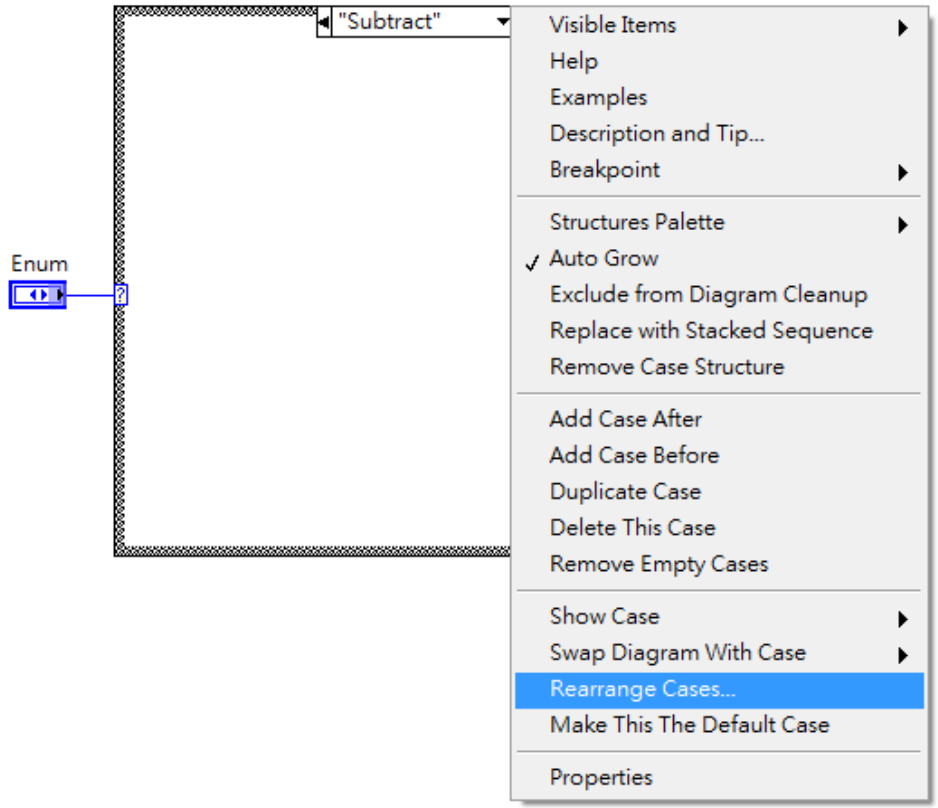

Enum
Add
Subtract
Multiply
Divide

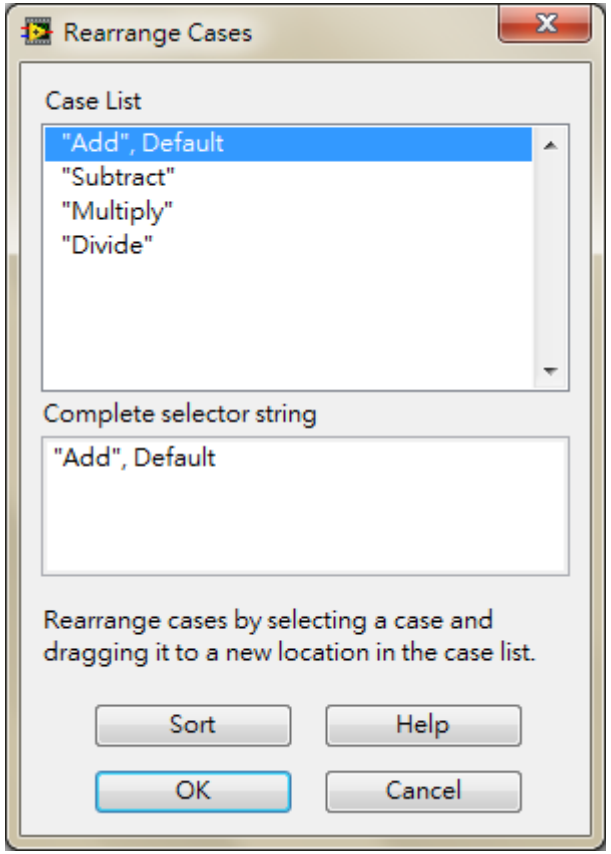
Enumerate Case



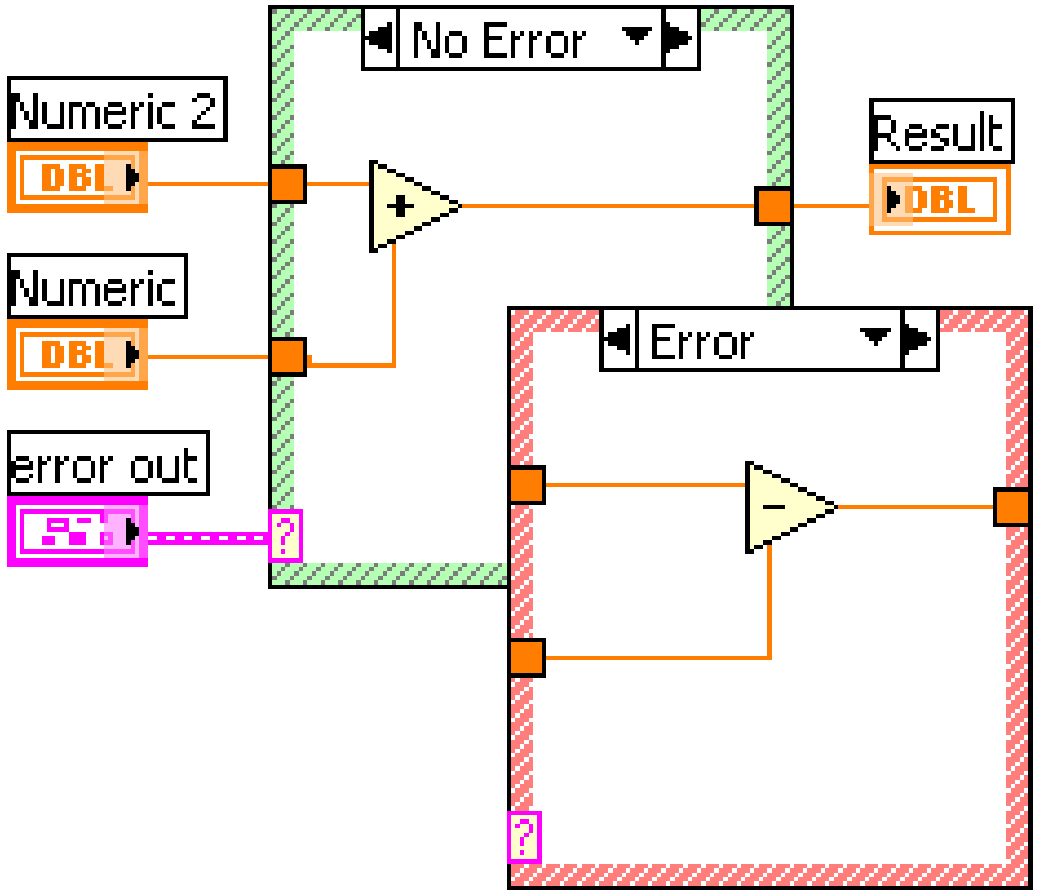

"Add", Default
Enum
"Add", Default
Enum
Visible Items
Help
Examples
Description and Tip...
Breakpoint
Structures Palette
Auto Grow
Exclude from Diagram Cleanup
Replace with Stacked Sequence
Remove Case Structure
Add Case After
Add Case Before
Duplicate Case
Delete This Case
Add Case for Every Value
Remove Empty Cases
Show Case "Subtract"
Make This Case "Subtract"
Remove Default
Properties

Rearrange Cases





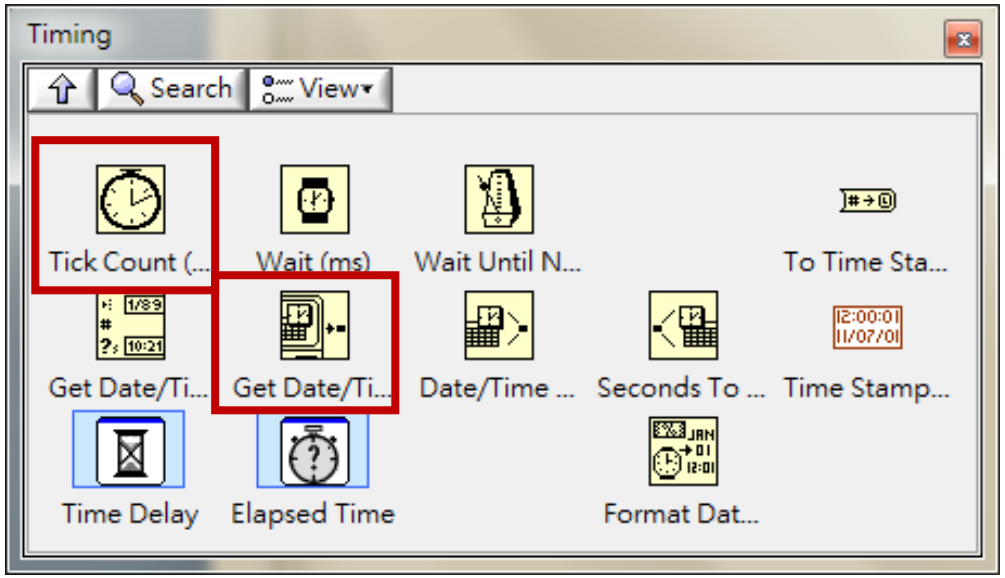
Error Case

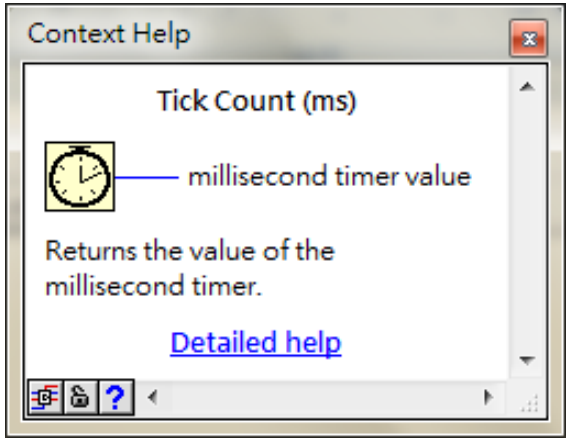

No Error
Numeric 2
DBL
Numeric
DBL
error out
Result
DBL
Error

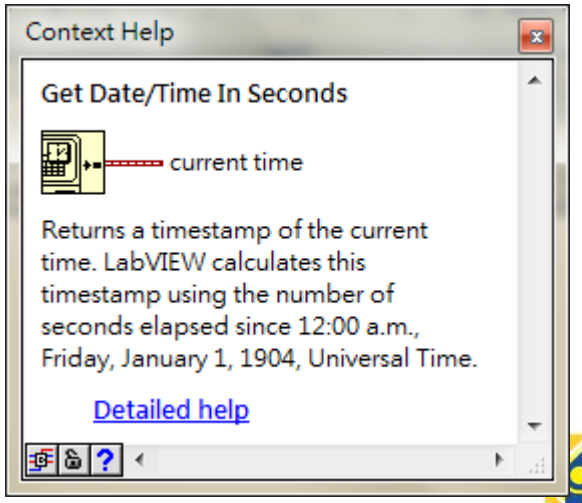
練習四

- 將練習三Select改成Case Structure

Get Time

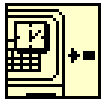




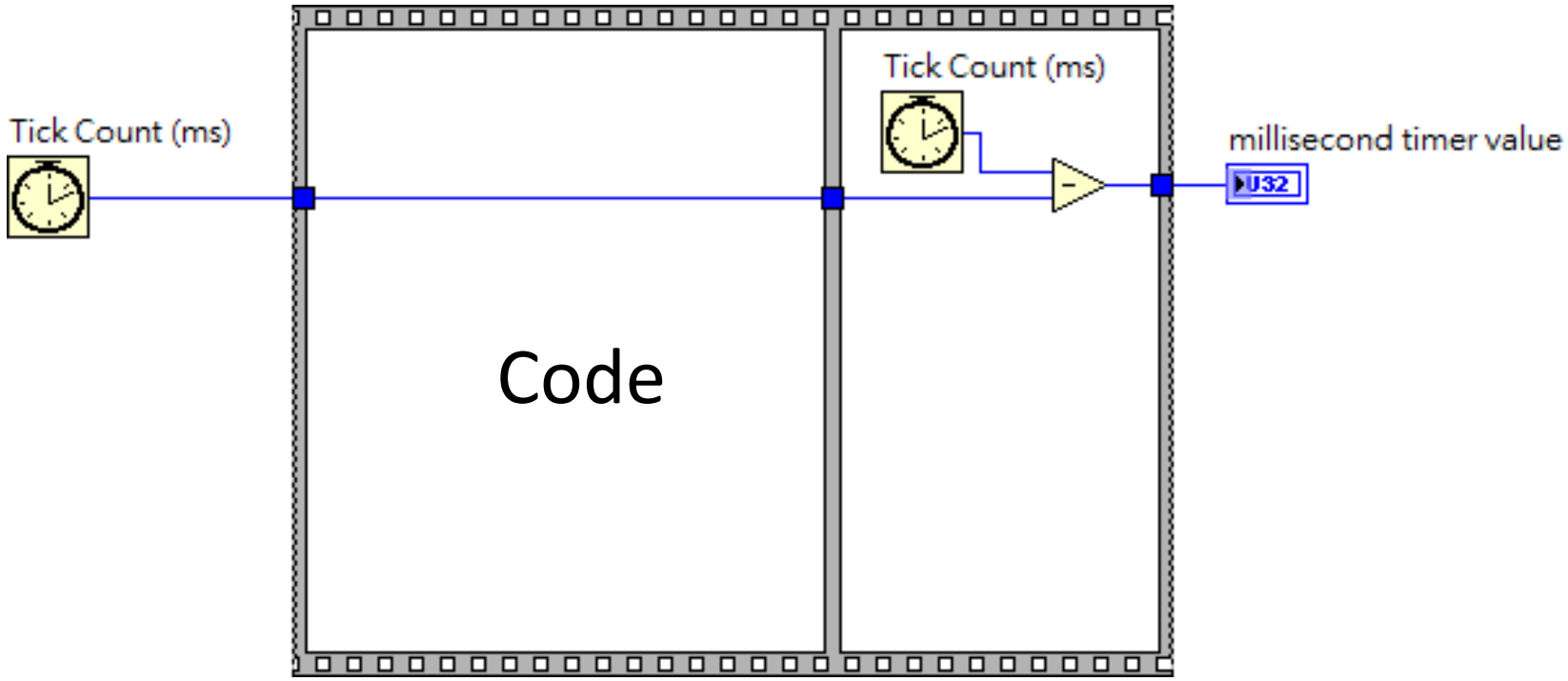


Tick Count (ms)

Get Date/Time In Seconds



經過時間計算


Tick Count (ms)
Tick Count (ms)
millisecond timer value
U32
Code

陣列Array

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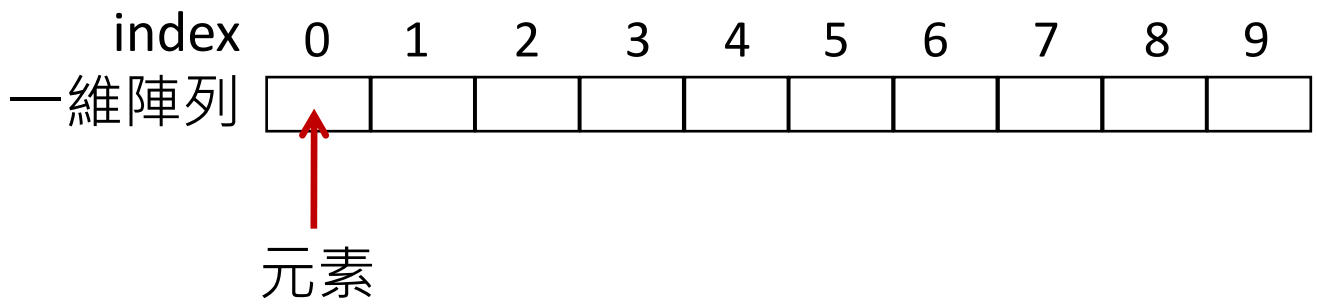
KK Intelligent Service,Inc.

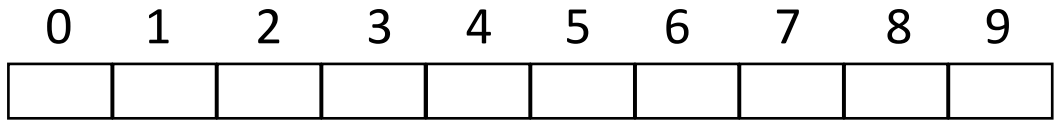
陣列

- 元素 Element
- 索引 Index
- 維度 Dimension

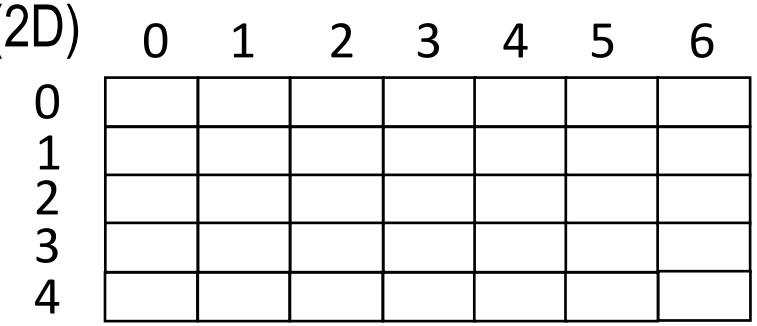


陣列的維度

一維陣列(1D)

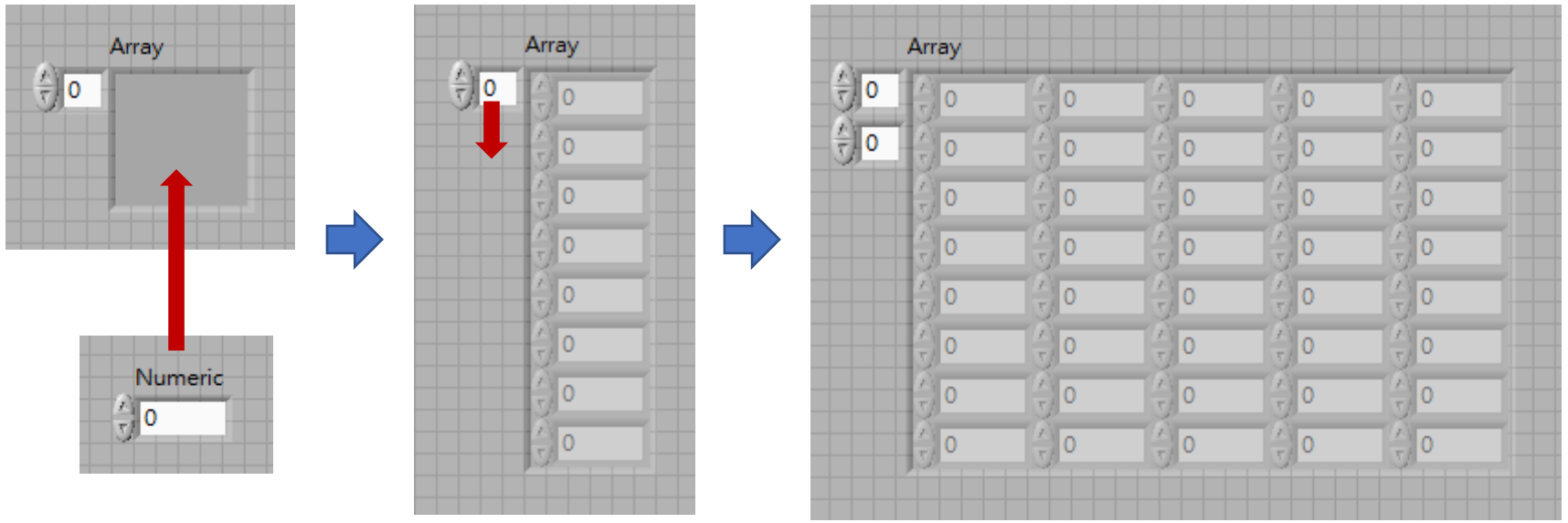


二維陣列(2D)

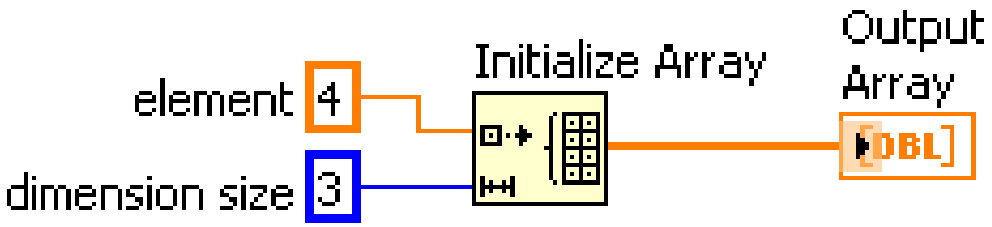


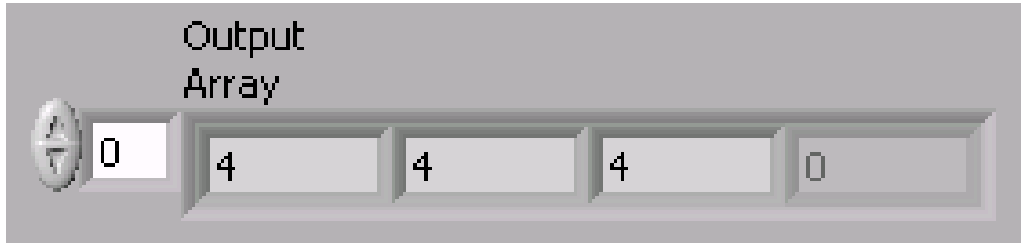
如何建立陣列

Front Panel

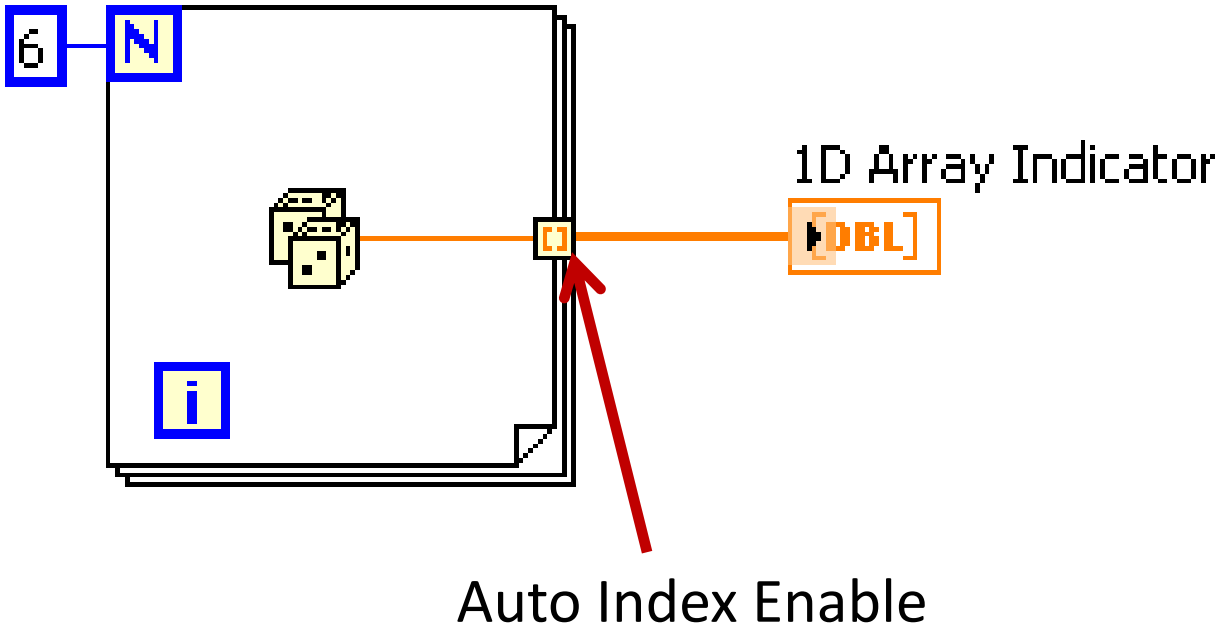


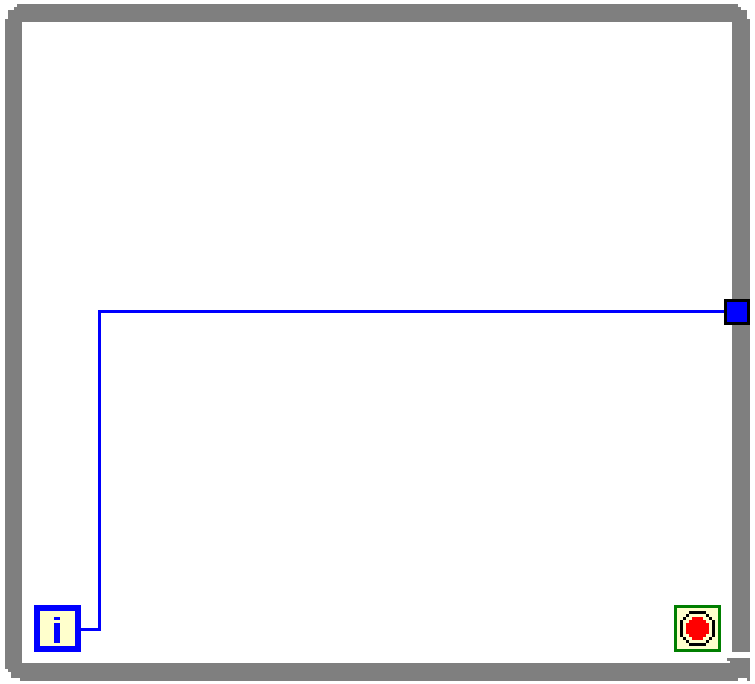
Initial Array

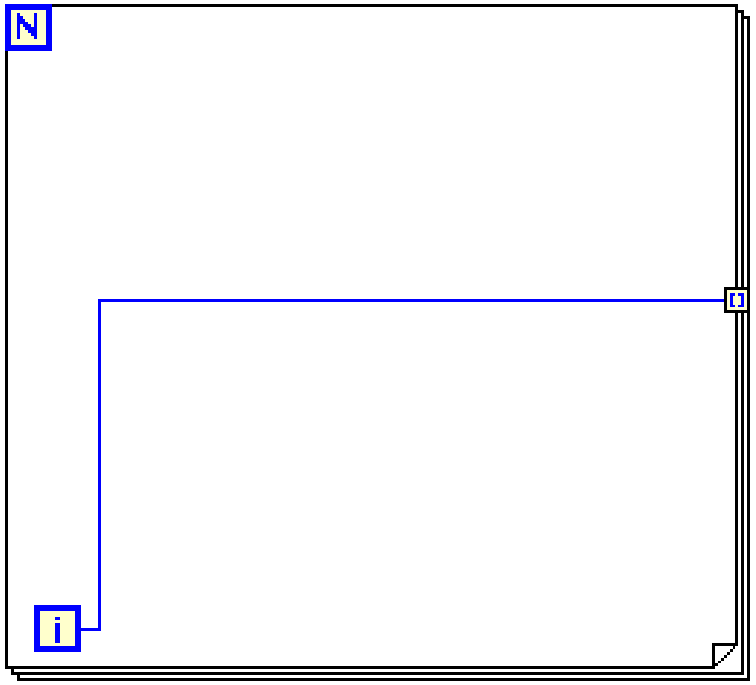




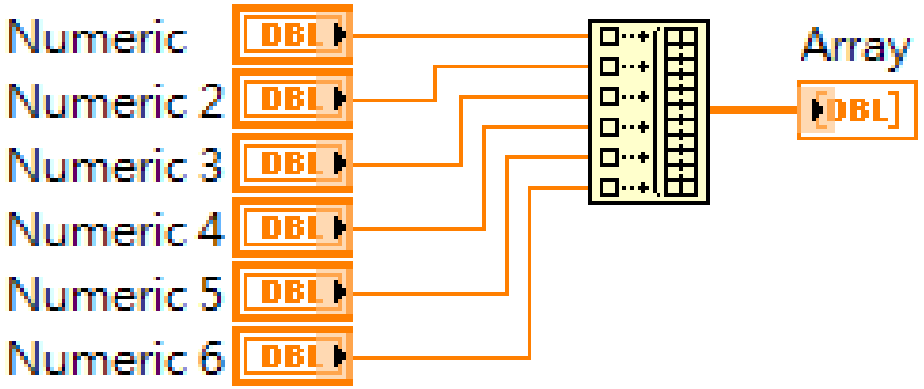
Use Auto Index



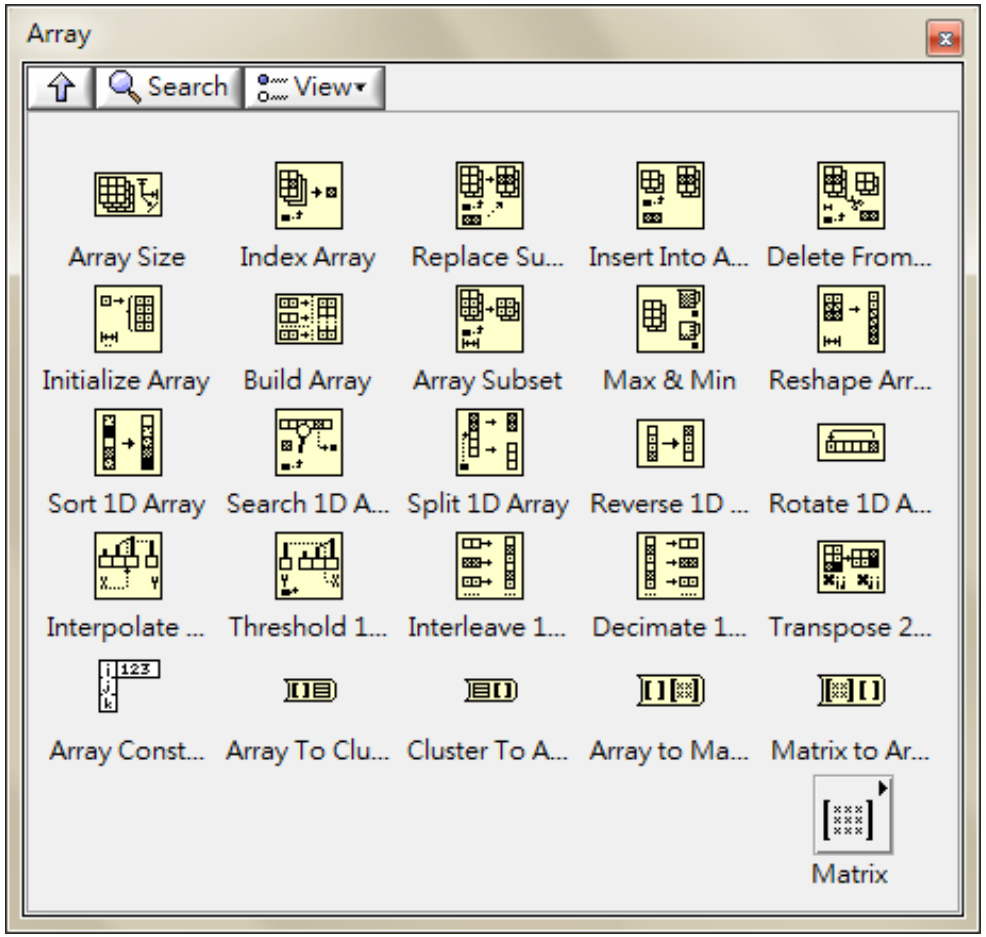

i


N
i

Build Array

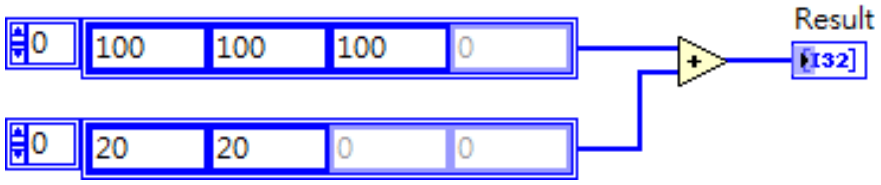

Numeric
Numeric 2
Numeric 3
Numeric 4
Numeric 5
Numeric 6
DBL
Array
[DBL]

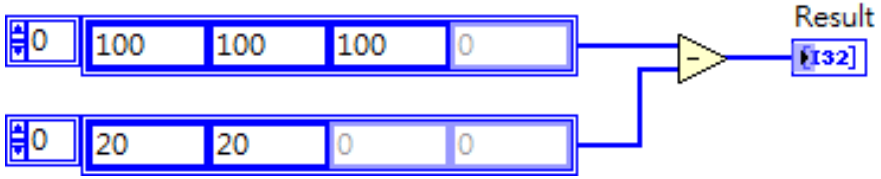
Common Array Functions



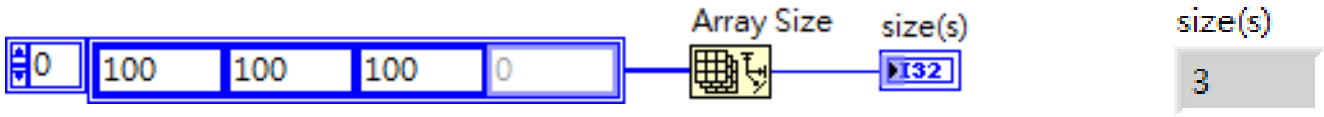
Array Size
Index Array
Build Array
Rotate 1D Array

Array Caculation





Array Size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Array Size
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I32
size(s)
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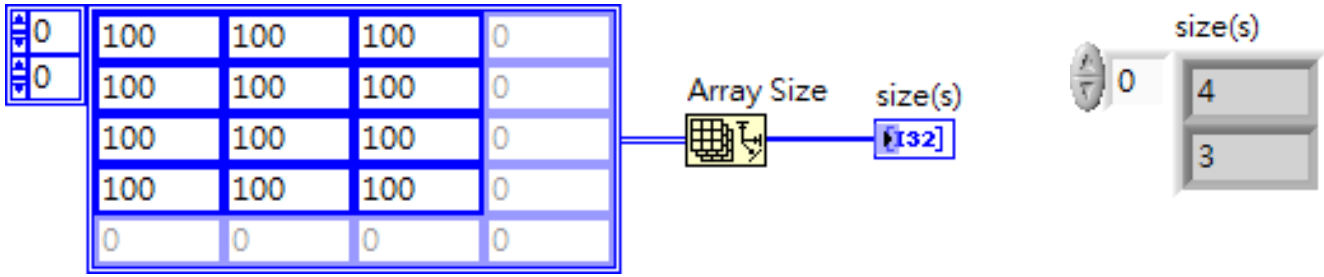
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Array Size
size(s)
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size(s)
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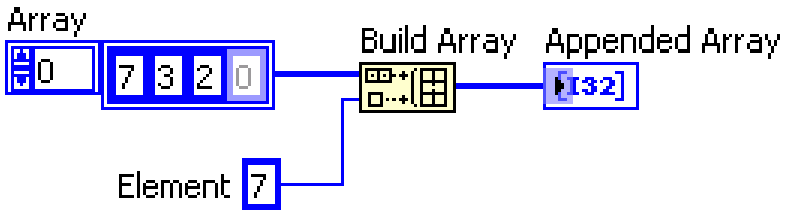
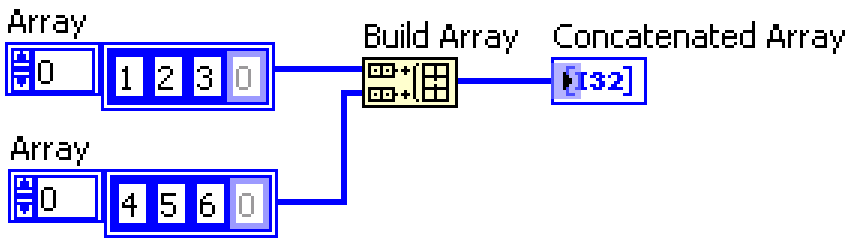
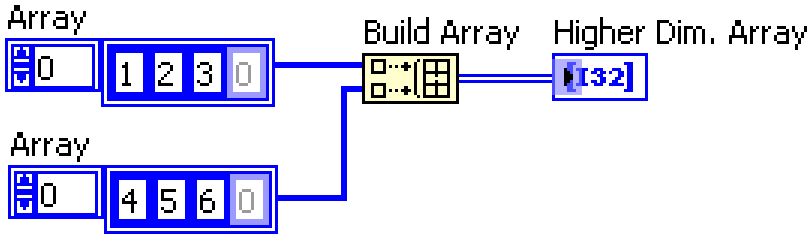
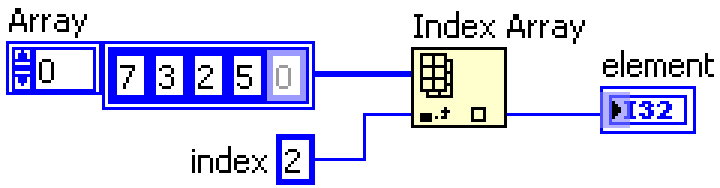
The Build Array Function

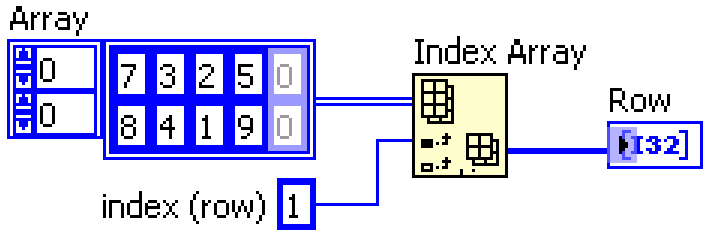


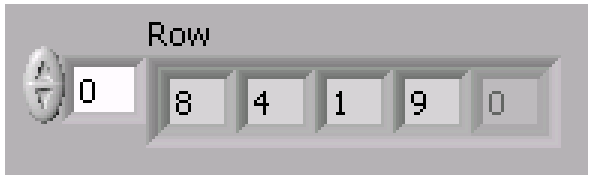




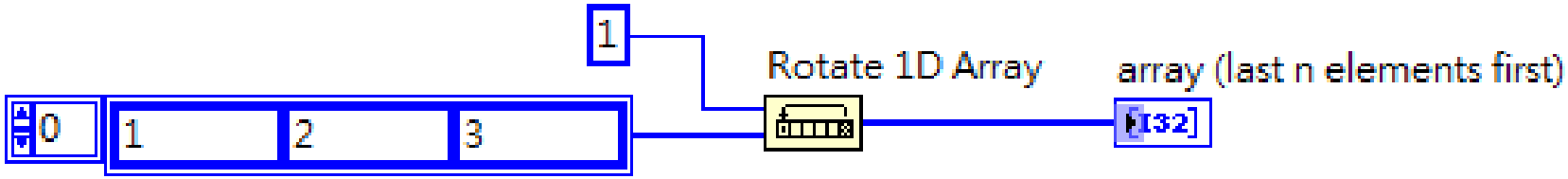
The Index Array Function

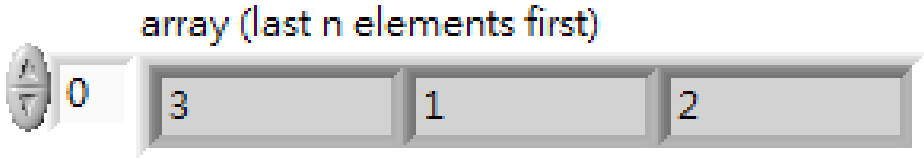






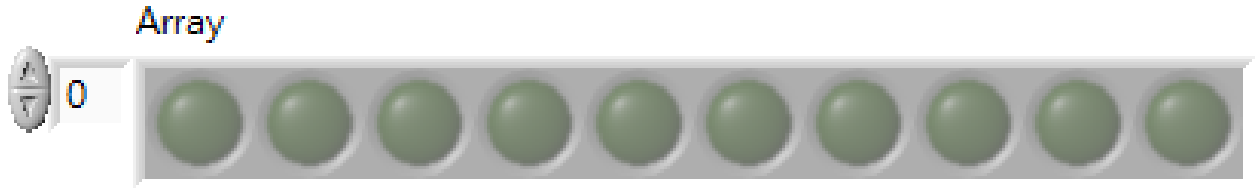
Rotate 1D Array

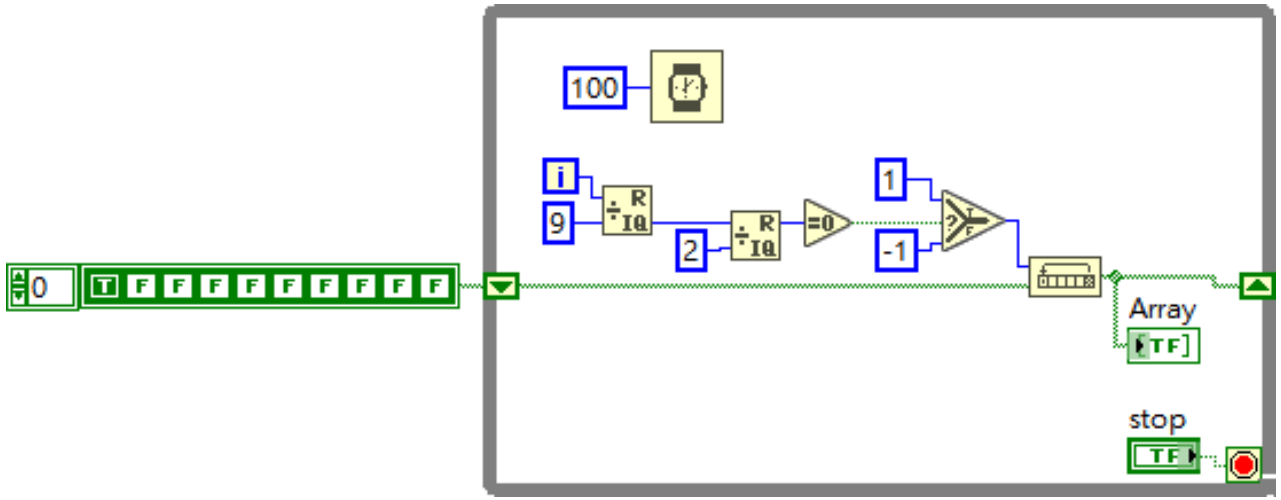


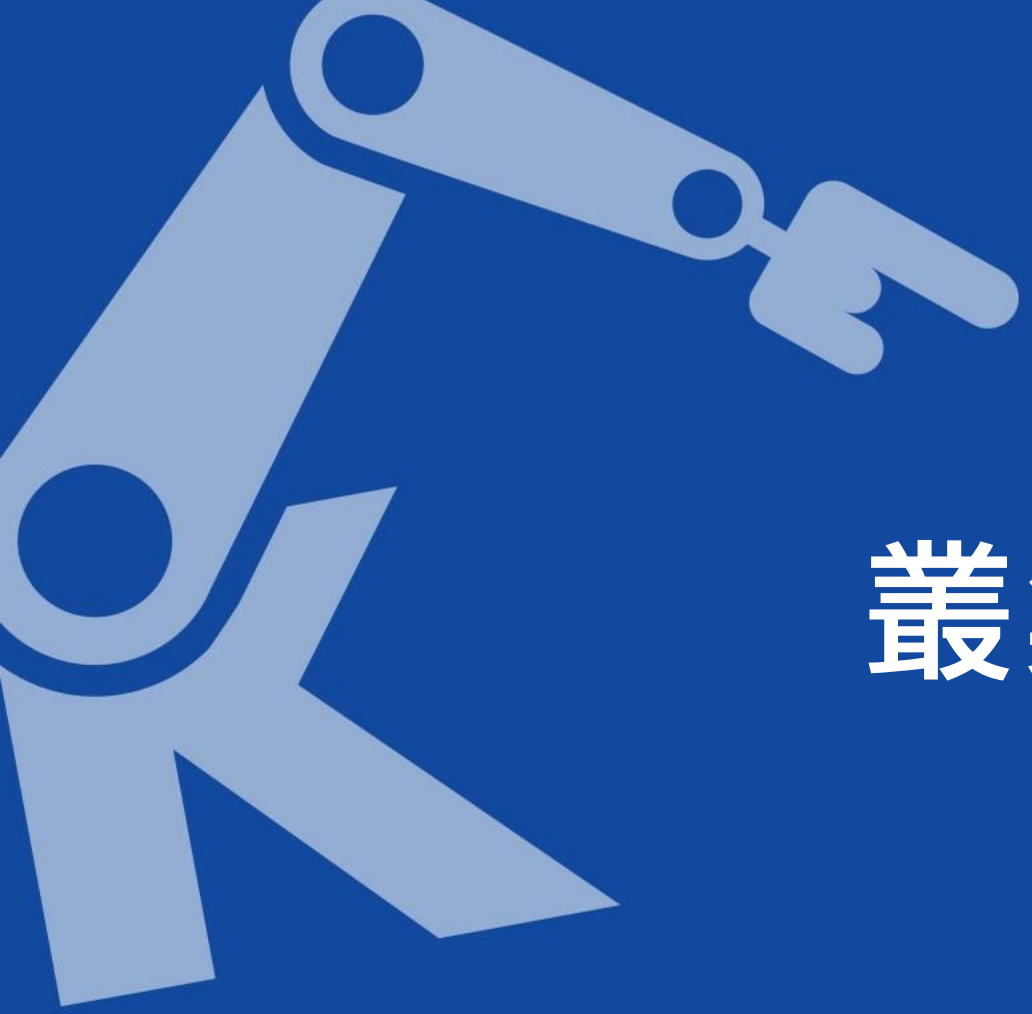


練習

- 設計一個跑馬燈，長度為10個小燈泡。





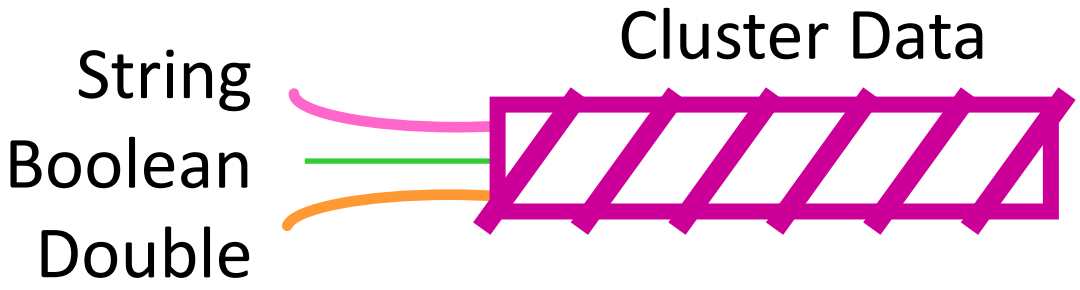


叢集Cluster

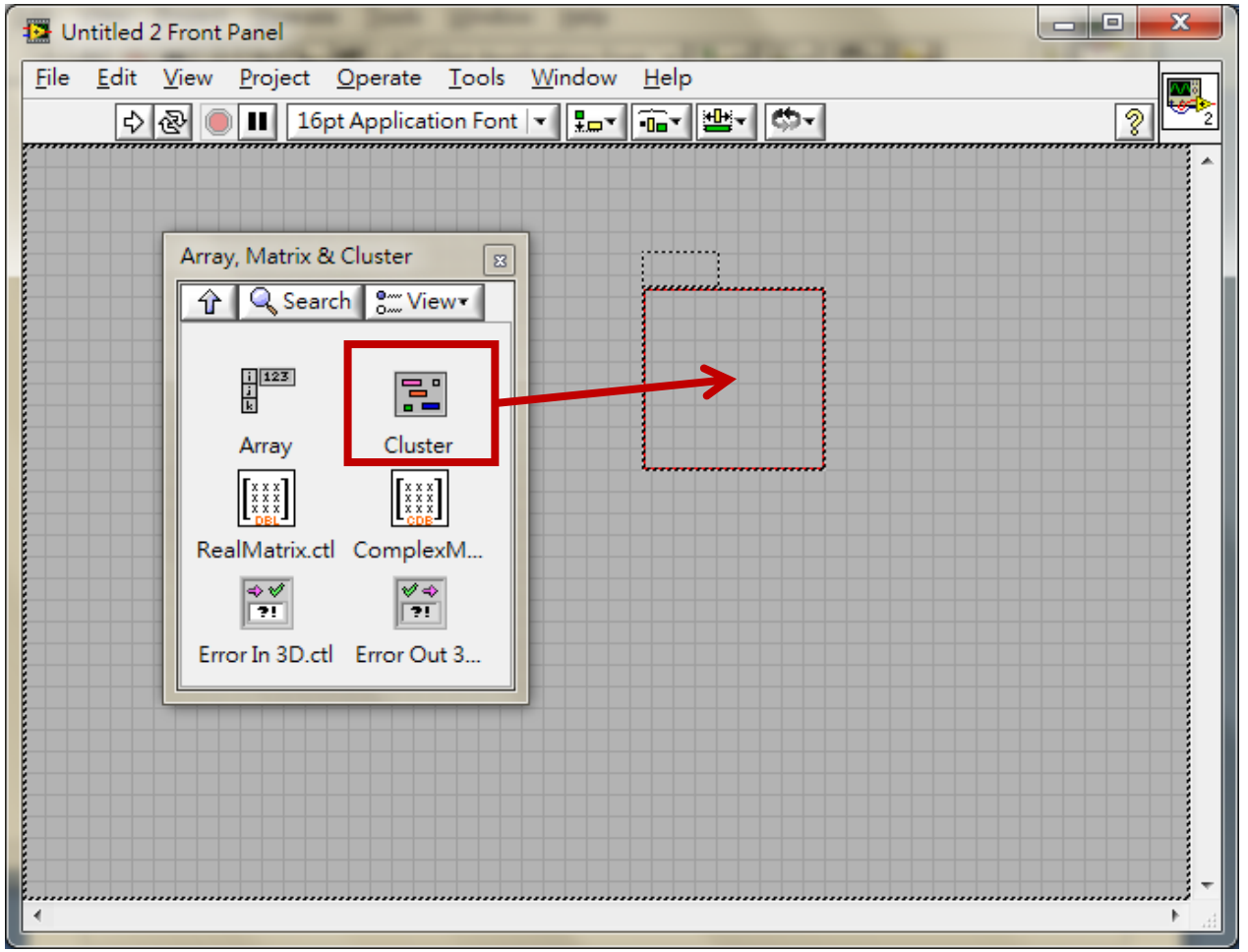
貝登堡智能
KK Intelligent Service,Inc.

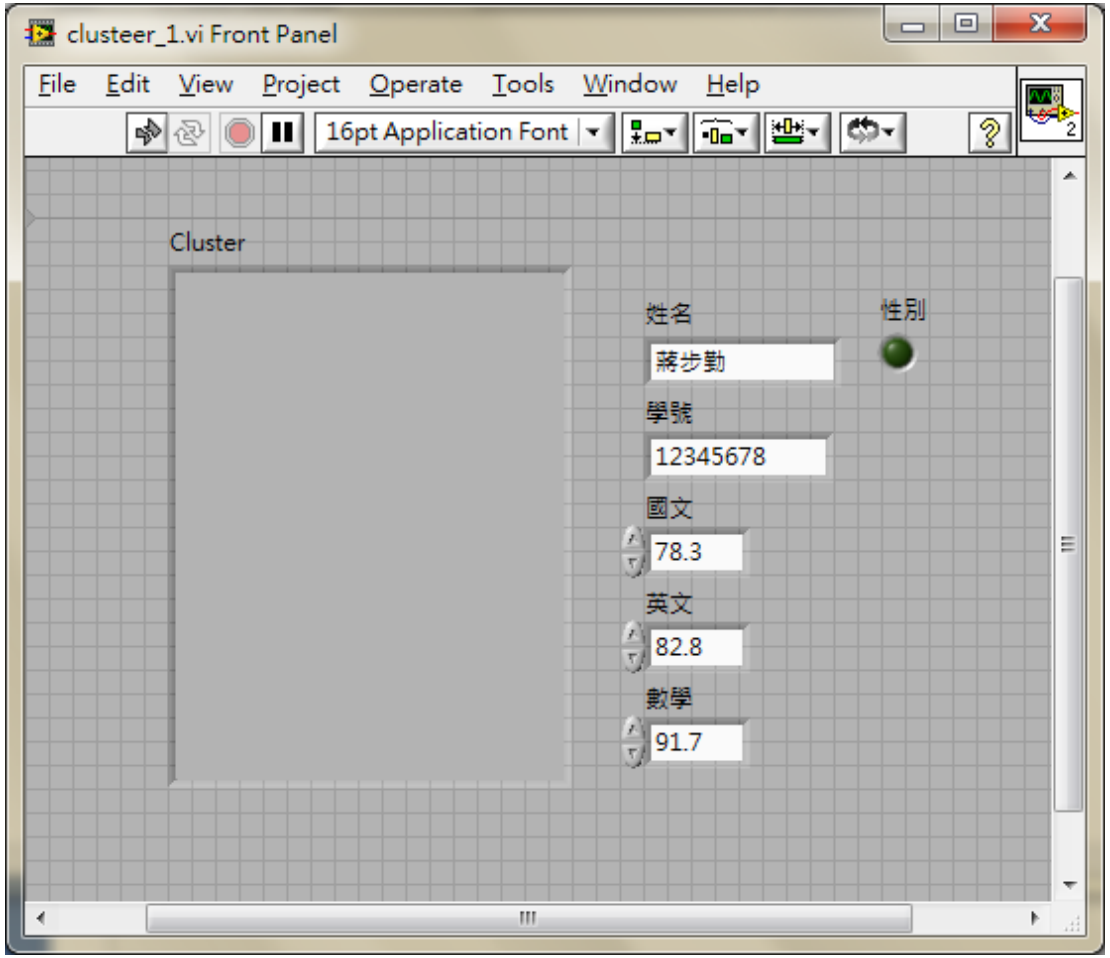
Cluster

- Array的功能是將相同型態的資料加以集中，方便程式撰寫者加以運用，而不同型態的資料，則是使用Cluster來加以打包使用，其功能類似於C語言中的Struct。



Create Cluster on Front Panel





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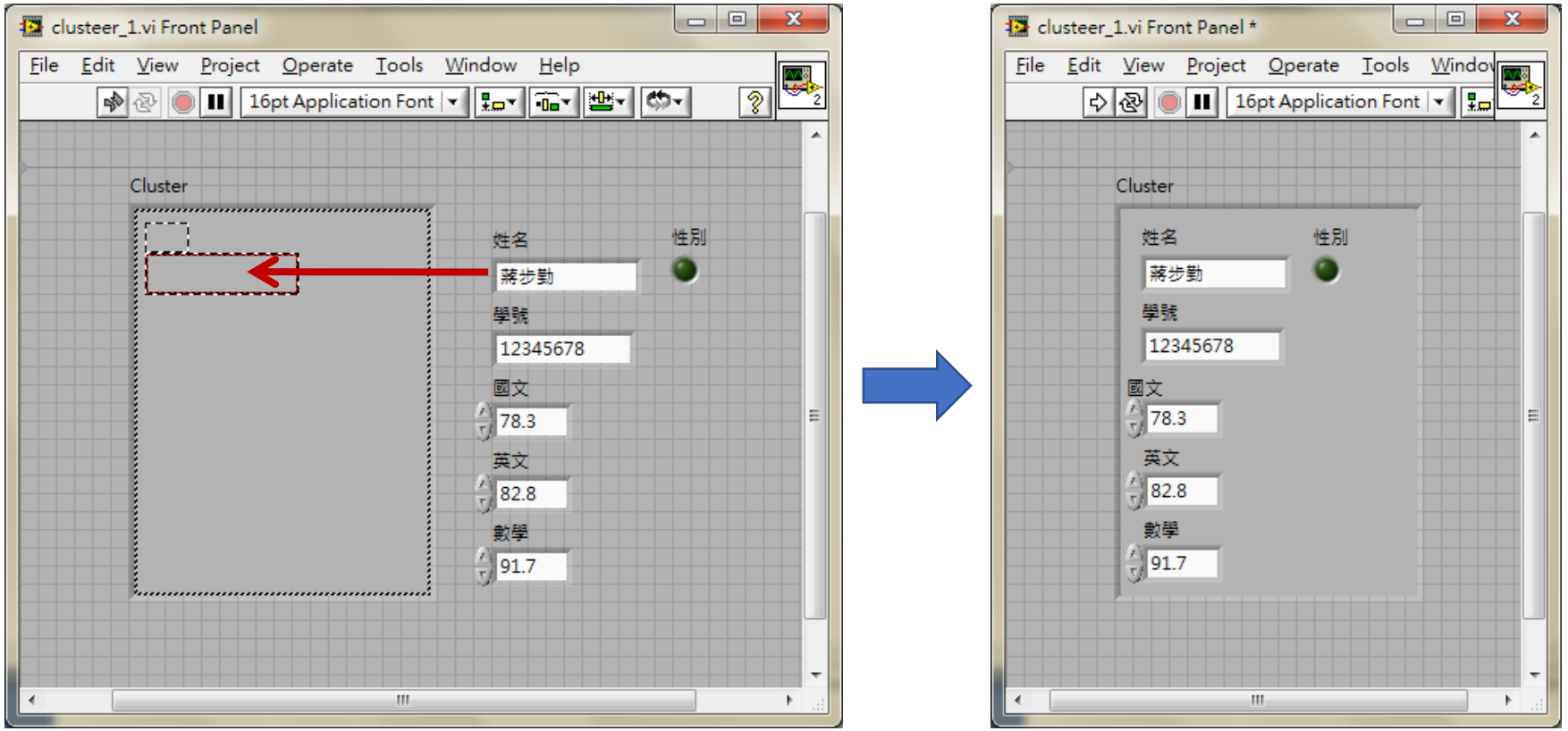
學號：Numeric Int32
國文：Numeric DBL
英文：Numeric DBL
數學：Numeric DBL


clusteer_1.vi Front Panel
File Edit View Project Operate Tools Window Help
16pt Application Font
Cluster
姓名
蔣步勤
性別
學號
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國文
78.3
英文
82.8
數學
91.7
clusteer_1.vi Front Panel *
File Edit View Project Operate Tools Windo
16pt Application Font
Cluster
姓名
蔣步勤
性別
學號
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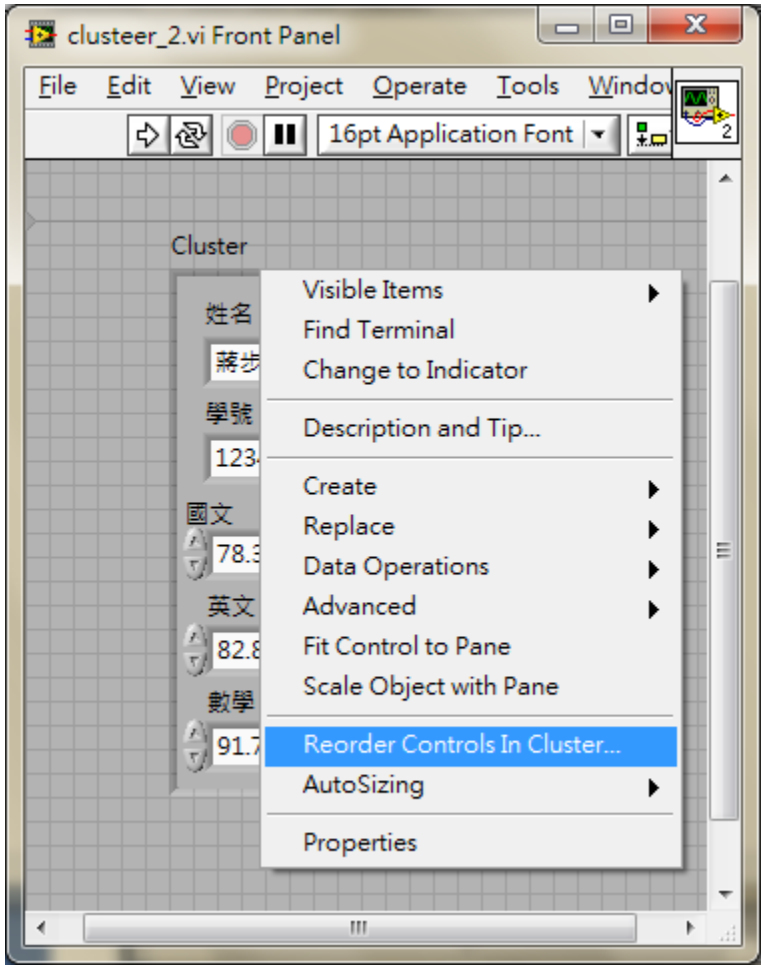
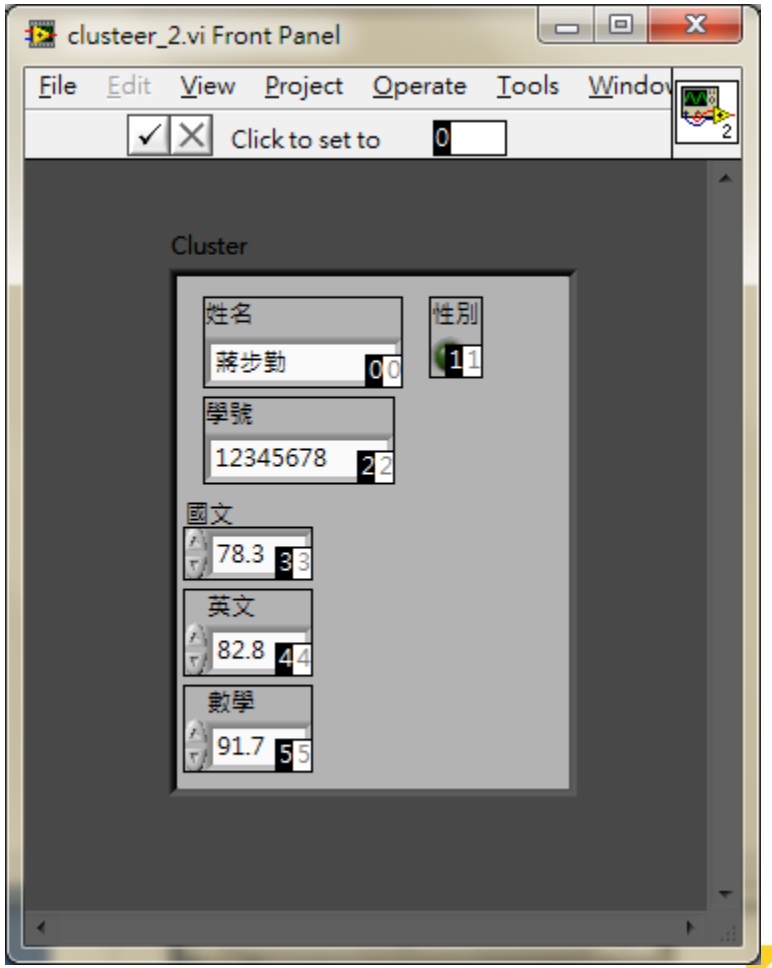
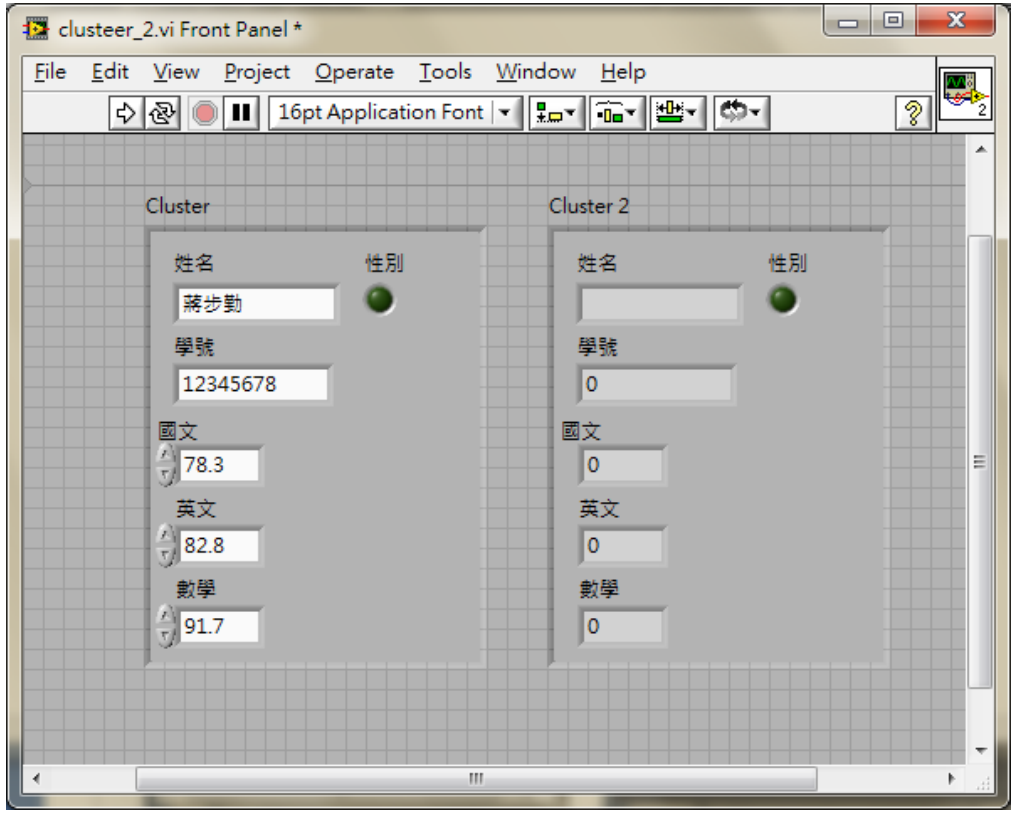
國文
78.3
英文
82.8
數學
91.7

Order of Cluster






clusteer_2.vi Front Panel *
File Edit View Project Operate Tools Window Help
16pt Application Font
Cluster
姓名
性別
蔣步勤
學號
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國文
78.3
英文
82.8
數學
91.7
Cluster 2
姓名
性別
學號
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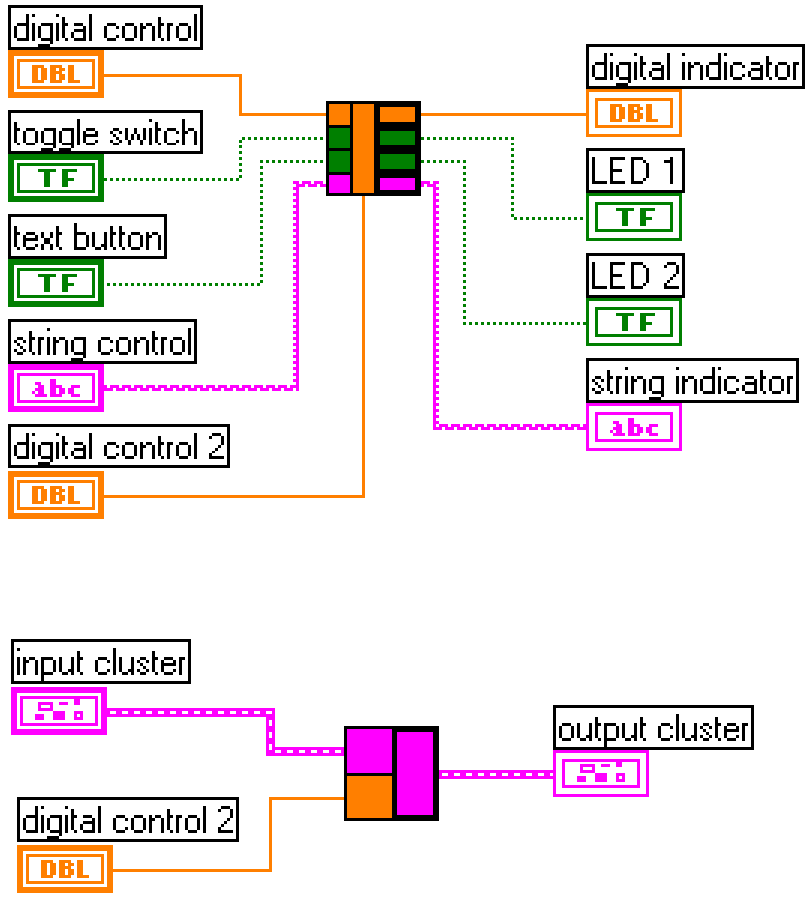
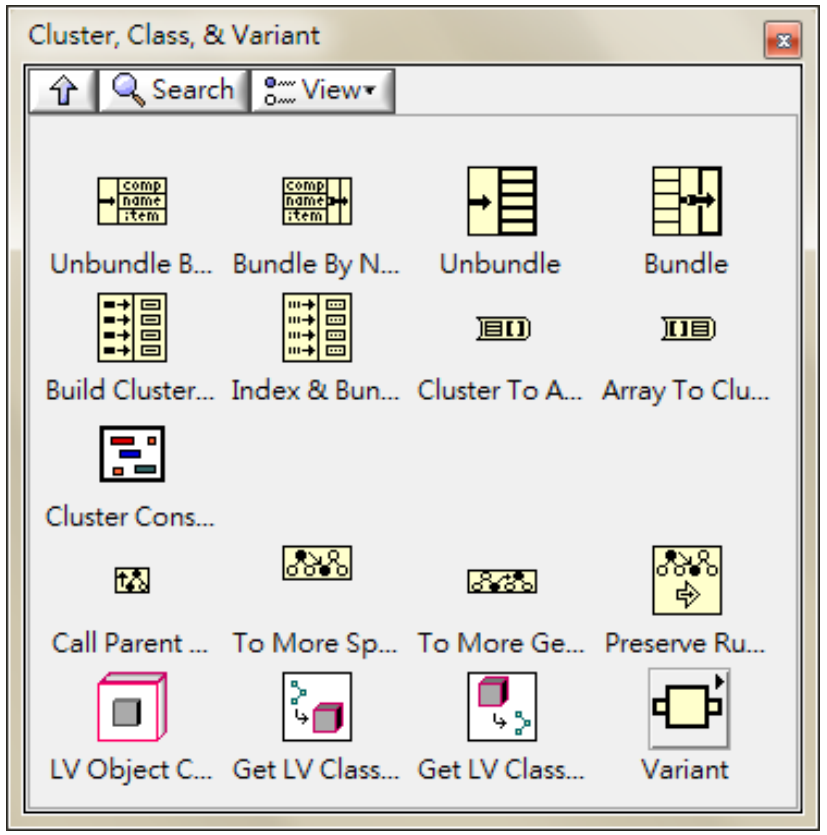
國文
0
英文
0
數學
0


Cluster
Cluster 2

Using Clusters to Pass Data to SubVIs

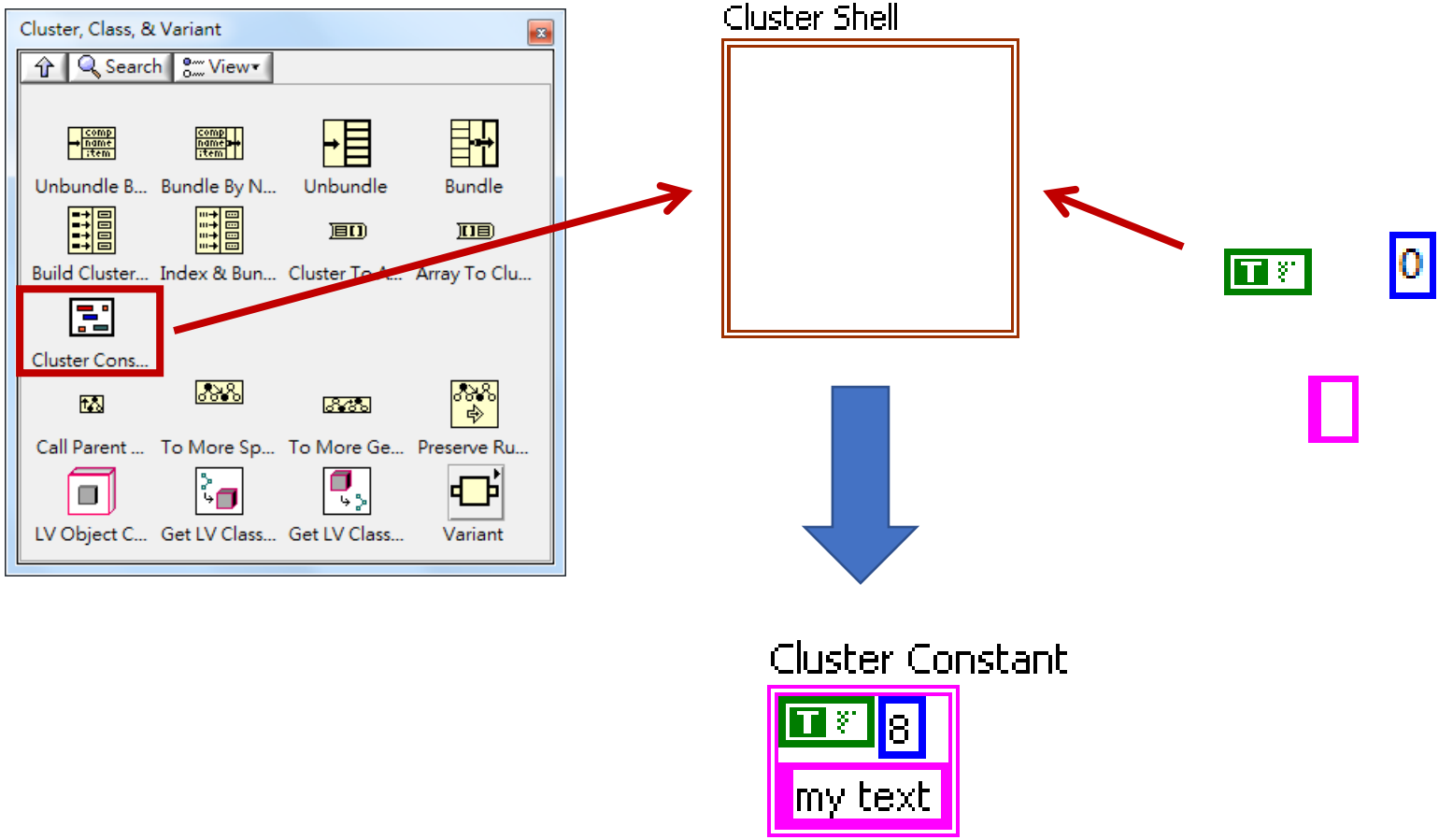


Cluster Function

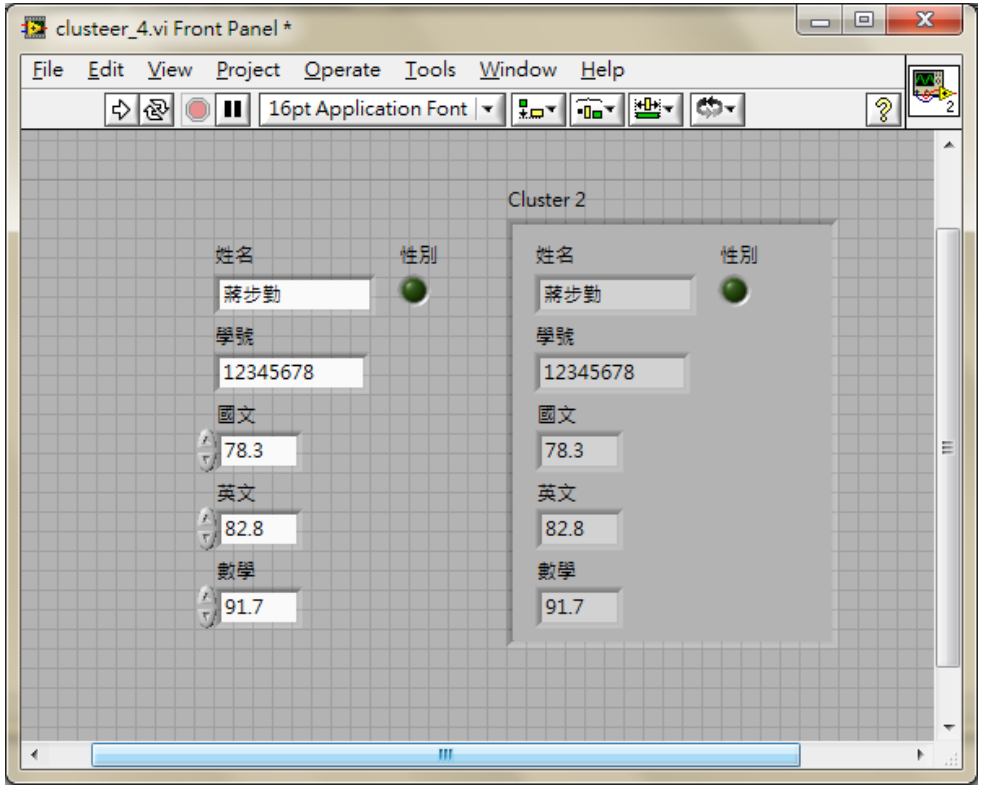


- Bundle
- Unbundle
- Bundle By Name
- Unbundle By Name
- Cluster Constant

Creating Cluster Constants



Bundle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File Edit View Project Operate Tools Window Help
16pt Application Font
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性別
蔣步勤
學號
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國文
78.3
英文
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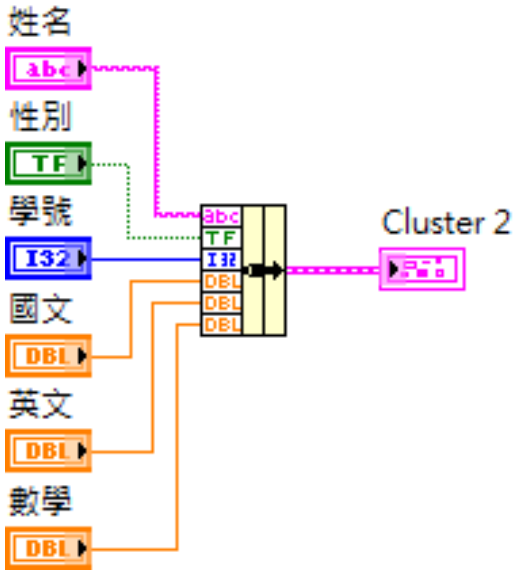
數學
91.7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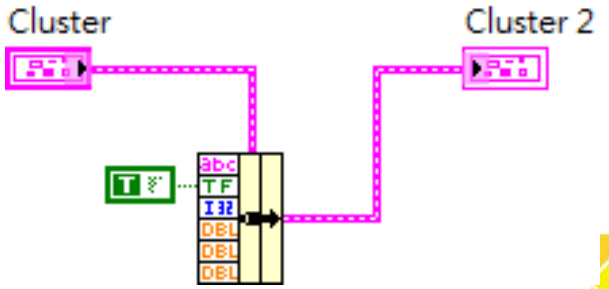
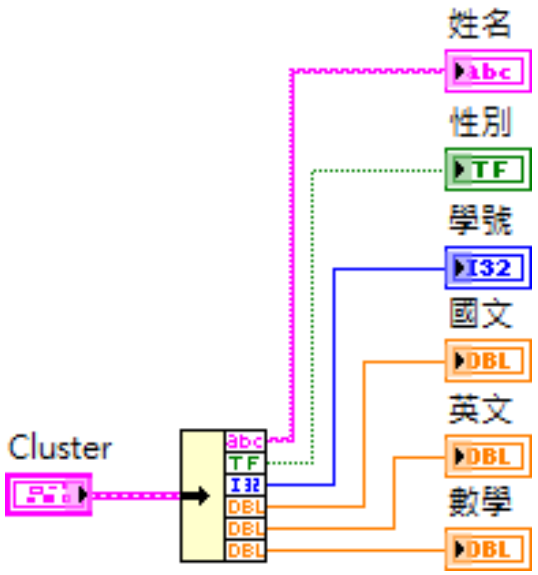
國文
英文
數學
Cluster 2


Cluster
Cluster 2

Unbundle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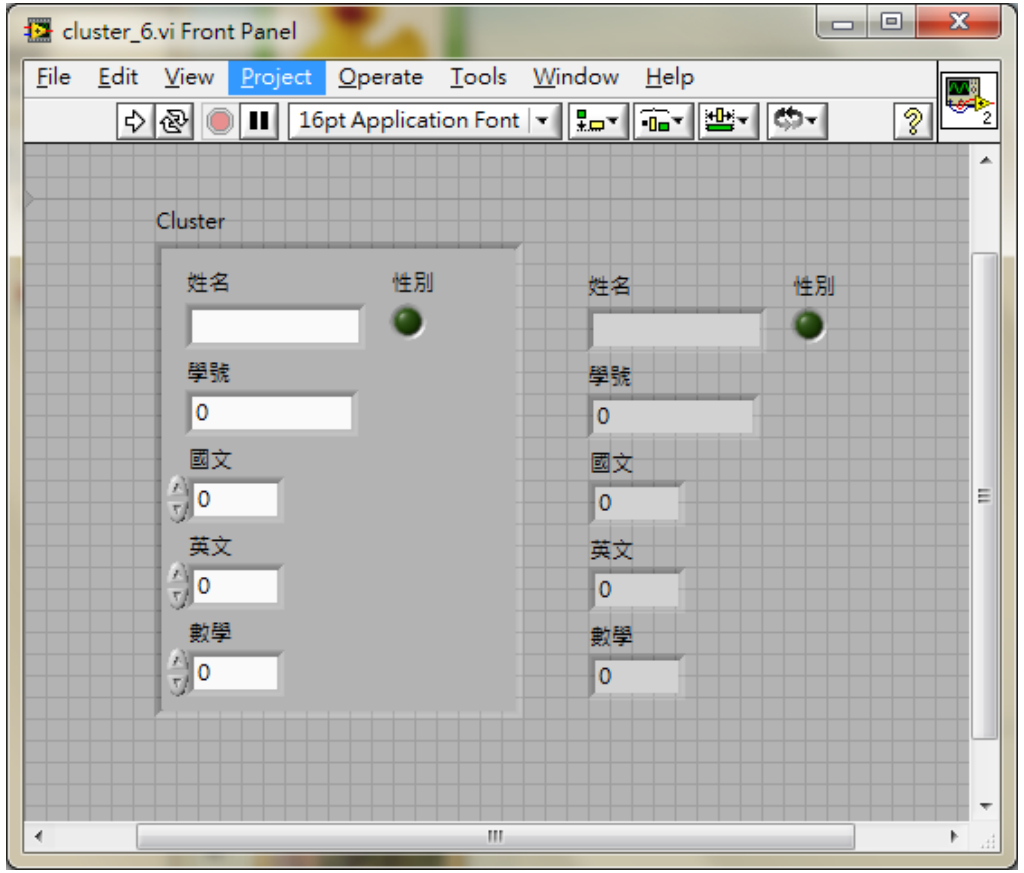
cluster_6.vi Front Panel
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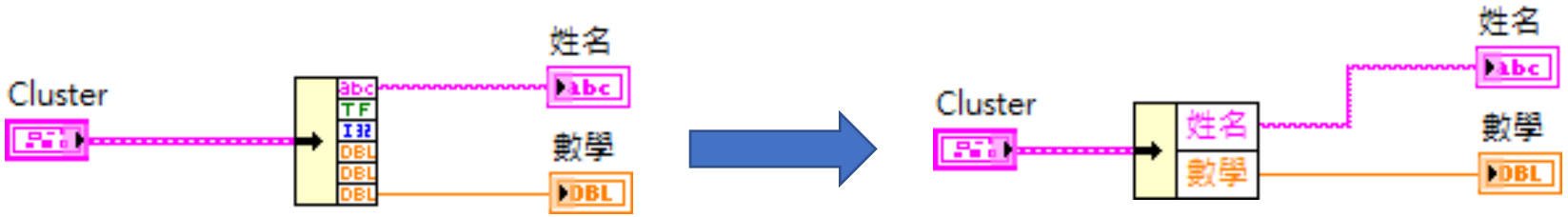
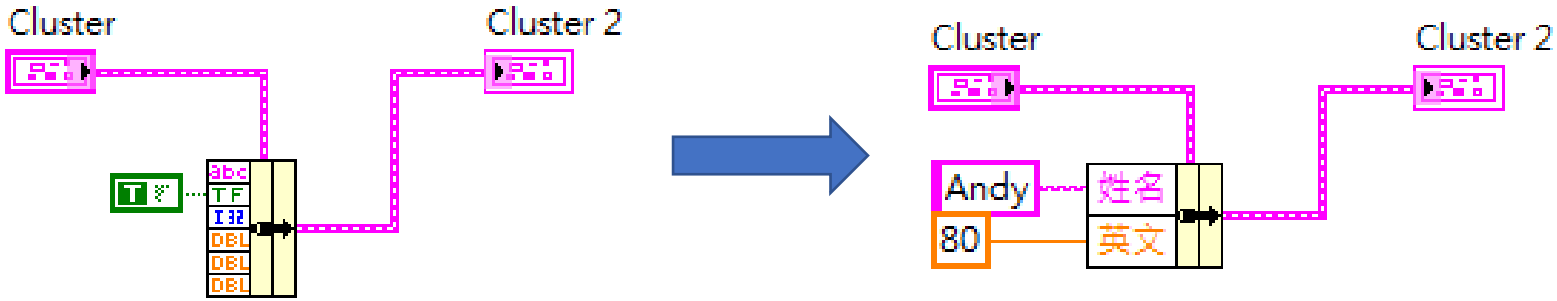
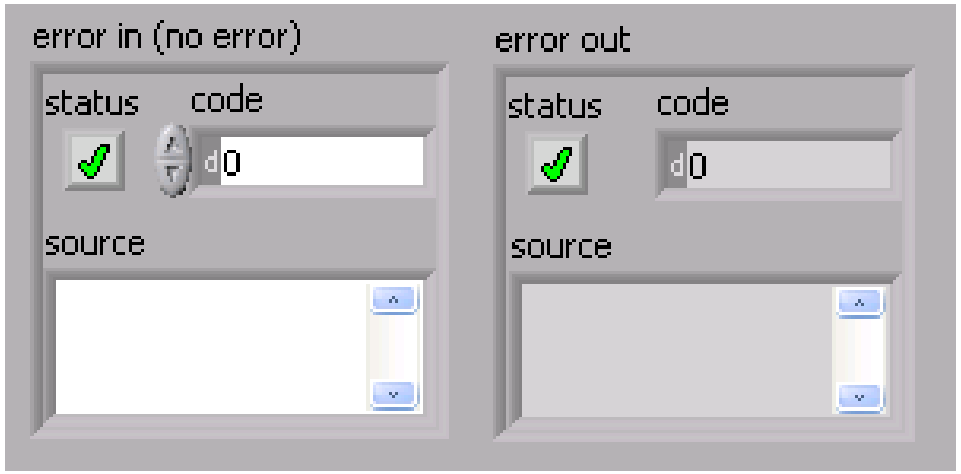
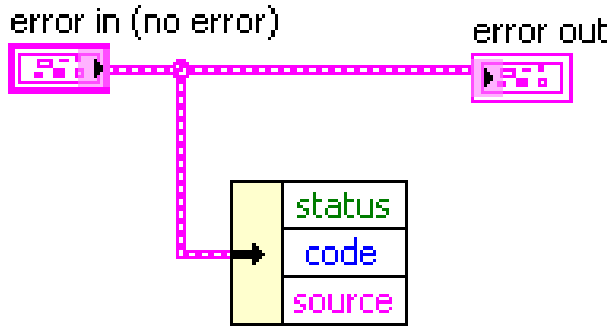
Bundle/Unbundle By Name

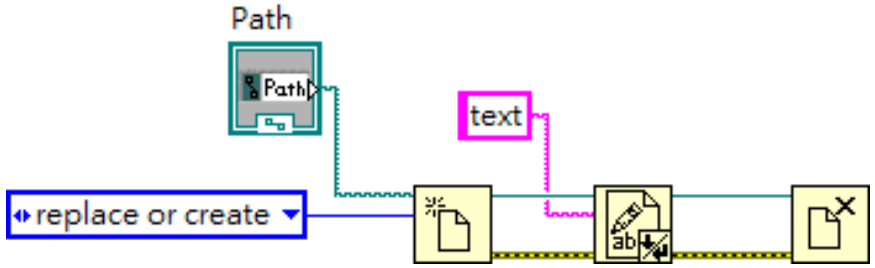




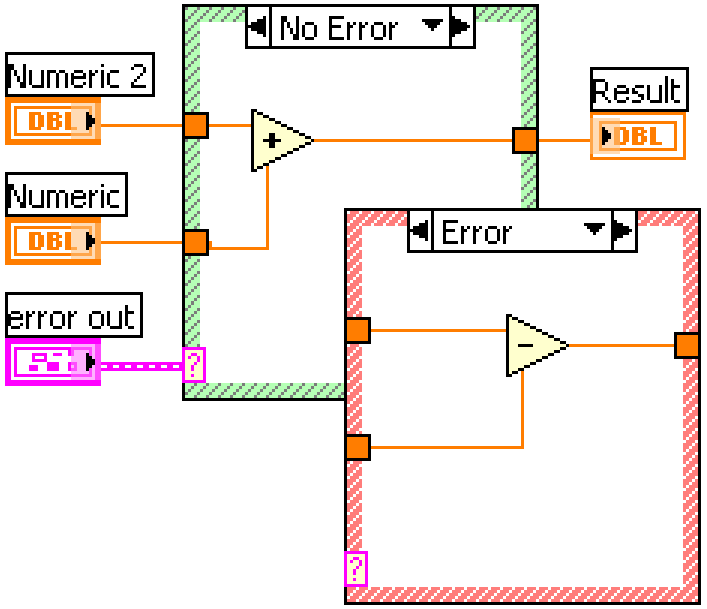
Error Cluster

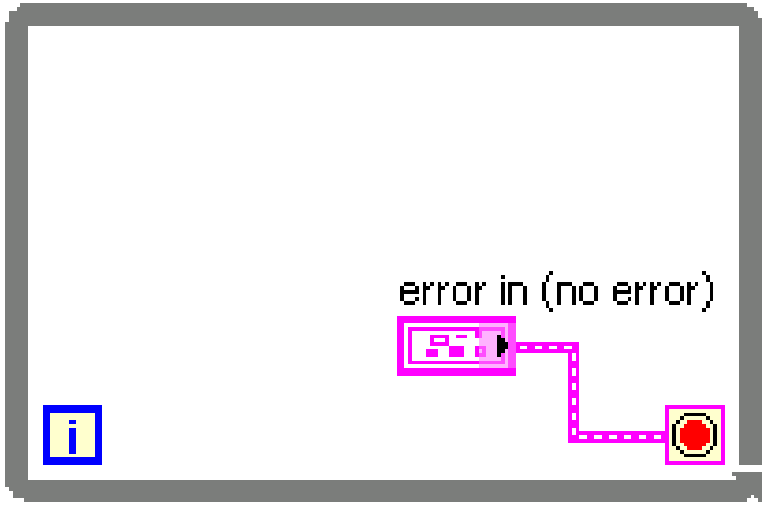






Error Structure

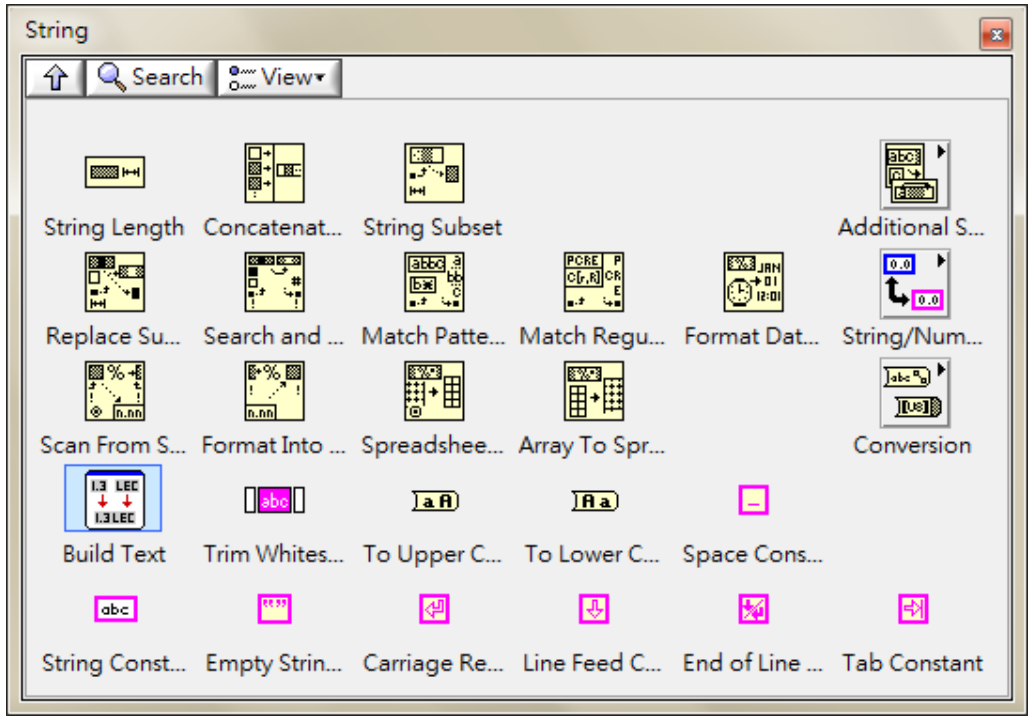




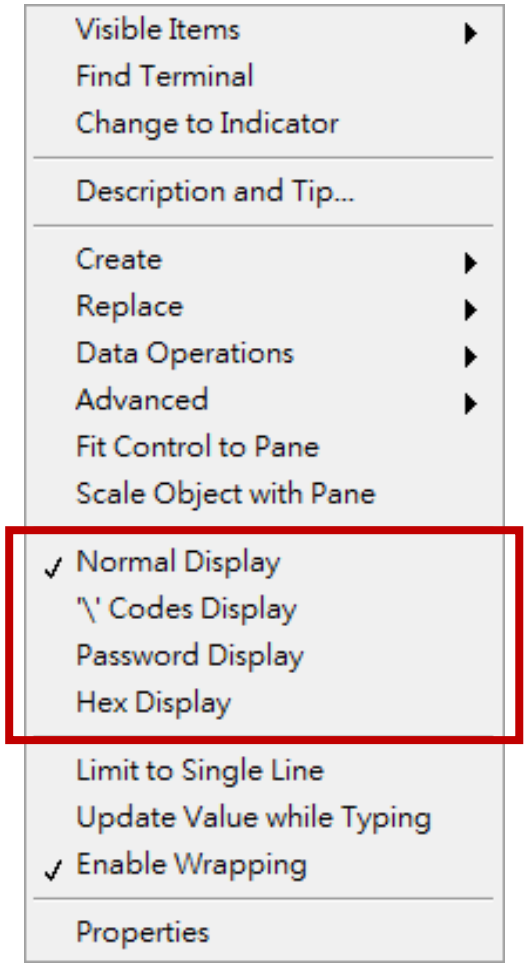
字串String

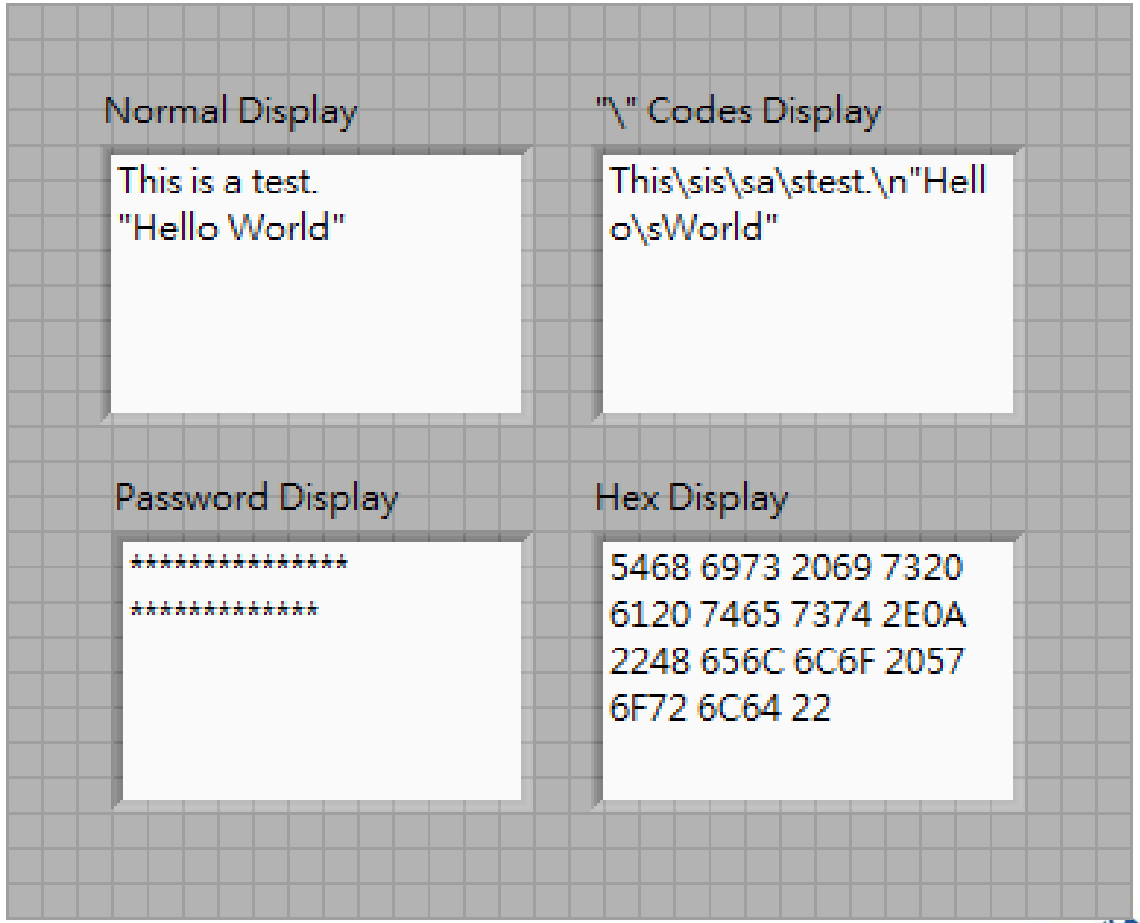
String

字串可以有效的提供訊息給使用者，並且可應用在檔案I/O上。

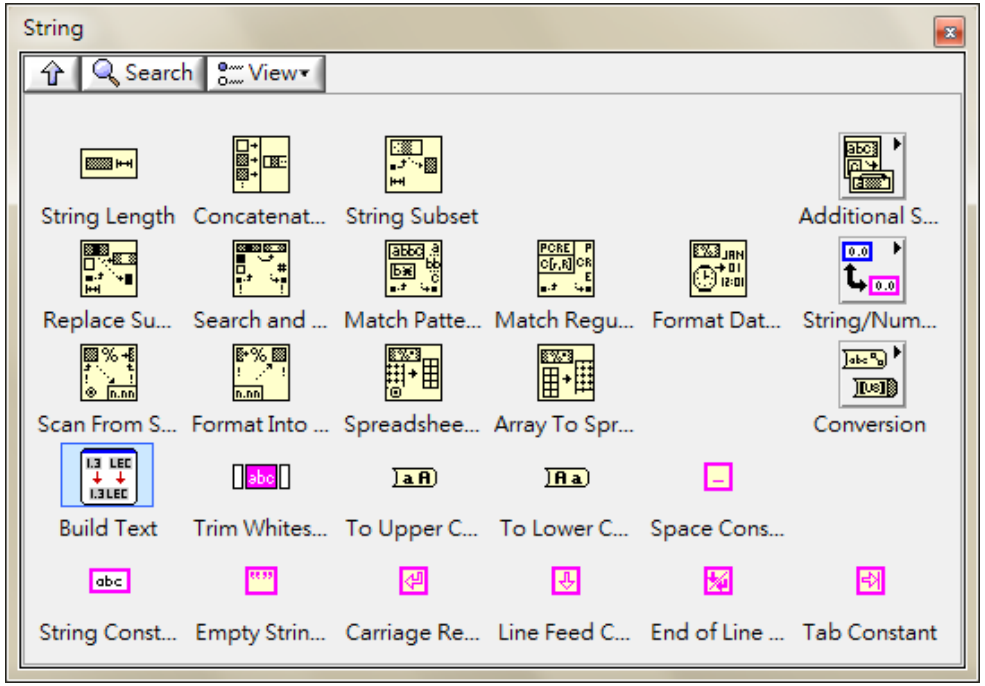


Display Mode



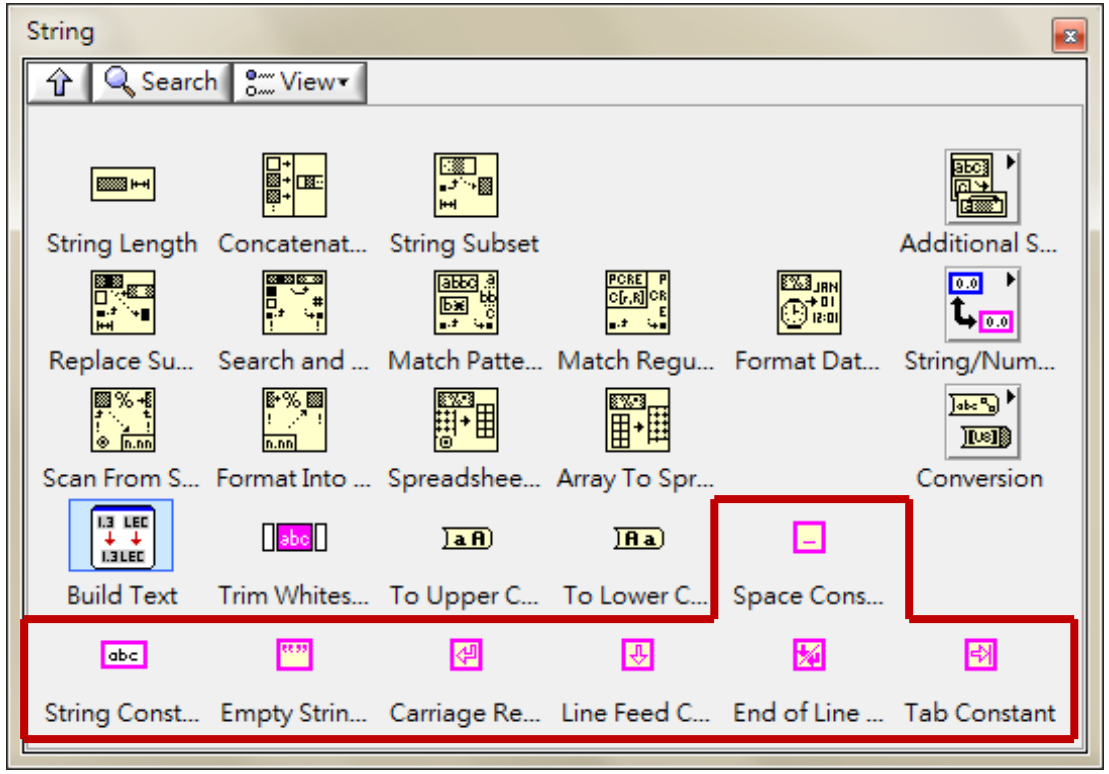


Common Functions



String Constant
String Length
Concatenate Strings
Match Pattern
Spreadsheet string
String/Number

String Constant



String Constant

Space Constant.vi

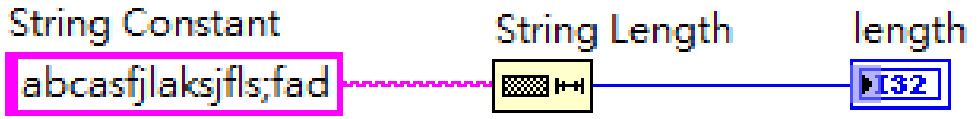
Empty String Constant

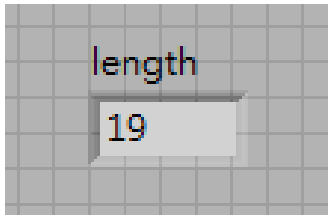
Carriage Return Constant

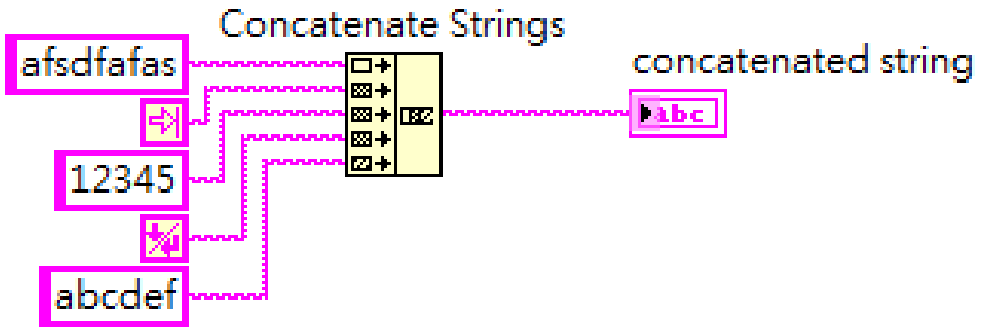
Line Feed Constant

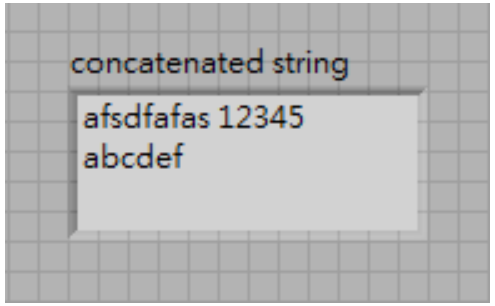
End of Line Constant

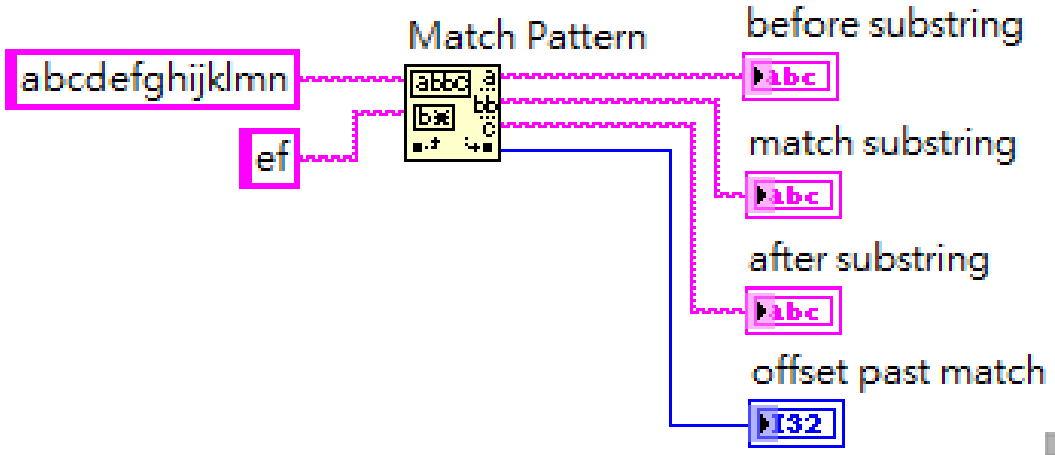
Tab Constant

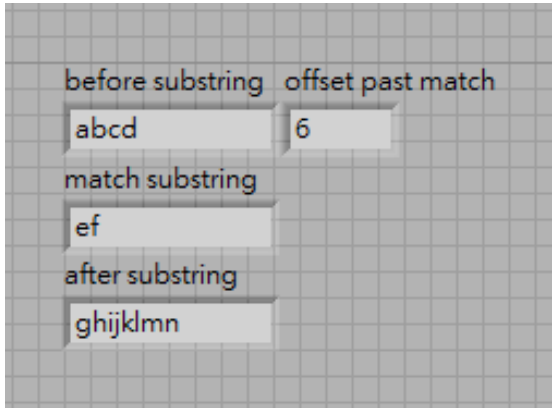

String Constant
abcasfjlaksjfls;fad
String Length
length
I32

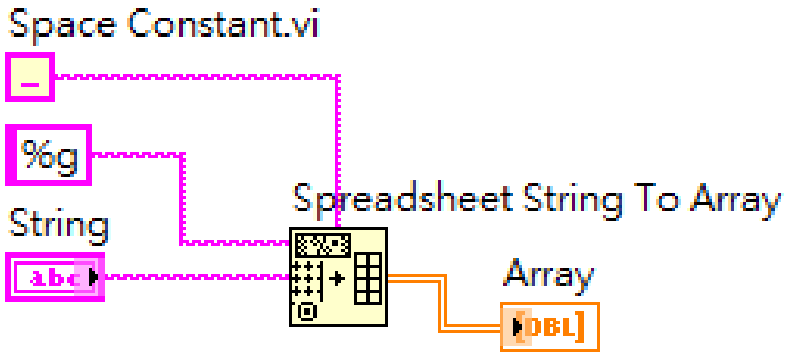

length
19

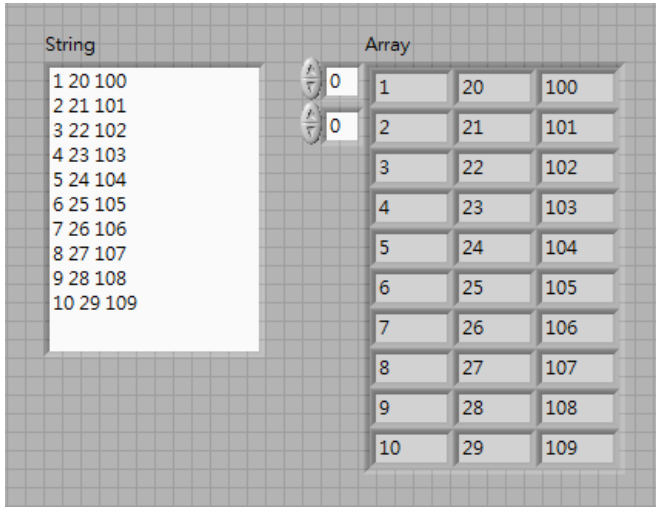

Concatenate Strings
afsdfafas
12345
abcdef
concatenated string
abc


concatenated string
afsdfafas 12345
abcdef

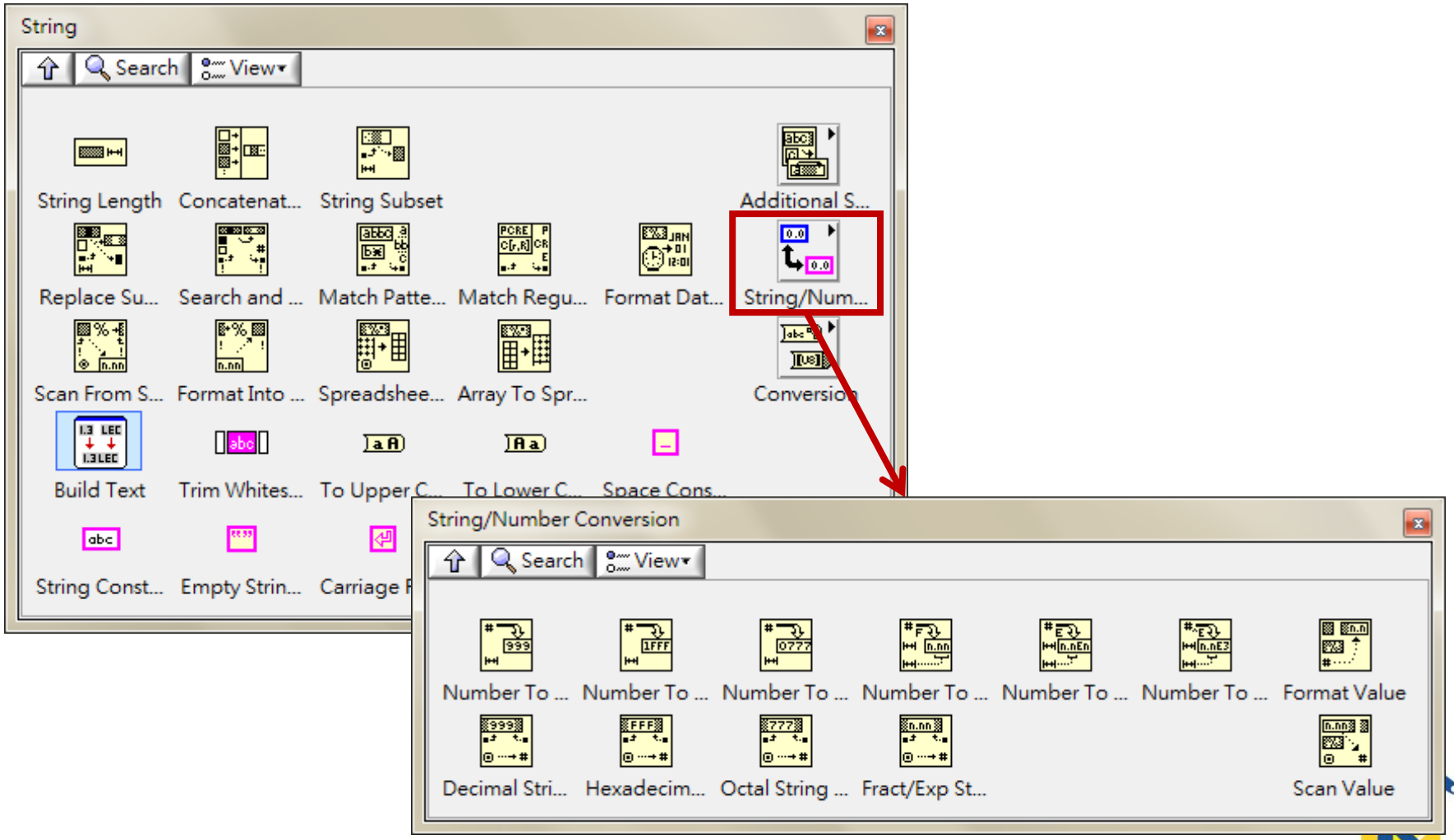

abcdefghijklmn
ef
Match Pattern
before substring
match substring
after substring
offset past match
abc
abc
abc
I32


before substring
offset past match
abcd
6
match substring
ef
after substring
ghijklmn


Space Constant.vi
%g
String
abc
Spreadsheet String To Array
Array
DBL]


String
1 20 100
2 21 101
3 22 102
4 23 103
5 24 104
6 25 105
7 26 106
8 27 107
9 28 108
10 29 109
Array
0
0
1 20 100
2 21 101
3 22 102
4 23 103
5 24 104
6 25 105
7 26 106
8 27 107
9 28 108
10 29 109

String/Number



進階應用

貝登堡智能
KK Intelligent Service,Inc.

Type Definition

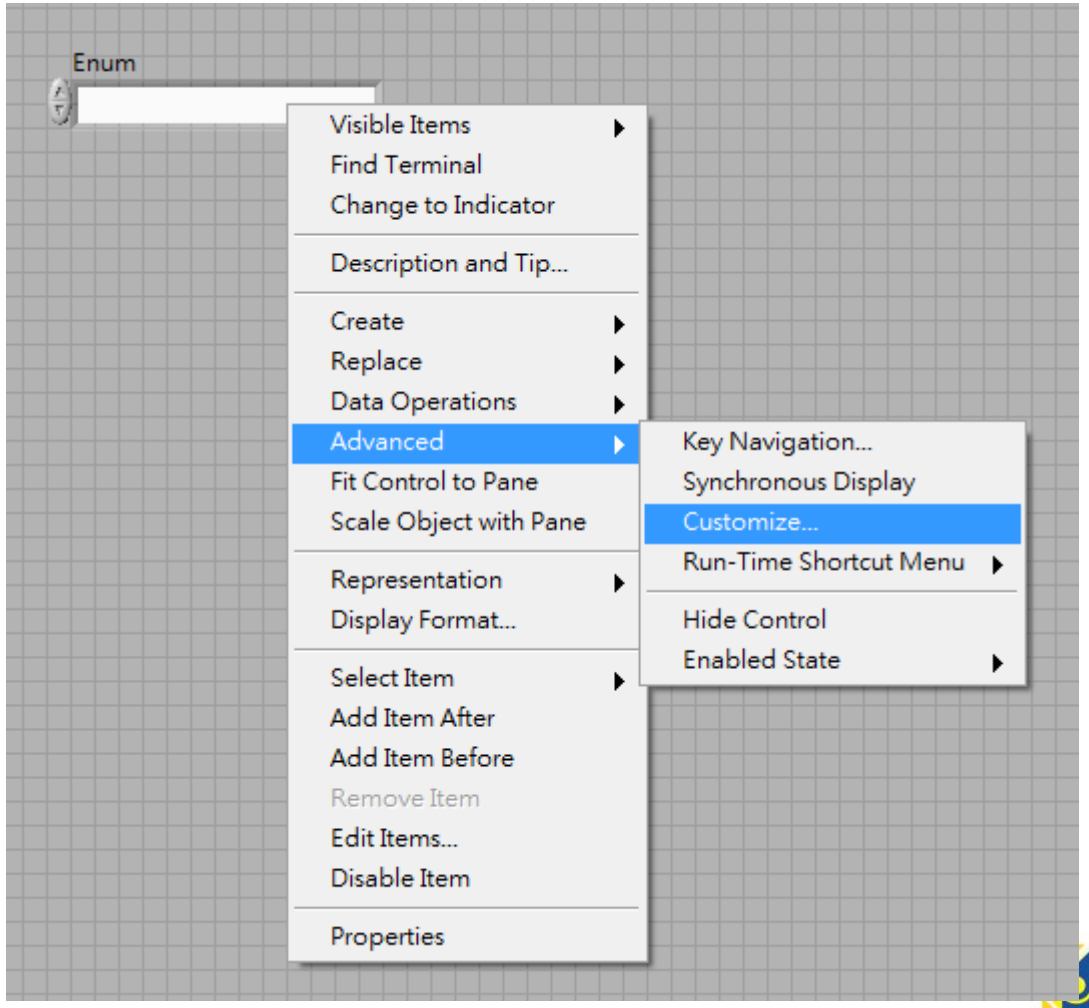
滑鼠按右鍵

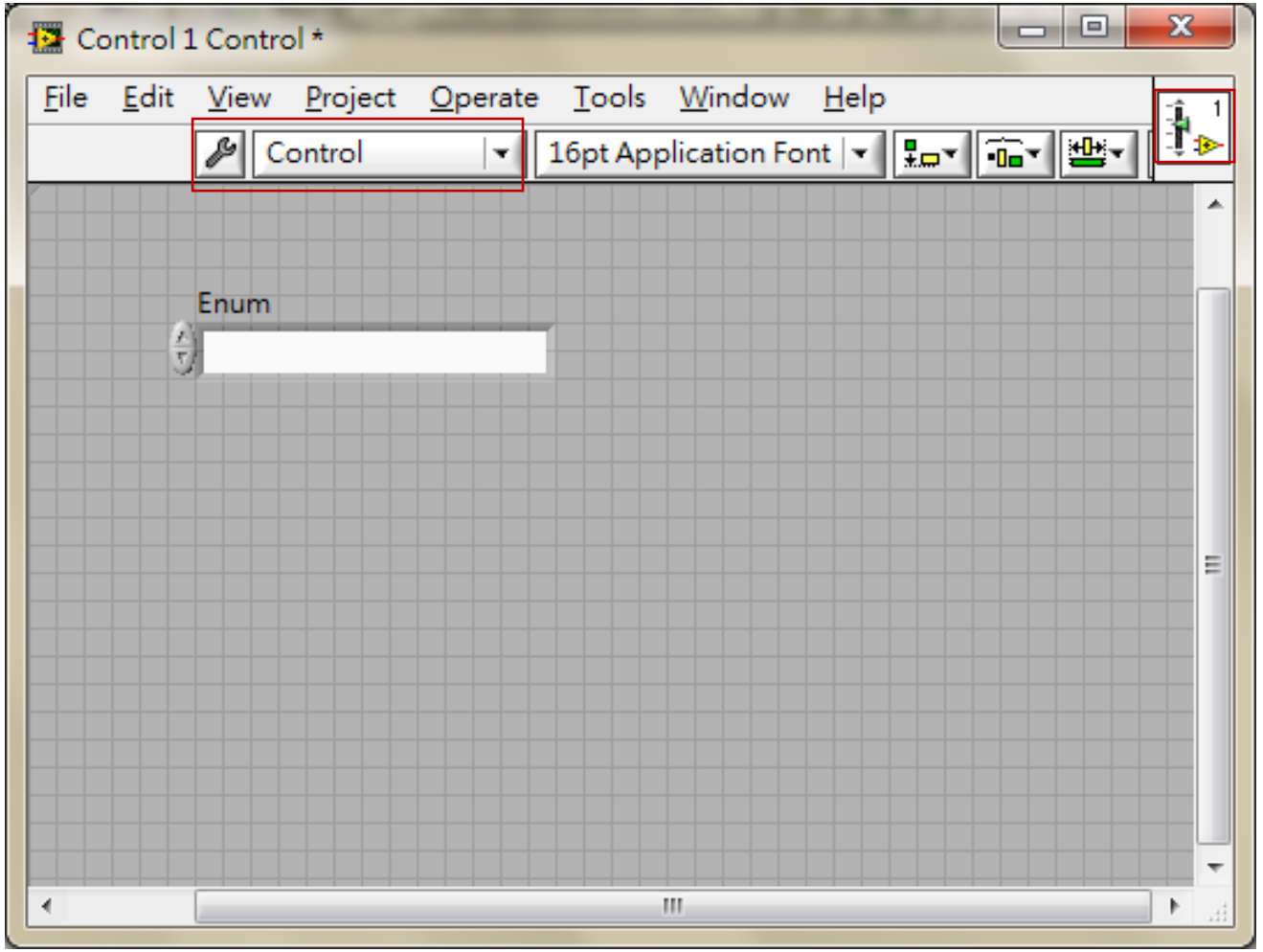
↓

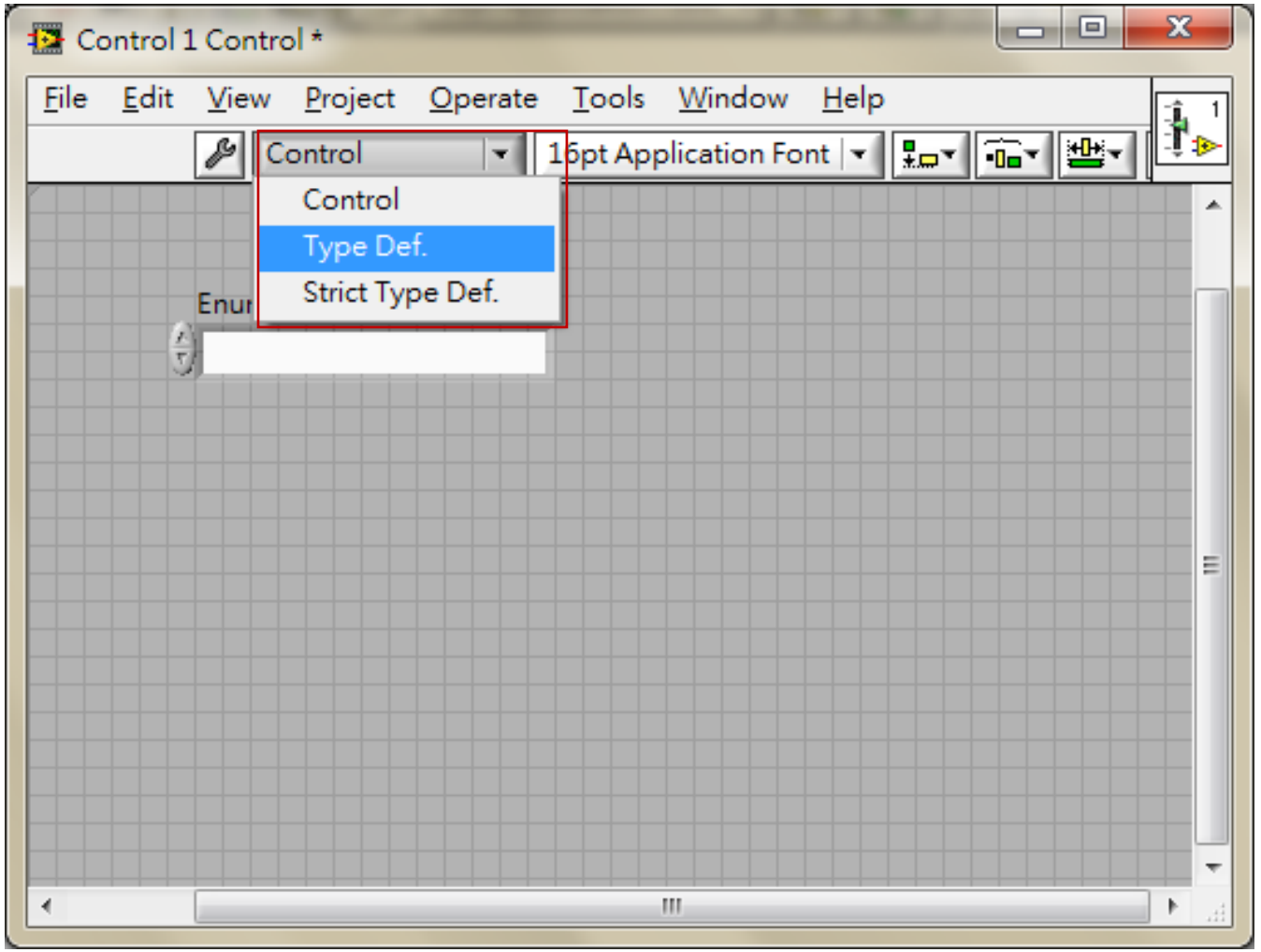
Advanced

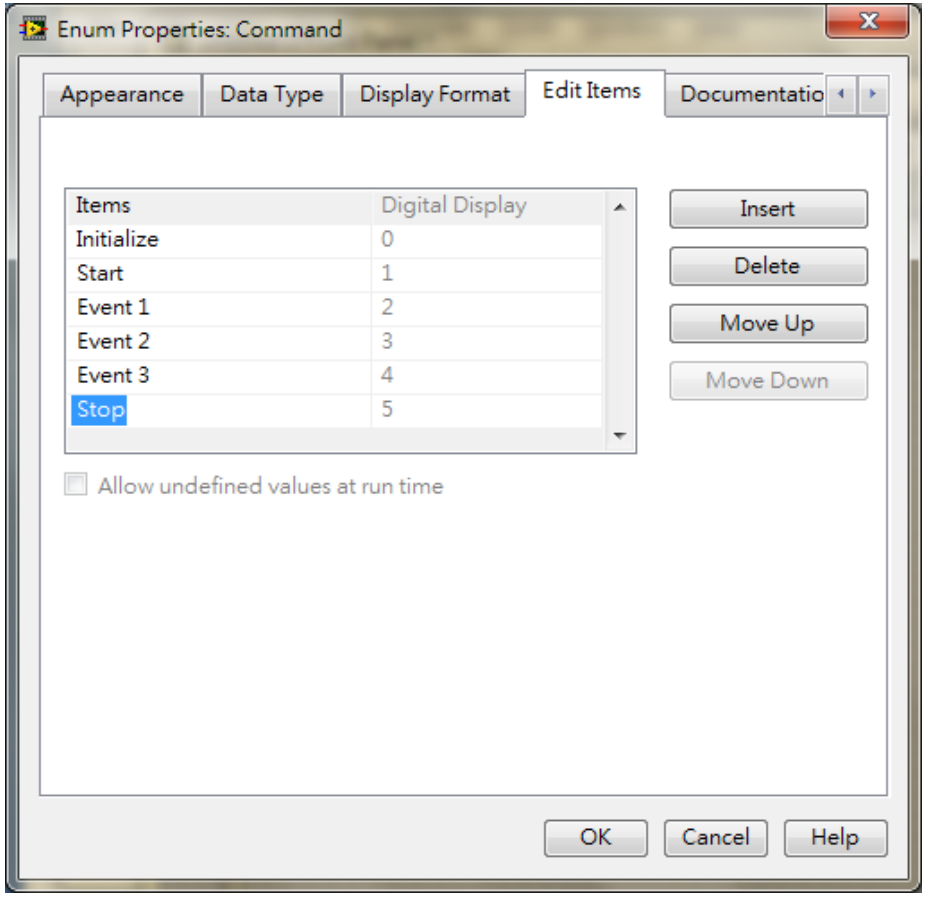
↓

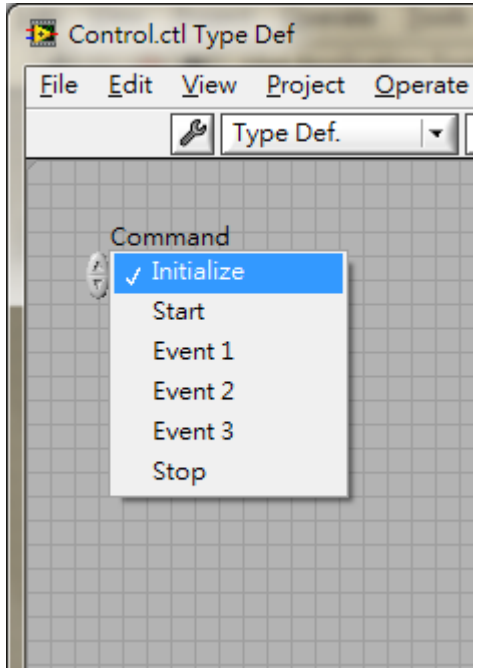
Customize




Control 1 Control *
File Edit View Project Operate Tools Window Help
Control
16pt Application Font
Enum


Control 1 Control *
File Edit View Project Operate Tools Window Help
Control
16pt Application Font
Control
Type Def.
Strict Type Def.
Enu

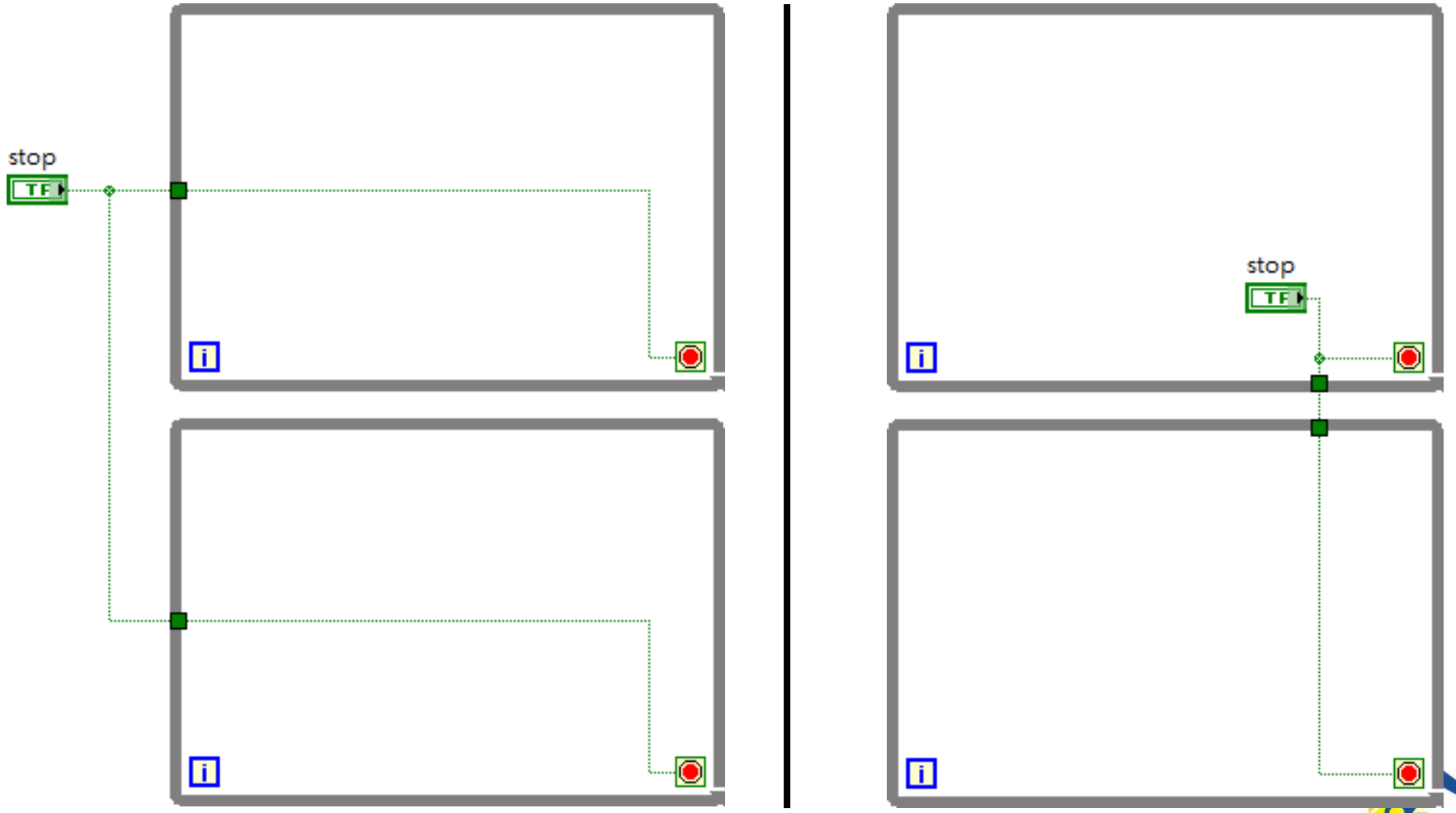

Enum Properties: Command
Appearance
Data Type
Display Format
Edit Items
Documentatio
Items
Digital Display
Initialize 0
Start 1
Event 1 2
Event 2 3
Event 3 4
Stop 5
Insert
Delete
Move Up
Move Down
Allow undefined values at run time
OK
Cancel
Help


Control.ctl Type Def
File
Edit
View
Project
Operate
Type Def.
Command
Initialize
Start
Event 1
Event 2
Event 3
Stop

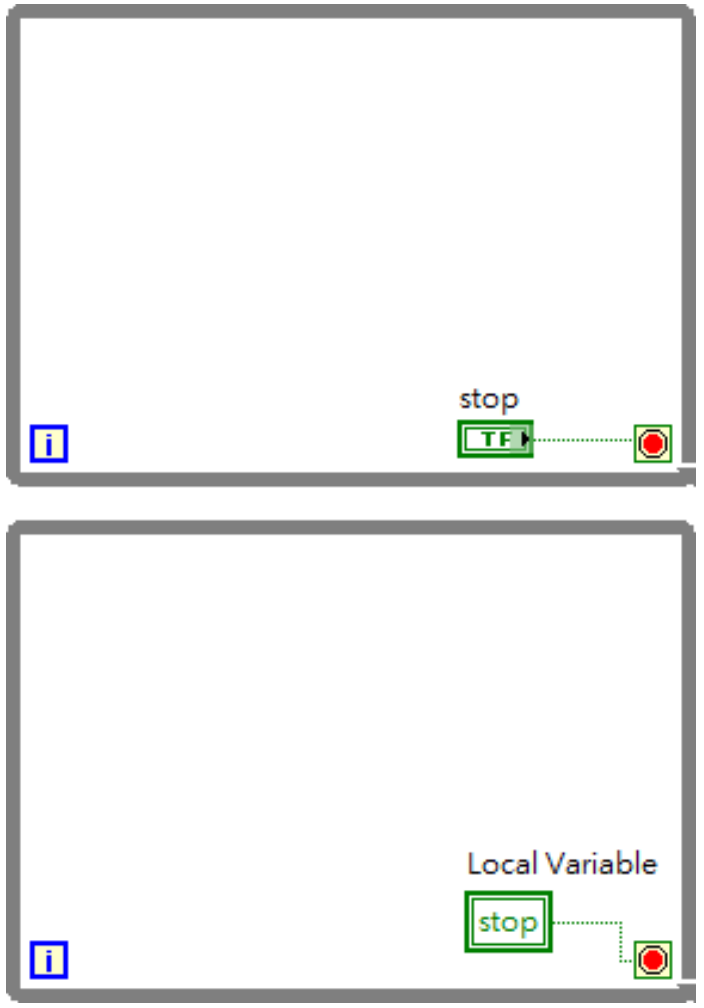
Variables

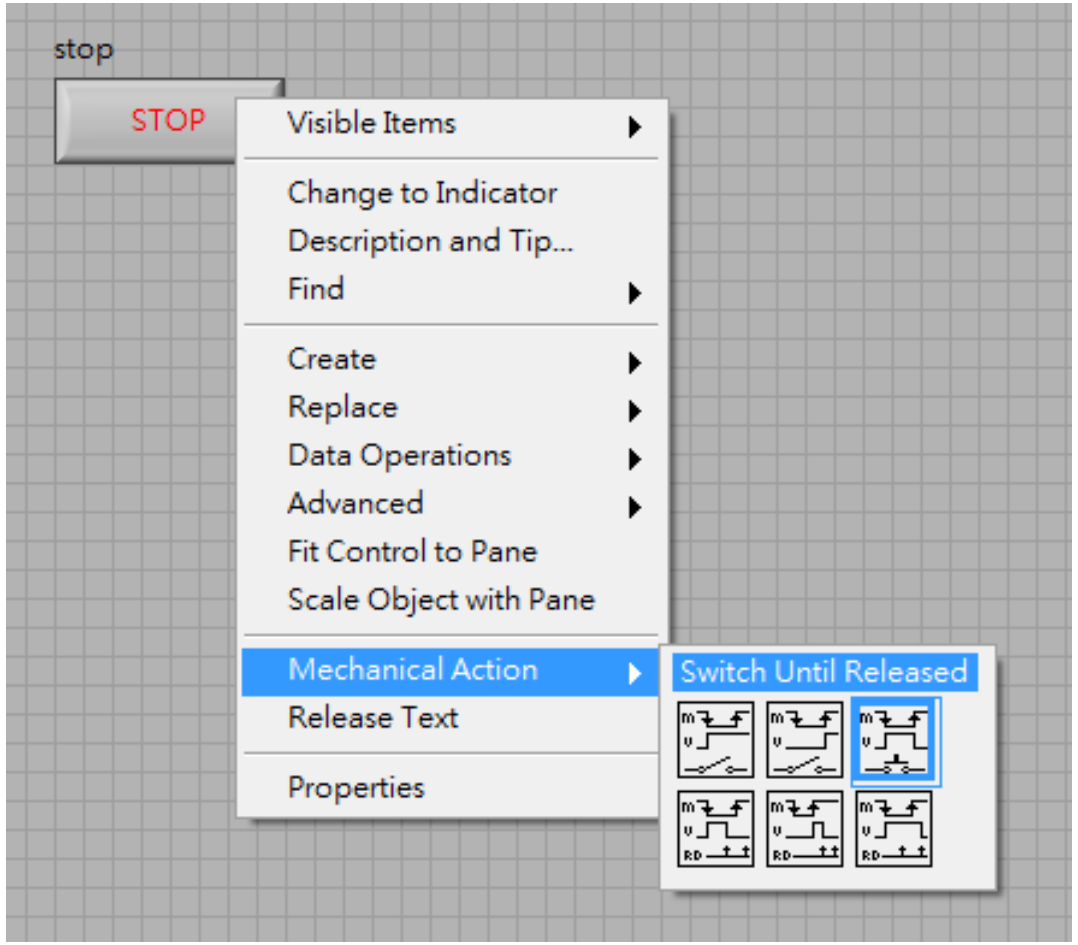
- Local Variable
- Global Variable
- Shared Variable
- Functional Global Variable

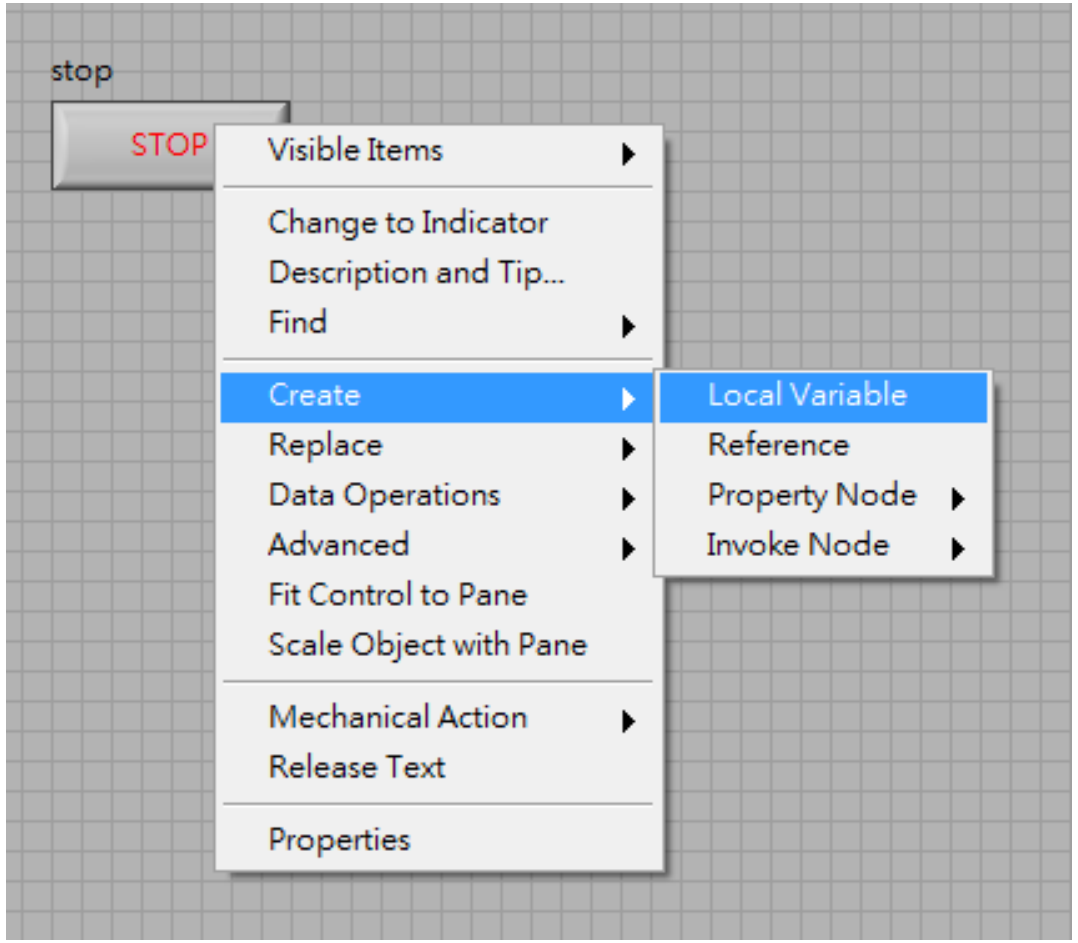
當按下Stop會發生甚麼事?

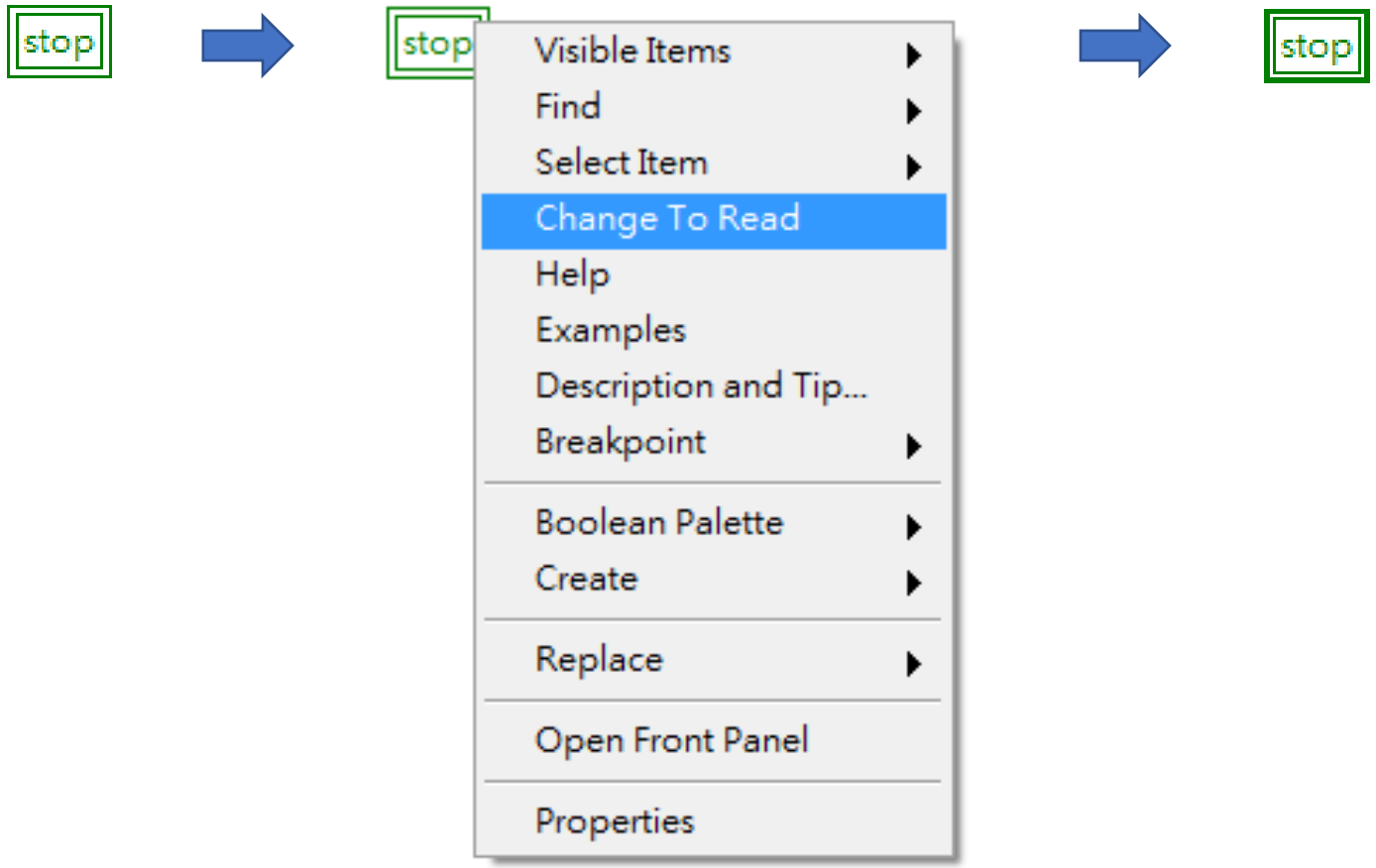


Use Local Variable

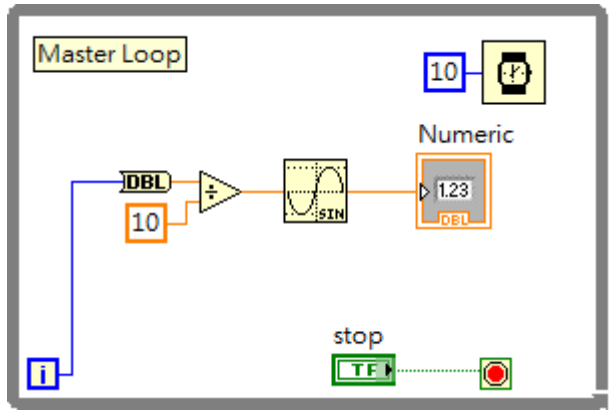


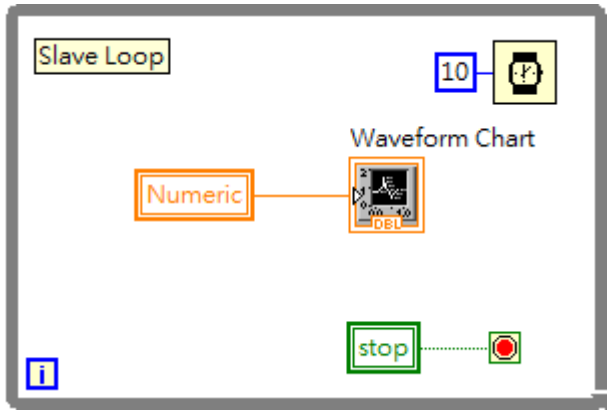

stop
STOP
Visible Items
Change to Indicator
Description and Tip...
Find
Create
Replace
Data Operations
Advanced
Fit Control to Pane
Scale Object with Pane
Mechanical Action
Release Text
Properties
Switch Until Released

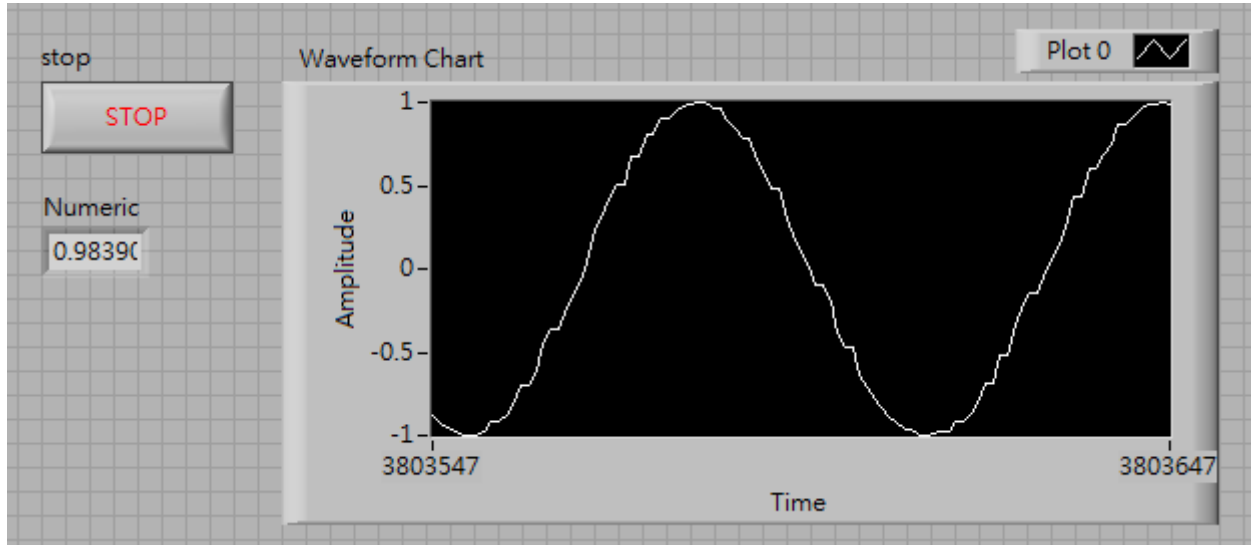

stop
STOP
Visible Items
Change to Indicator
Description and Tip...
Find
Create
Replace
Data Operations
Advanced
Fit Control to Pane
Scale Object with Pane
Mechanical Action
Release Text
Properties
Local Variable
Reference
Property Node
Invoke Node


stop
stop
Visible Items
Find
Select Item
Change To Read
Help
Examples
Description and Tip...
Breakpoint
Boolean Palette
Create
Replace
Open Front Panel
Properties
stop

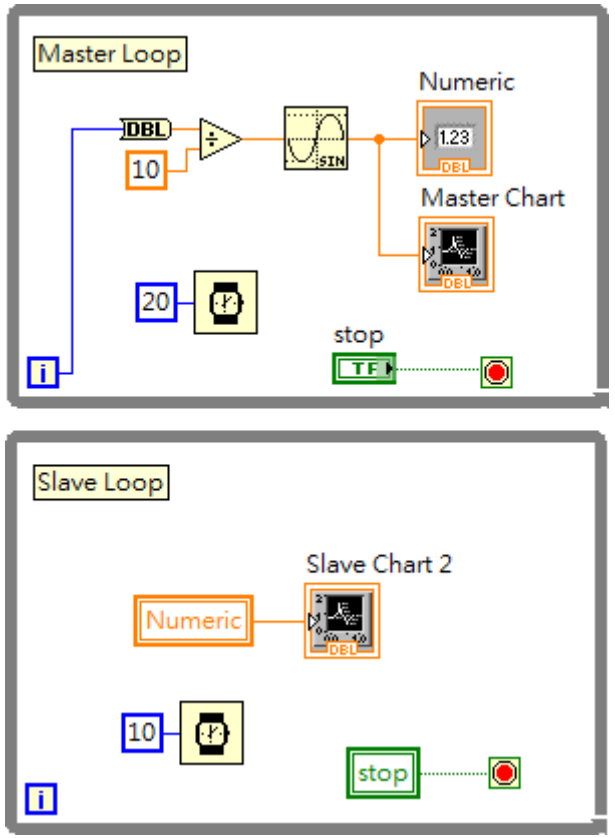
Example

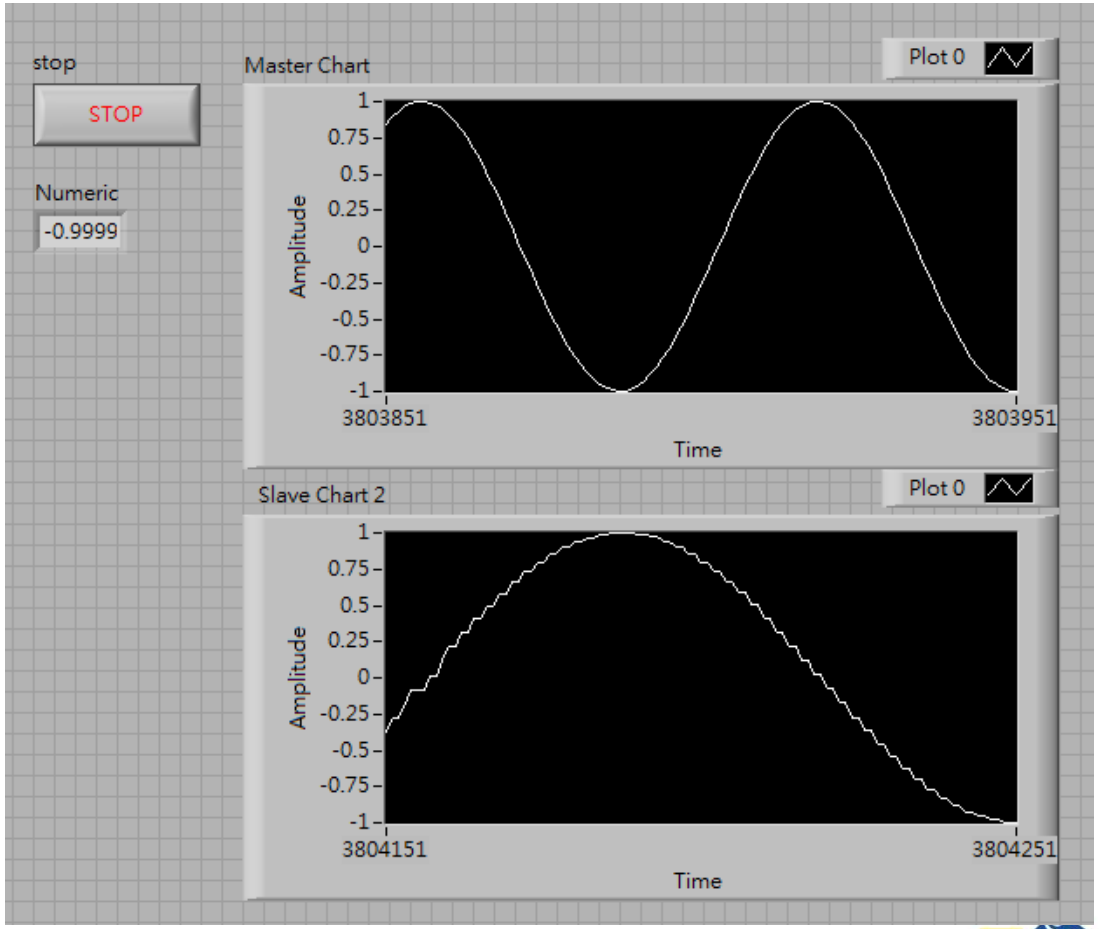

Master Loop
10
Numeric
DBL
10
SIN
1.23
DBL
stop
TF


Slave Loop
10
Waveform Chart
Numeric
DBL
stop


stop
STOP
Numeric
0.9839(
Waveform Chart
Plot 0
1
0.5
0
-0.5
-1
Amplitude
3803547
3803647
Time

修改一下Delay Time

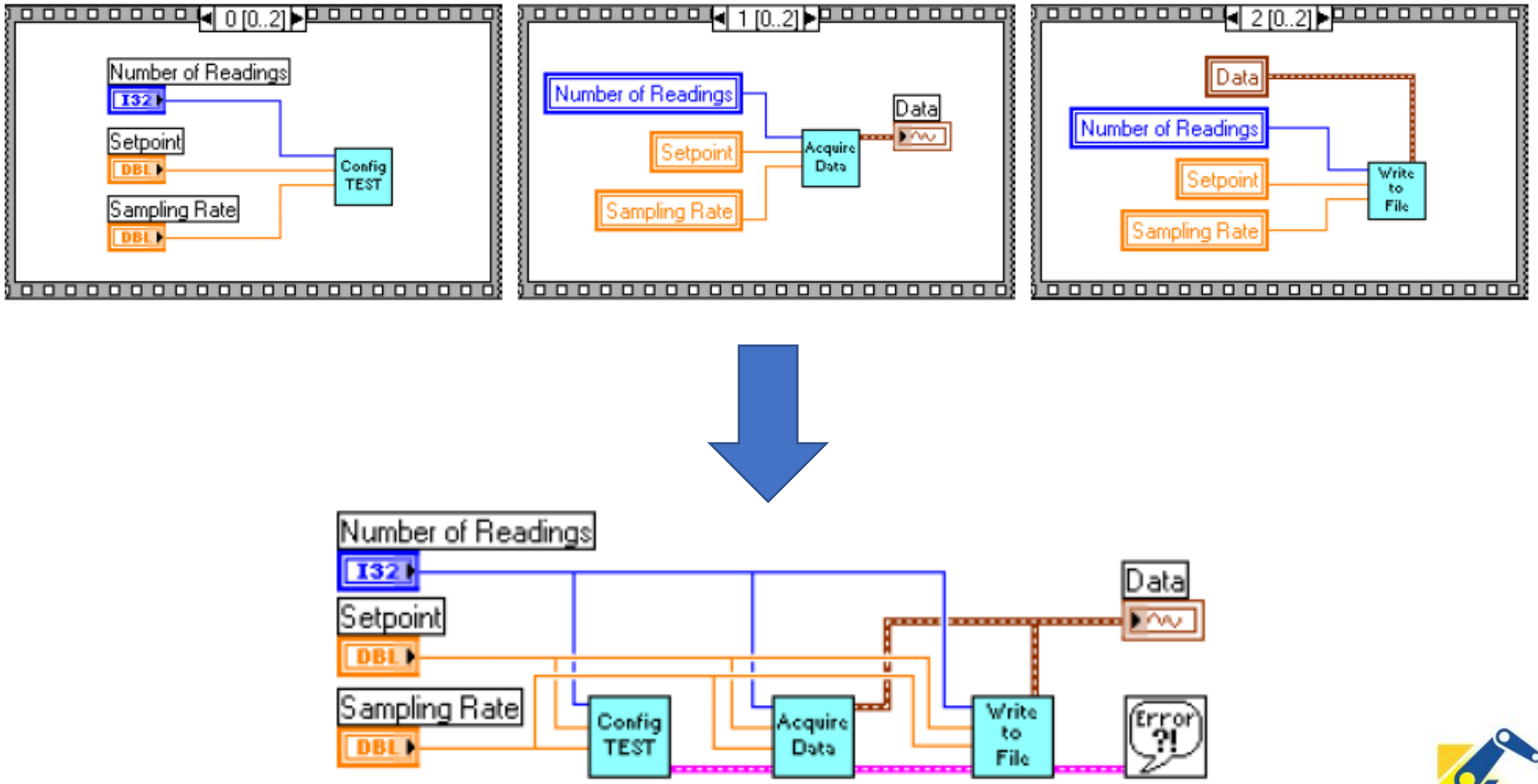




濫用Variable

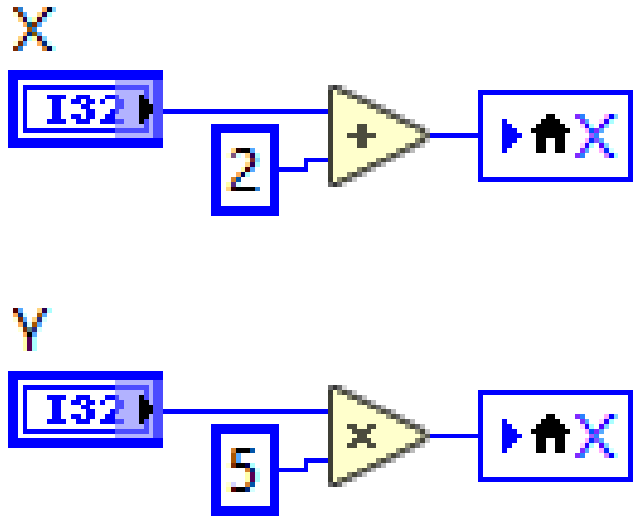
- 破壞Data Flow，程式結構鬆散
- 可讀性變差，等於一般程式語言濫用Goto
- 可能造成Race Condition

濫用Variable


0 [0..2]
Number of Readings
I32
Setpoint
DBL
Sampling Rate
DBL
Config TEST
1 [0..2]
Number of Readings
Setpoint
Sampling Rate
Acquire Data
Data
2 [0..2]
Data
Number of Readings
Setpoint
Sampling Rate
Write to File
Number of Readings
I32
Setpoint
DBL
Sampling Rate
DBL
Config TEST
Acquire Data
Write to File
Data
Error ?!

Race Condition

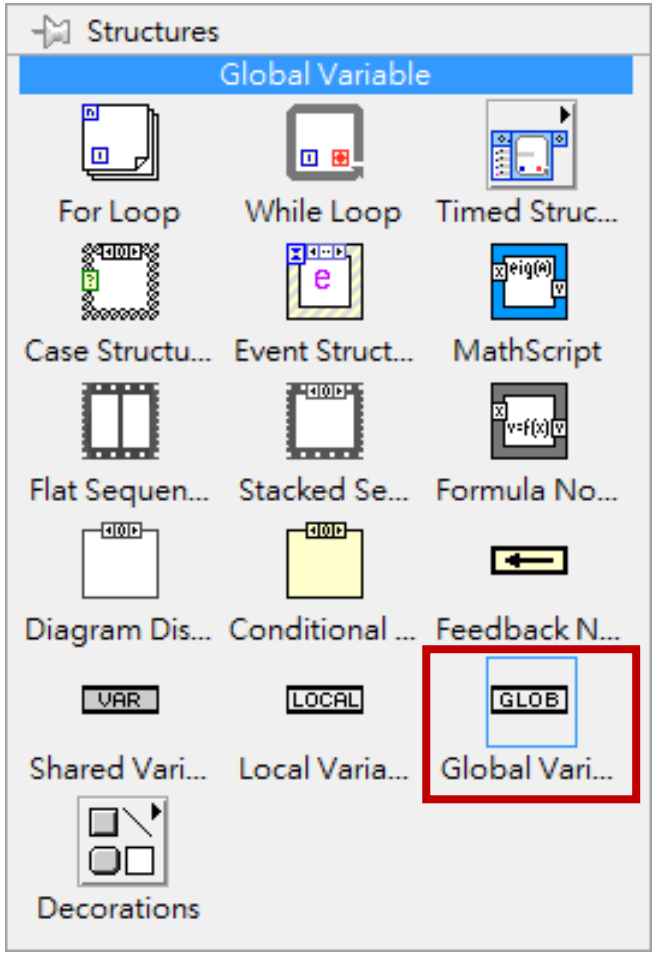
- 右圖可能結果為何?
  (1) X = X+2
  (2) X = Y*5



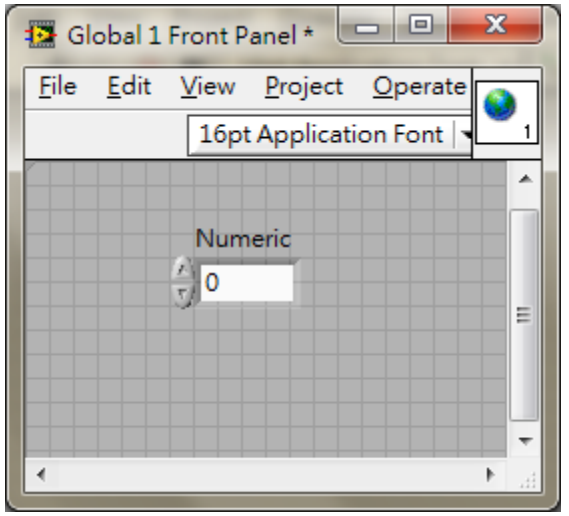
Variables

- Local Variable
  --在同一VI中使用
- Global Variable
  --在不同VI，同一平台使用
- Shared Variable
  --在跨平台使用
- Functional Global Variable
  --在不同VI，同一平台使用

Global Variable



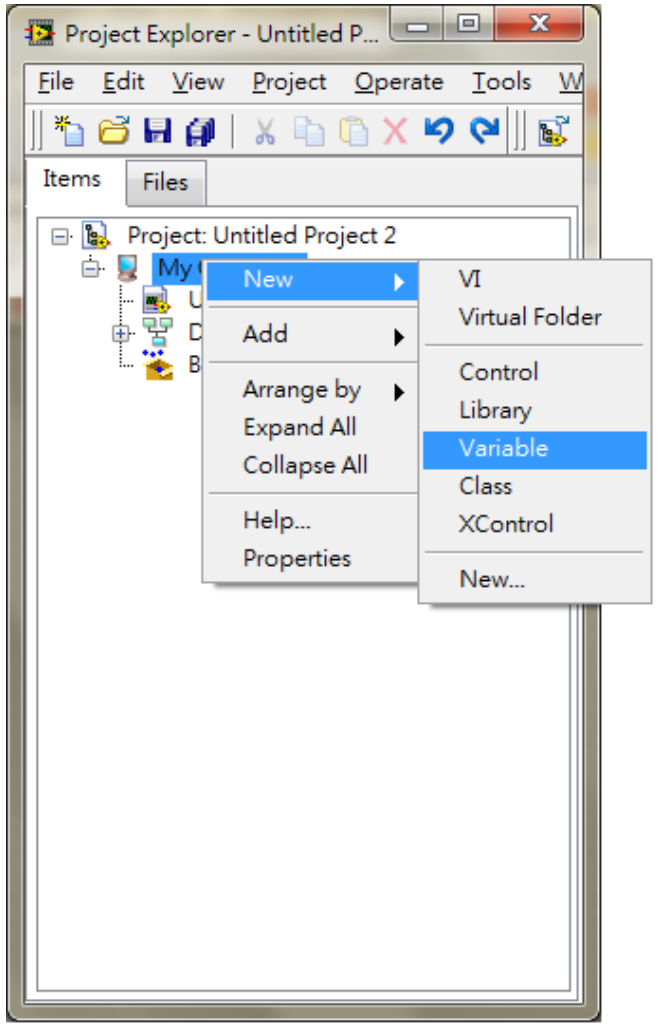
Double Click

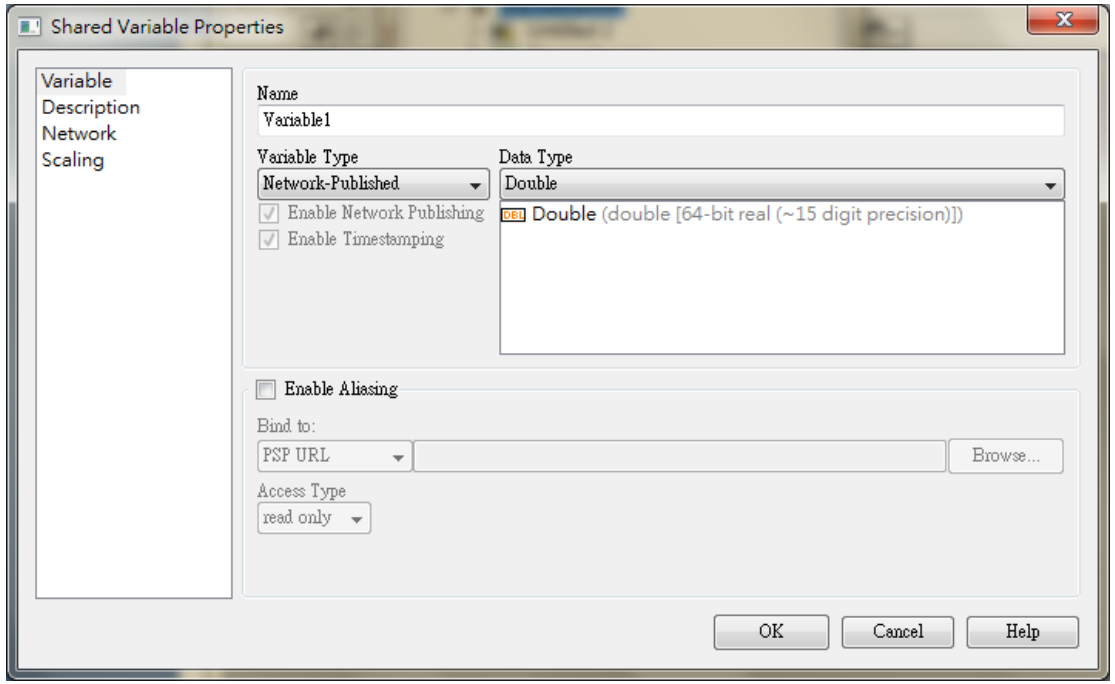


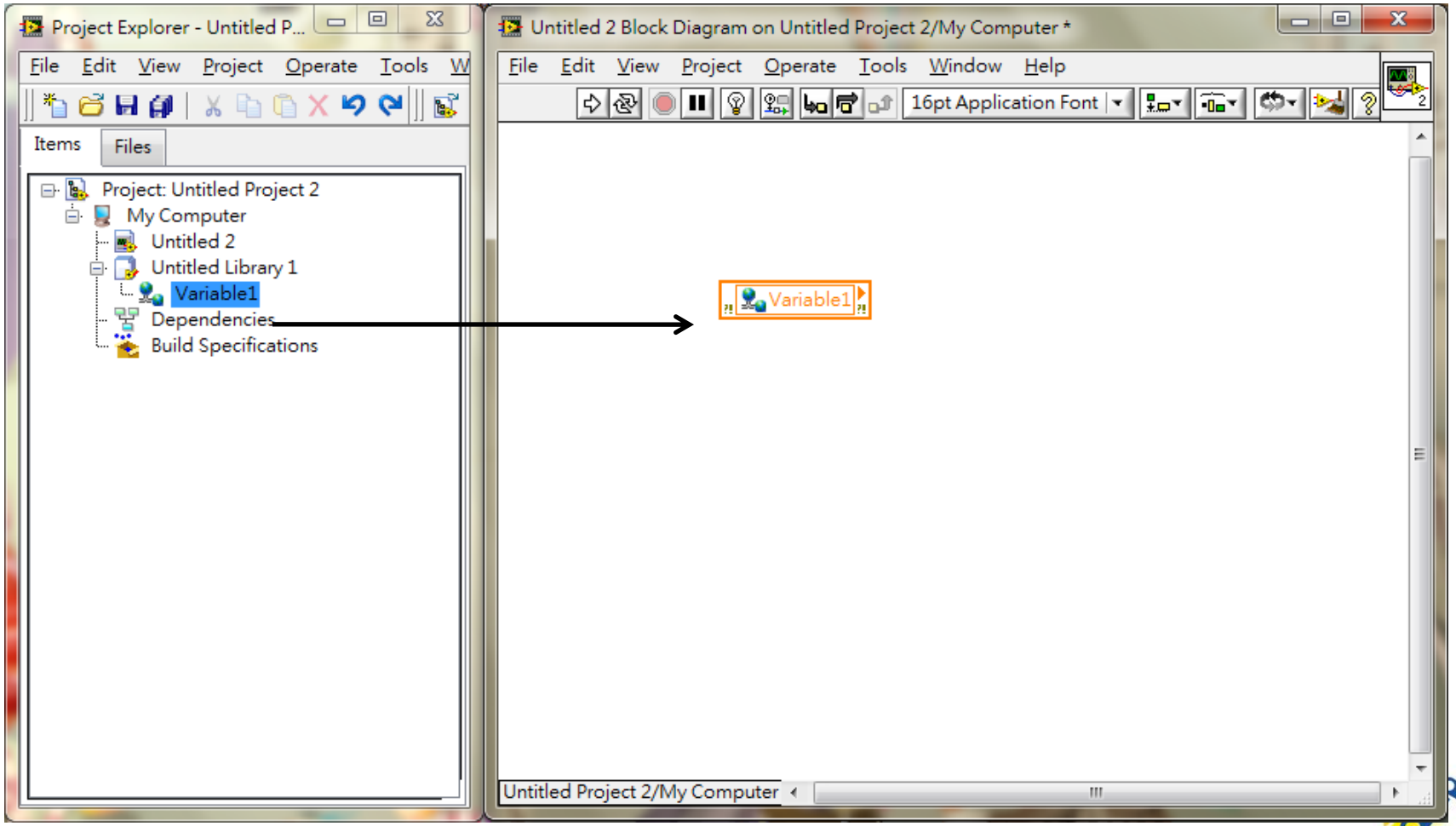
Place Numeric and Save

Select Numeric

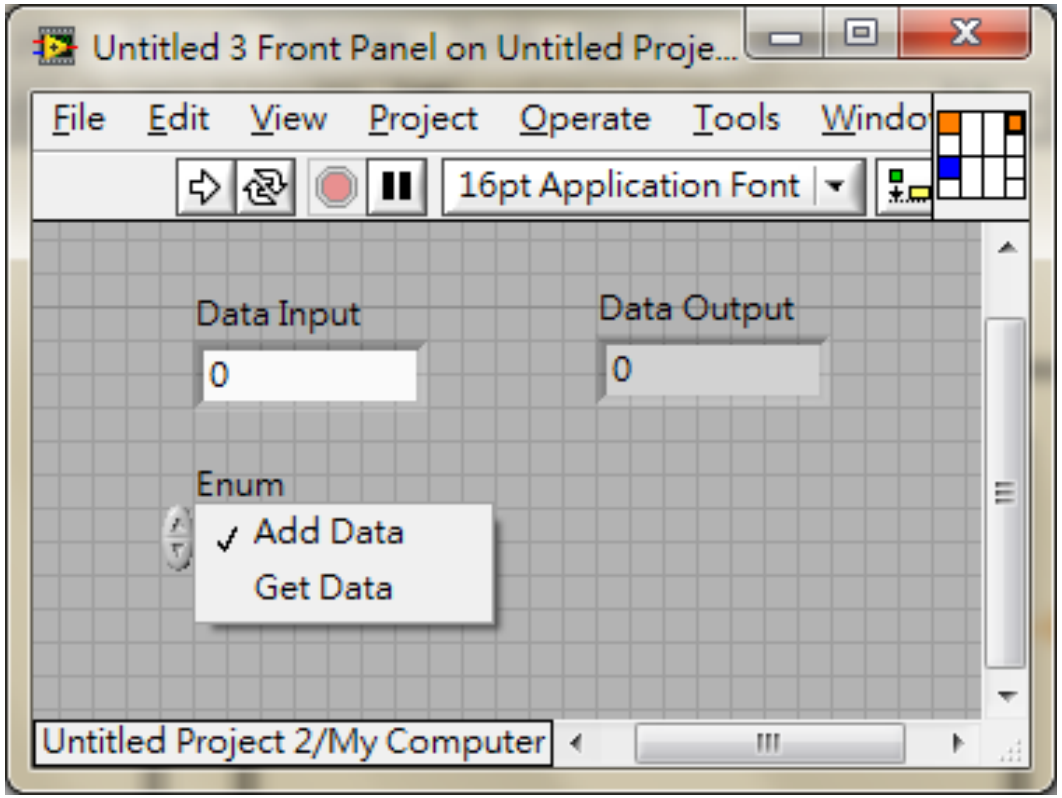
Shared Variable



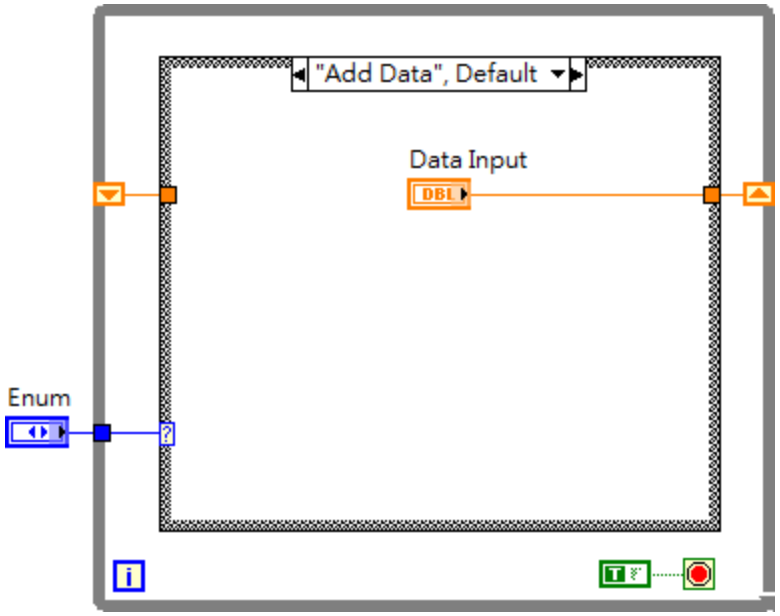


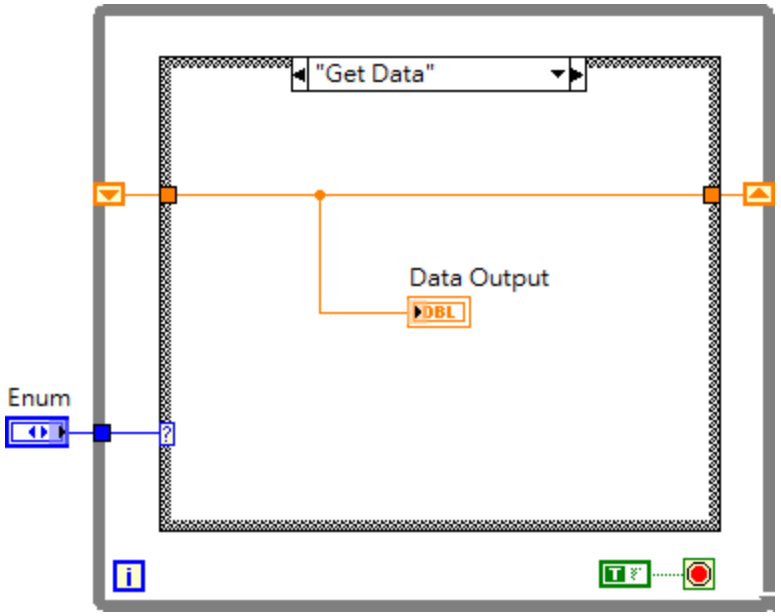

Project Explorer - Untitled P...
File Edit View Project Operate Tools W
Items
Files
Project: Untitled Project 2
My Computer
Untitled 2
Untitled Library 1
Variable1
Dependencies
Build Specifications
Untitled 2 Block Diagram on Untitled Project 2/My Computer *
File Edit View Project Operate Tools Window Help
16pt Application Font
Variable1
Untitled Project 2/My Computer

Funtional Global Variable



Block Diagram



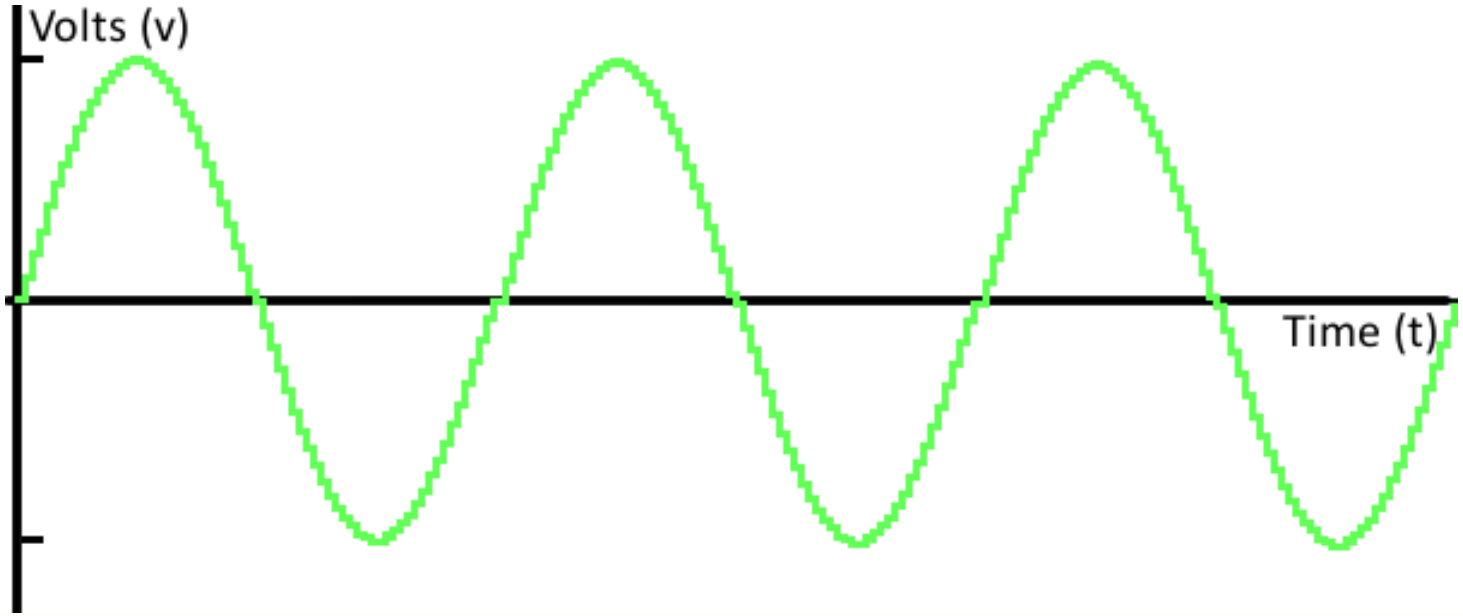


課堂四 ：馬達控制（一）──PWM訊號與編碼器原理

貝登堡智能
KK Intelligent Service,Inc.

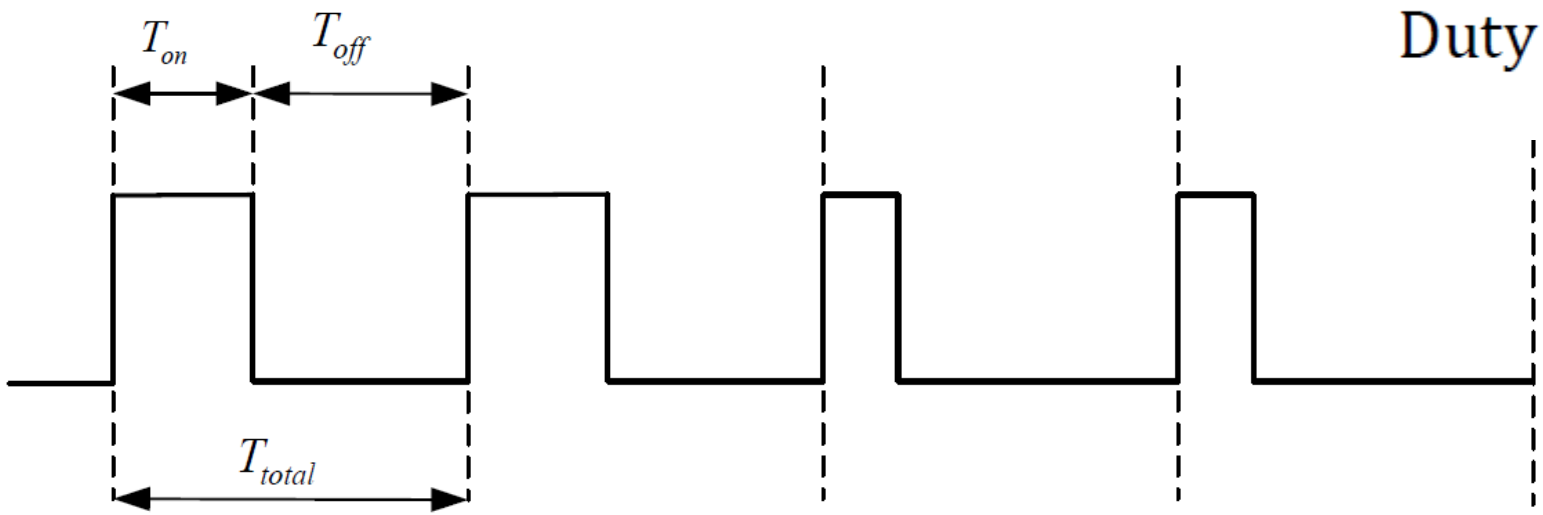
Pulse Width Modulation (PWM)訊號與工作原理

在類比電路中，類比訊號的值可以連續進行變化，在時間和值的幅度上都幾乎沒有限制，基本上可以取任何實數值，輸入與輸出也呈線性變化。所以在類比電路中，電壓和電流可直接用來進行控制對象，例如家用電器設備中的音量開關控制、採用鹵素燈泡燈具的亮度控制等等。
但類比電路有諸多的問題：例如控制訊號容易隨時間漂移，難以調節；功耗大；易受雜訊和環境干擾等等。



Pulse Width Modulation (PWM)訊號與工作原理

與類比電路不同，數位電路是在預先確定的範圍內取值，在任何時刻，其輸出只可能為ON和OFF兩種狀態，所以電壓或電流會通/斷方式的重複脈波序列加載到類比負載。PWM技術是一種對類比訊號電位的數位編碼方法，通過使用高解析度計數器（調變頻率）調變方波的占空比，從而實現對一個類比訊號的電位進行編碼。其最大的優點是從處理器到被控對象之間的所有訊號都是數位形式的，無需再進行數位類比轉換過程；而且對雜訊的抗干擾能力也大大增強（雜訊只有在強到足以將邏輯值改變時，才可能對數位訊號產生實質的影響）



$$\text{Duty cycle} = \frac{T_{on}}{T_{on}+T_{off}} \times 100\%$$

編碼器(Encoder)工作原理

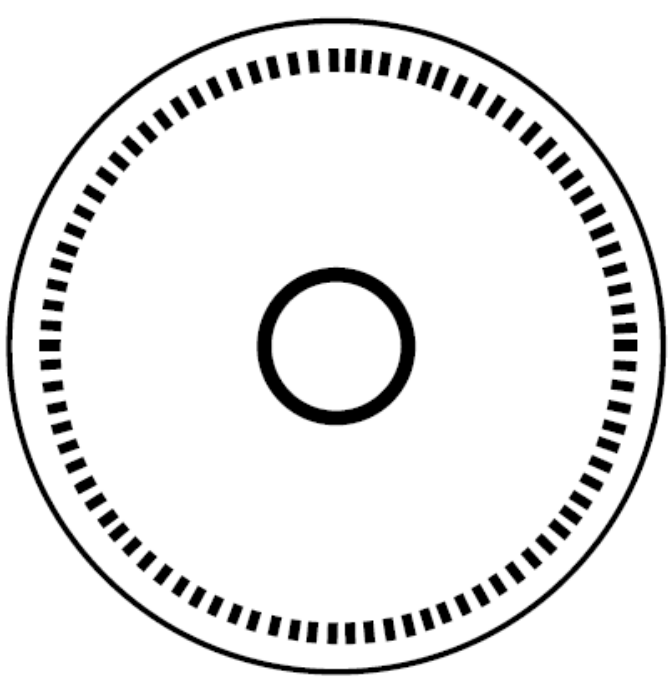
旋轉編碼器（rotary encoder）也稱為軸編碼器，是將旋轉位置或旋轉量轉換成類比或數位訊號的機電裝置。一般裝設在旋轉物體中垂直旋轉軸的一面。旋轉編碼器用在許多需要精確旋轉位置及速度的場合，如工業控制、機器人技術、專用鏡頭、電腦輸入裝置（如滑鼠及軌跡球）等。

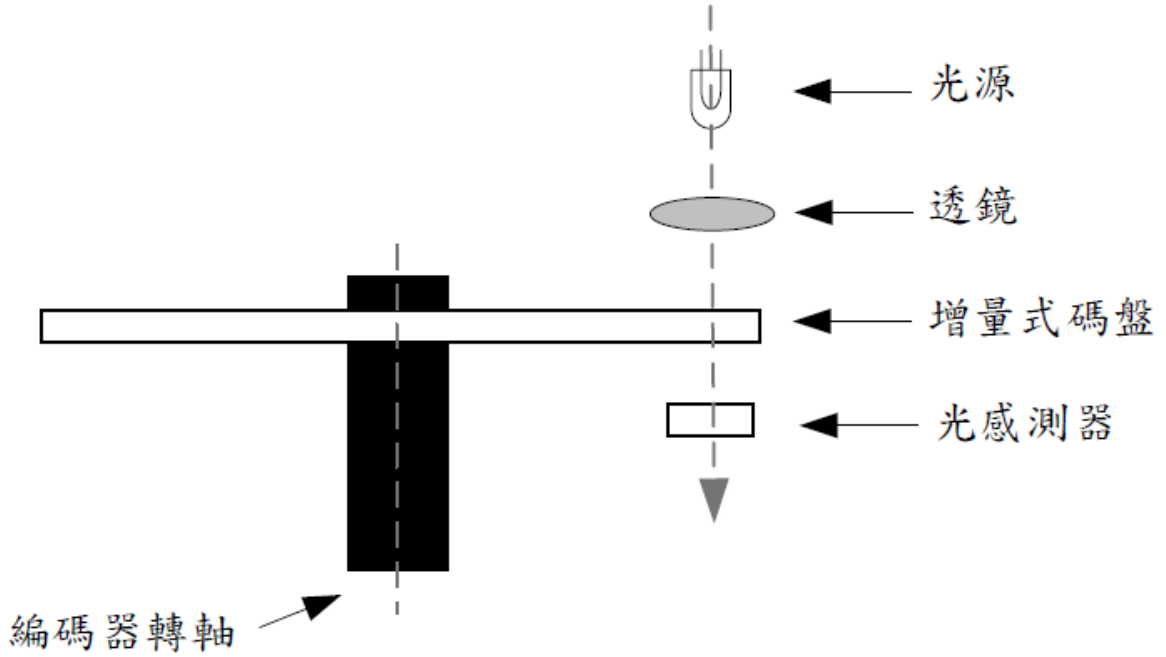
旋轉編碼器可分為絕對型（absolute）編碼器及增量型（incremental）編碼器兩種。增量型編碼器也稱作相對型編碼器（relative encoder），利用檢測脈衝的方式來計算轉速及位置，可輸出有關旋轉軸運動的資訊，一般會由其他裝置或電路進一步轉換為速度、距離、每分鐘轉速或位置的資訊。絕對型編碼器會輸出旋轉軸的位置，可視為一種角度傳感器。

KNR 馬達使用光學式增量型編碼器。

增量型編碼器工作原理

光學式增量型編碼器



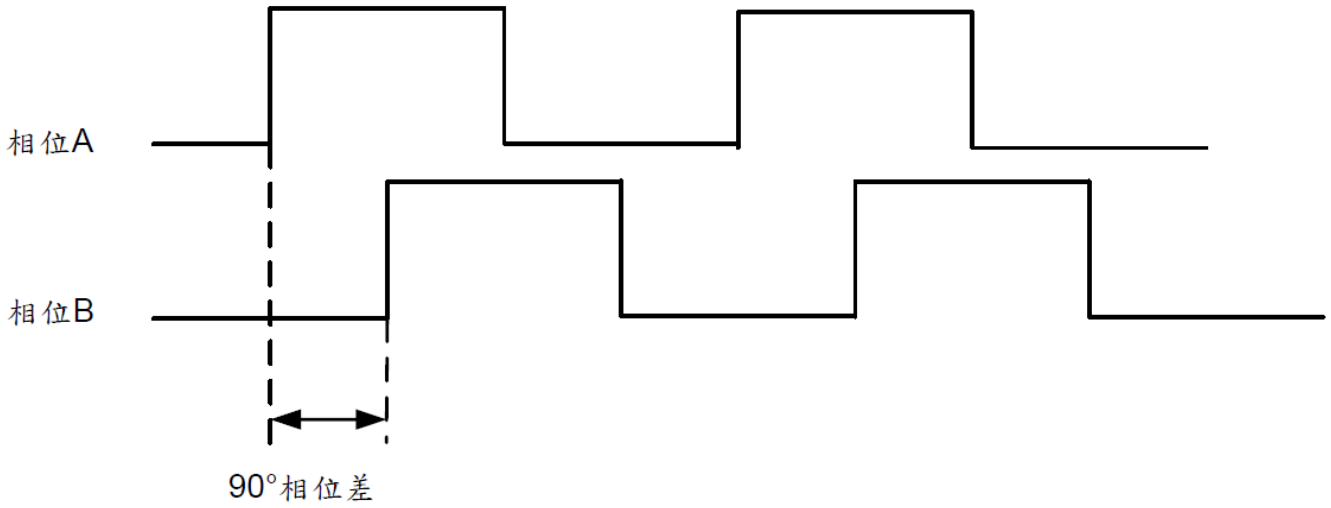


增量型編碼器工作原理

增量型編碼器有機械式的及光學式的，光學式的編碼器用在高速或是需要高精準度的場合。

增量型編碼器有二個輸出，分別稱為A和B，二個輸出是正交輸出，相位差為90度。增量型編碼器的單圈脈衝數（PPR）為其旋轉一圈時會輸出的方波數，如PPR為500表示旋轉一圈時A和B都會輸出500個方波，但先後順序不同。光學式增量型編碼器可以有較高的單圈脈衝數，例如2500其至到10000。

以下是順時針及逆時針旋轉時，編碼器輸出的變化：



順時針旋轉的輸出

Phase	A	B
1	0	0
2	0	1
3	1	1
4	1	0

逆時針旋轉的輸出

Phase	A	B
1	1	0
2	1	1
3	0	1
4	0	0

增量型編碼器工作原理

增量型編碼器有機械式的及光學式的，光學式的編碼器用在高速或是需要高精準度的場合。

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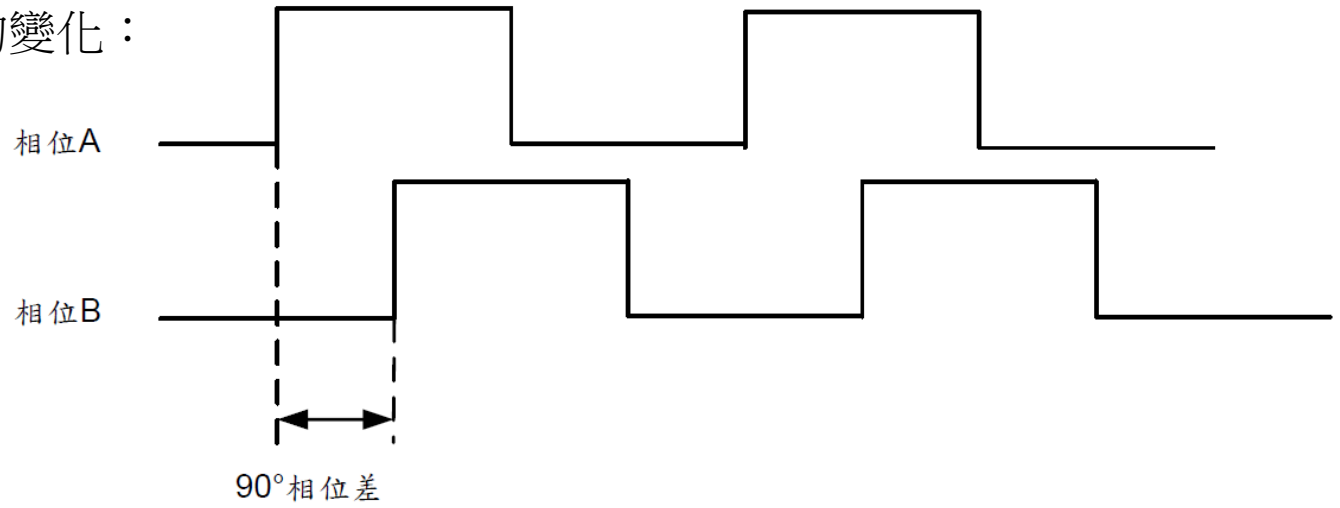
以下是順時針及逆時針旋轉時，編碼器輸出的變化：



$$\text{Wheel counts per rev.} = \text{Encoder pulse per rev.} \times 4 \times \text{gear ratio}$$

$$= 500 \times 4 \times 20.8 = 41600$$

馬達編碼器(Encoder)與輪子轉動距離、速度

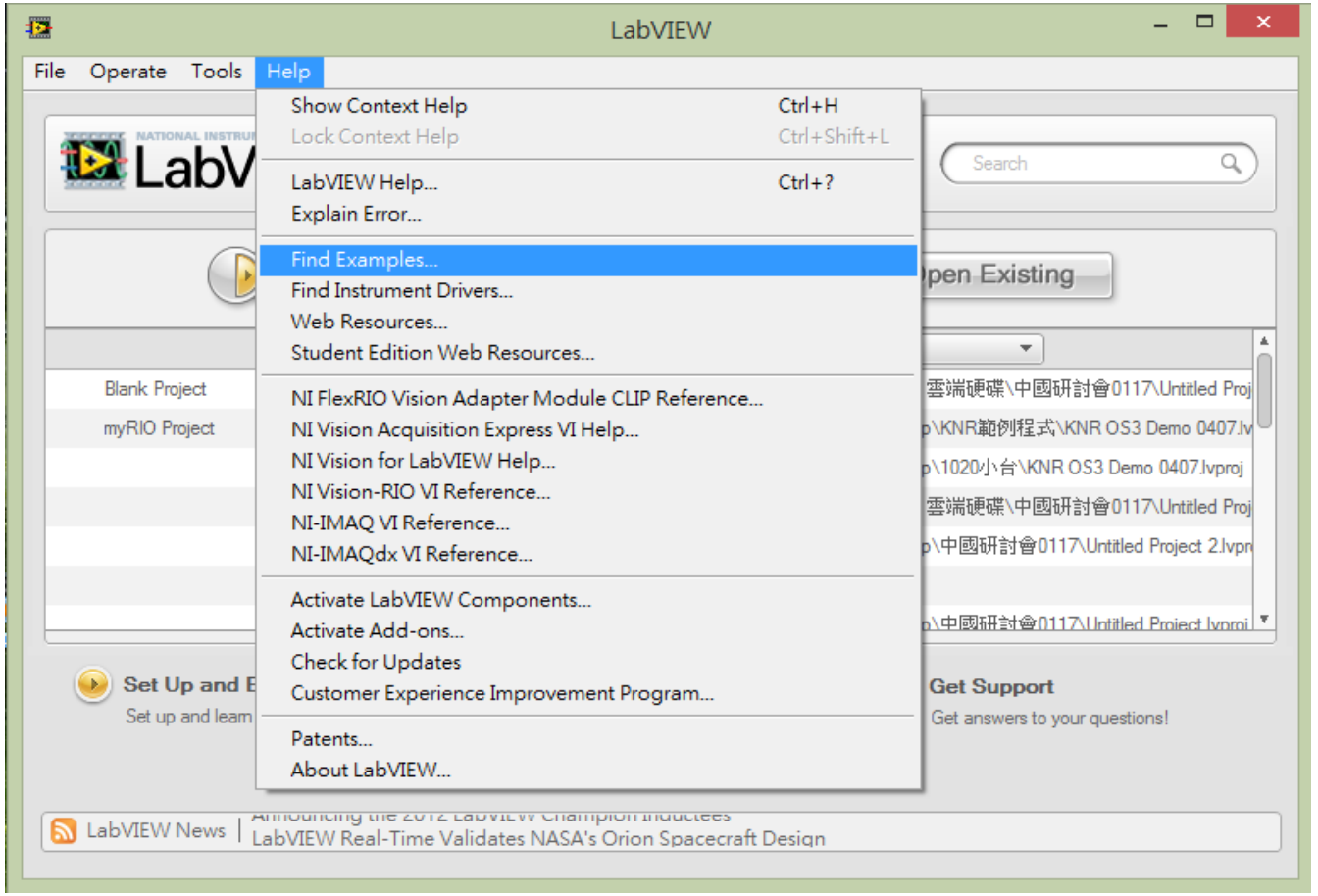
$$\text{Wheel counts per rev.} = \text{Encoder pulse per rev.} \times 4 \times \text{gear ratio}$$
$$= 500 \times 4 \times 20.8 = 41600$$

$$\text{Position(cm)} = \frac{total\ counts}{\text{Wheel counts per rev.}} \times 2\pi R = \frac{total\ counts}{41600} \times 9.6\pi$$

$$\text{Velocity(cm/s)} = \frac{Velocity(counts/s)}{\text{Wheel counts per rev.}} \times 2\pi R = \frac{Velocity(counts/s)}{41600} \times 9.6\pi$$

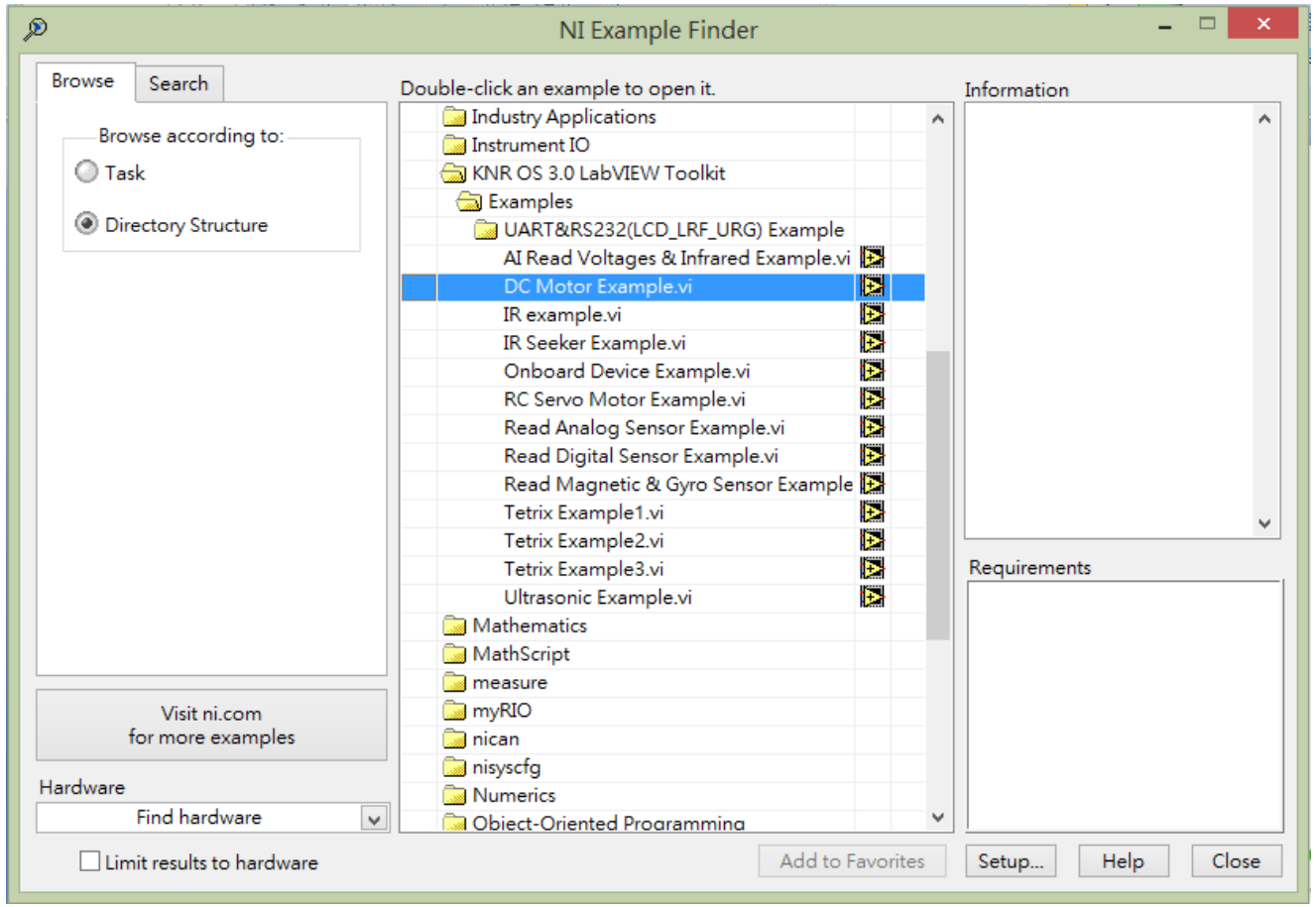
打開馬達控制範例

- 範例程式



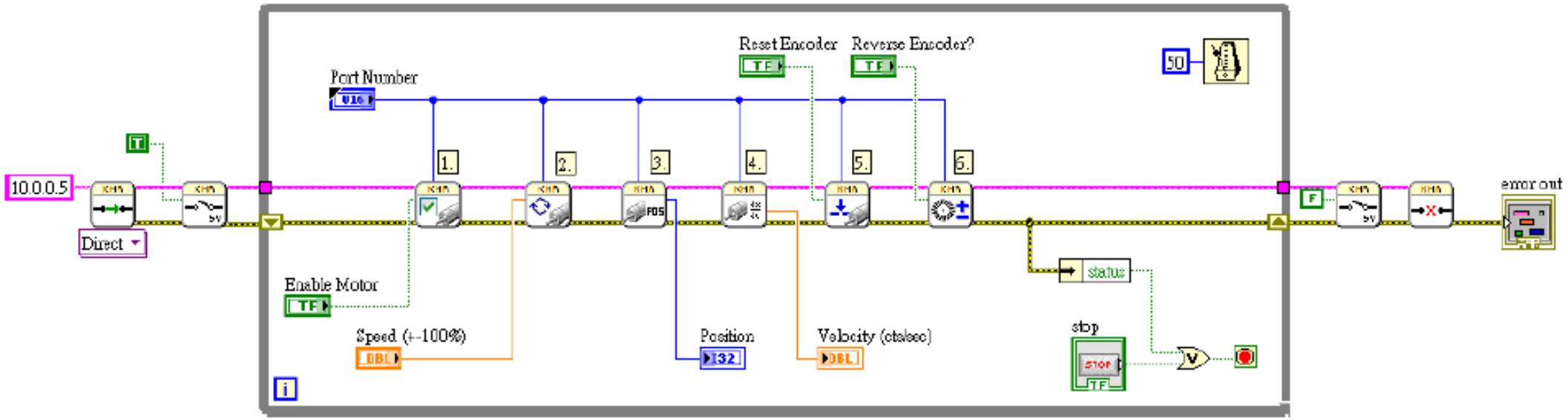
打開馬達控制範例

- 開啟DC範例程式



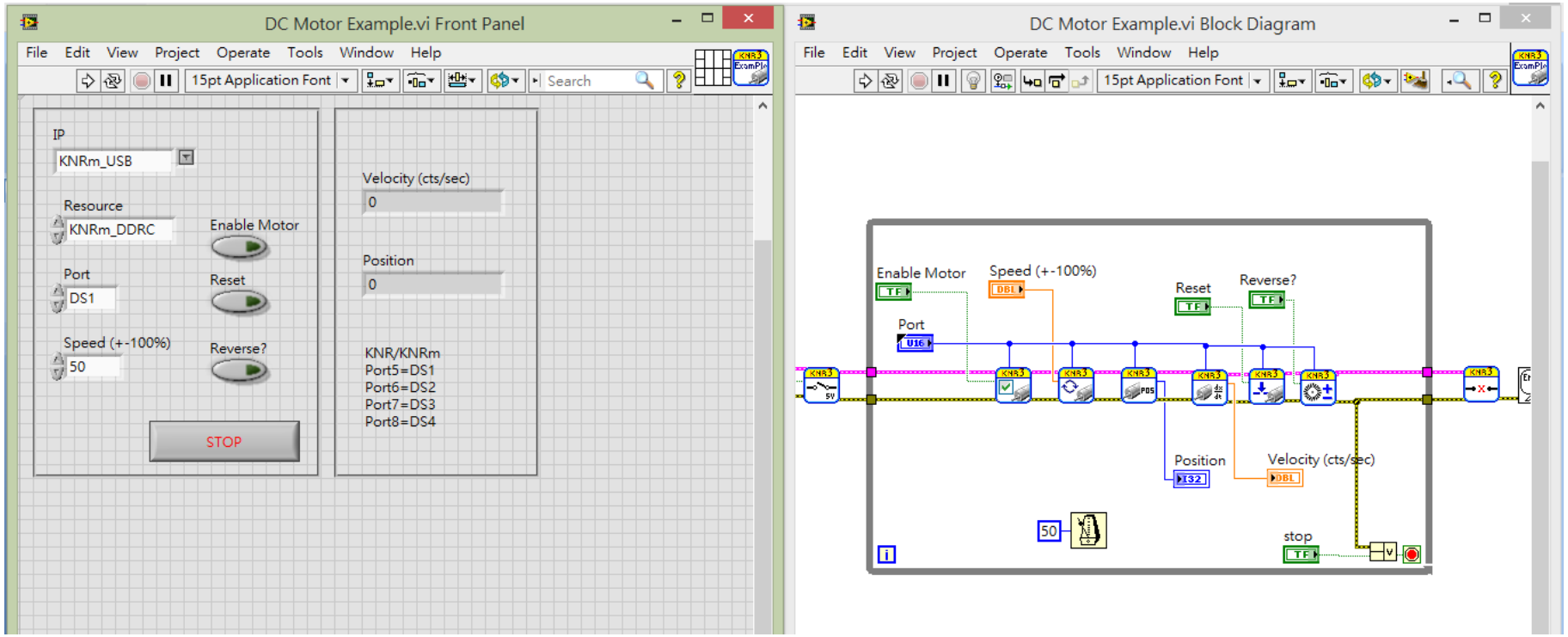
打開馬達控制範例

Help -> Find Example 開啟 DC Motor Example.vip



DC motor控制

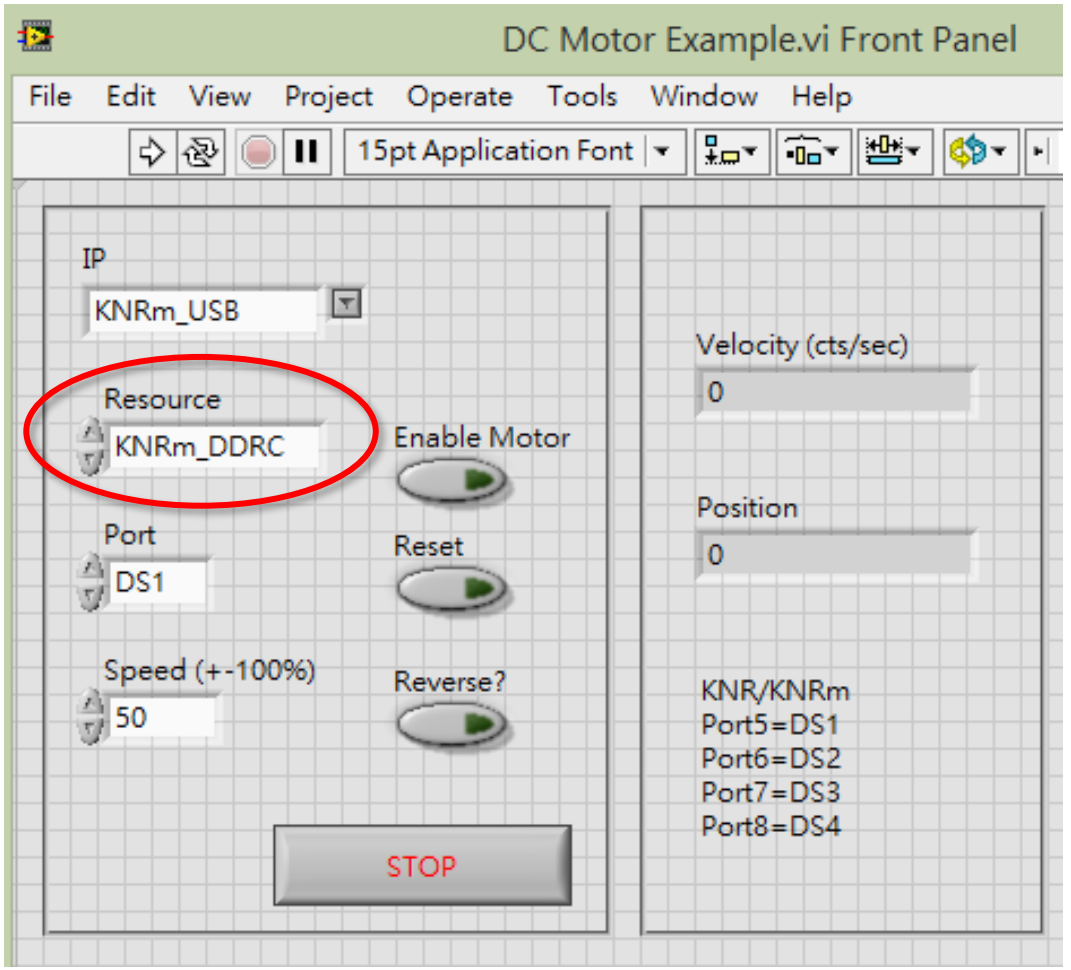
- 按下ctrl+T



DC motor控制

- Resource
- D：DC servo
- R：RC servo
- C：I2C

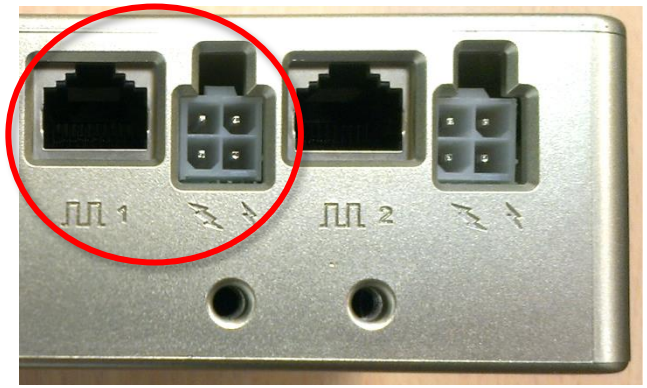
- ex：KNRm_DDRC
- DS1→DC
- DS2→DC
- DS3→RC
- DS4→I2C

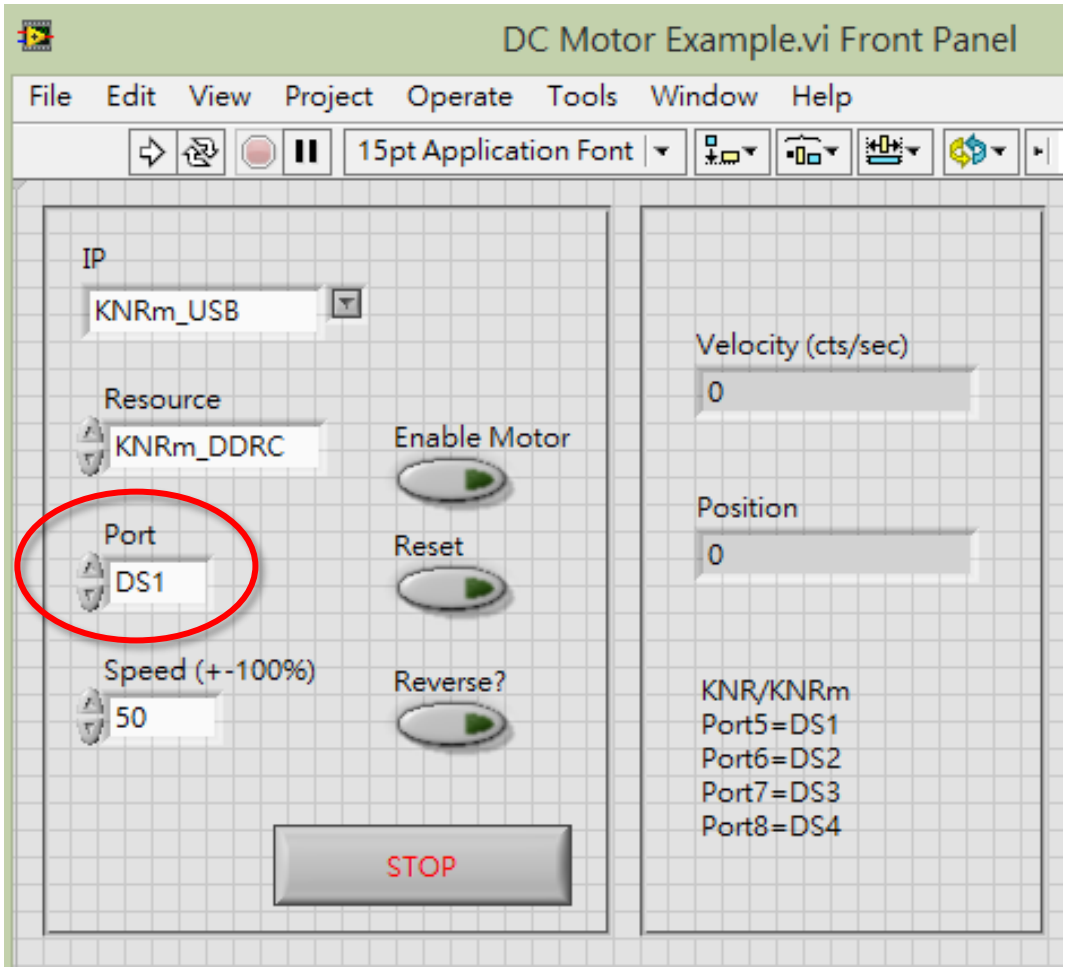


DC motor控制

- Port
- 選擇要控制的馬達

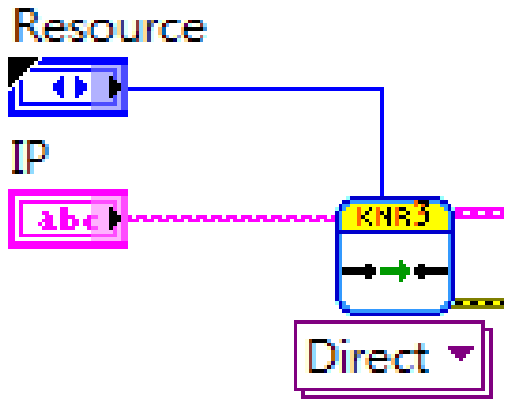
- ex：DS1
- 選擇控制第一個馬達





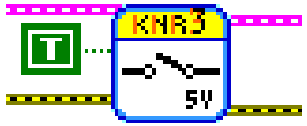
DC motor控制

- KNR3 Open
- Resource：選擇FPGA如何分配(例如：DDDR、DDDC、DDRC或DDDD)。
- IP：選擇電腦跟KNR的通訊方式。



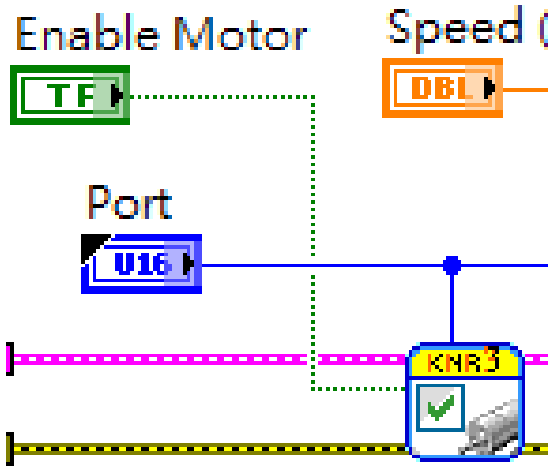
DC motor控制

- Set 5V Power
- 設定5V電源輸出



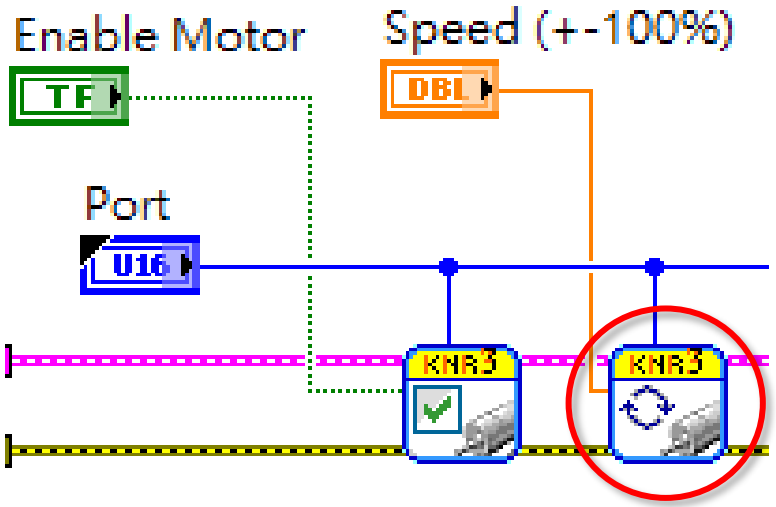
DC motor控制

- DC Motor Enable
- 選擇DC馬達的Port
- 啟動馬達



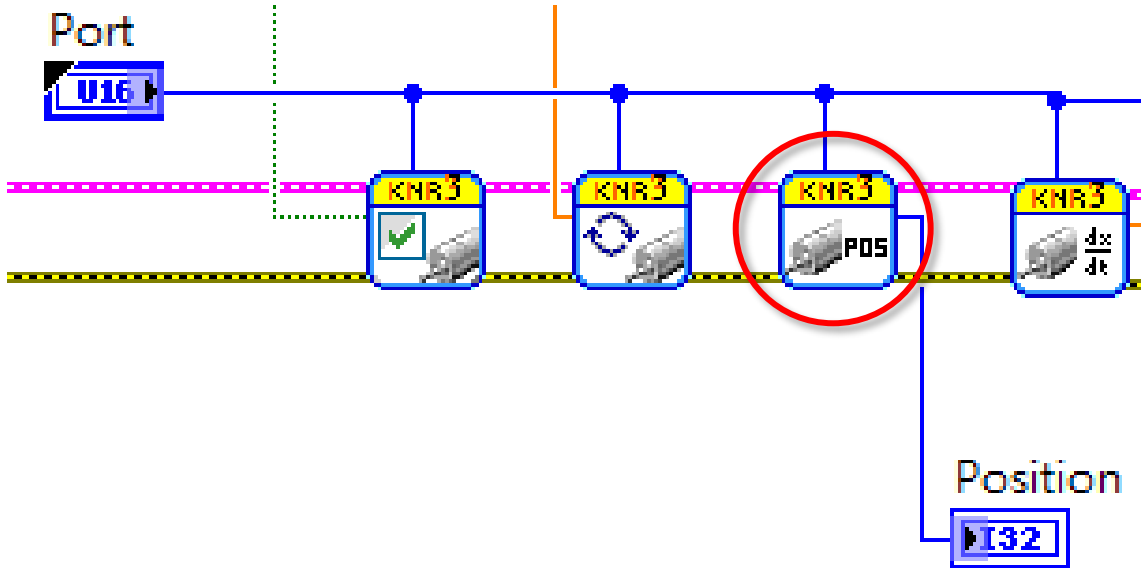
DC motor控制

- DC Motor Set Speed
- 選擇DC馬達的Port
- 設定馬達速度



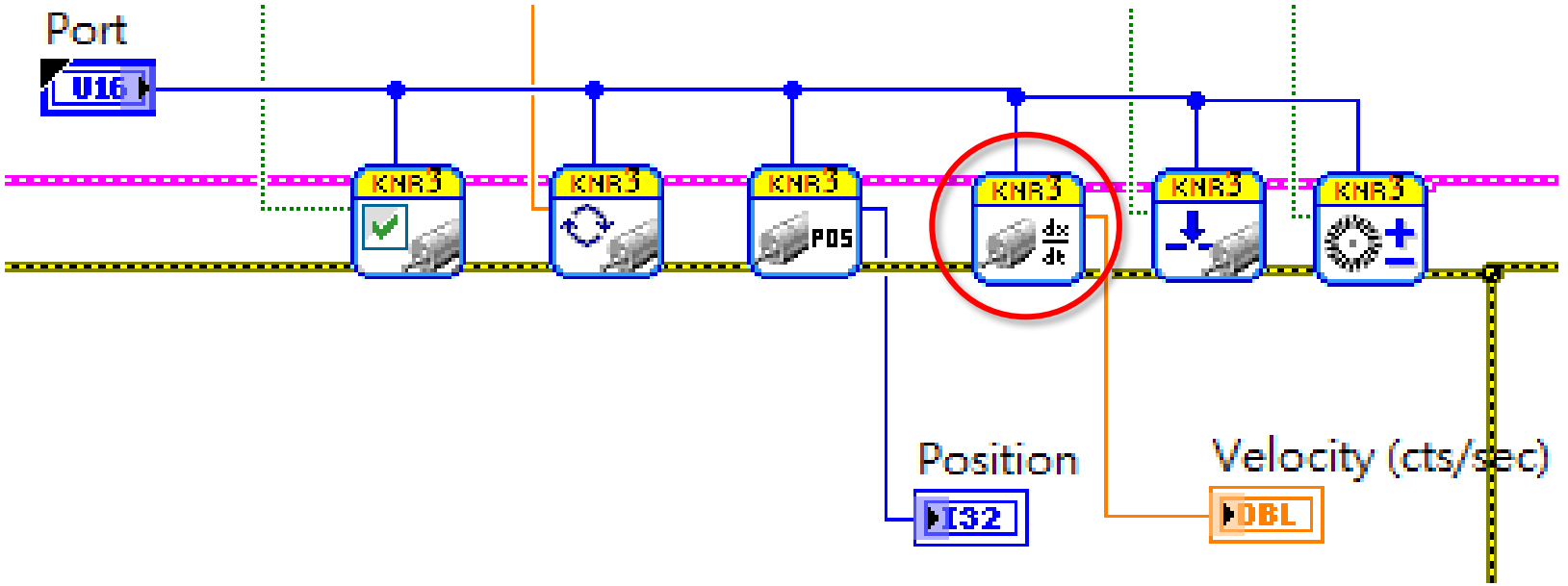
DC motor控制

- DC Motor Read Position
- 選擇DC馬達的Port
- 讀取馬達編碼器位置



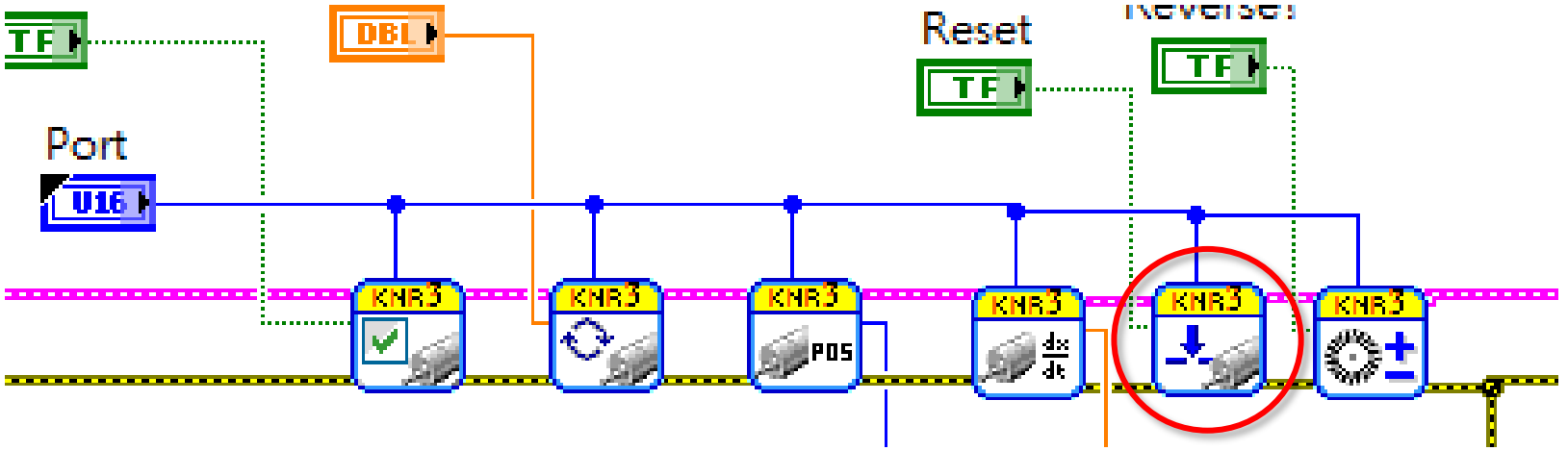
DC motor控制

- DC Motor Read Velocity
- 選擇DC馬達的Port
- 讀取馬達轉動速度



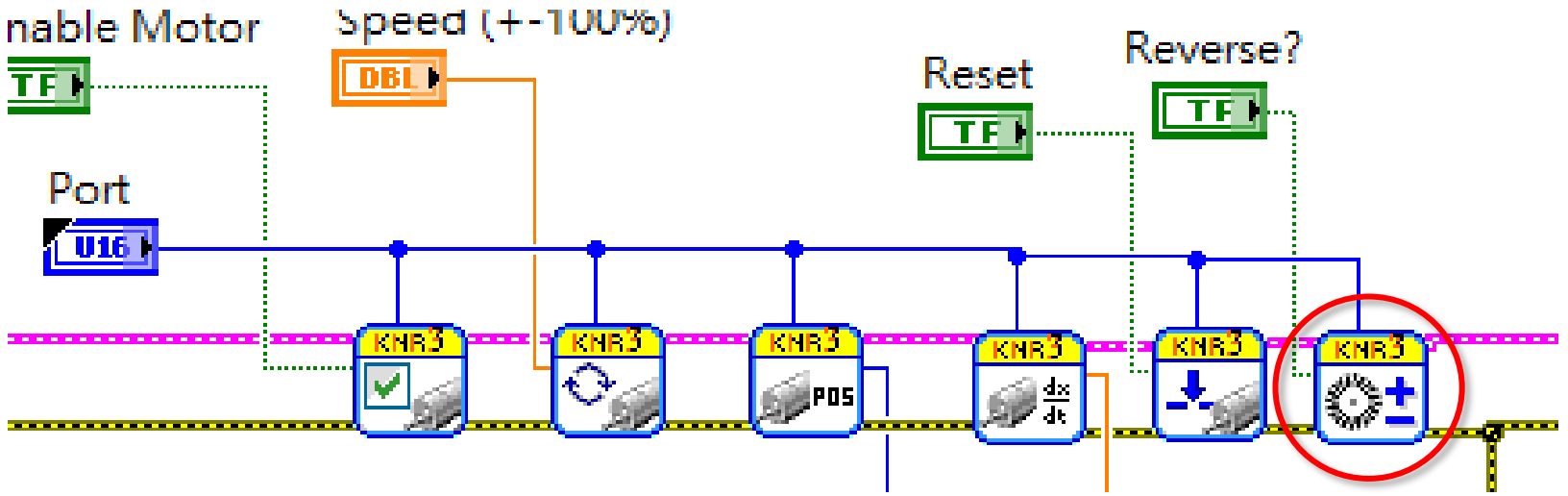
DC motor控制

- DC Motor Reset Position
- 選擇DC馬達的Port
- 編碼器歸零



DC motor控制

- DC Motor Set Encoder
- 選擇DC馬達的Port
- 編碼器反向



DC motor控制

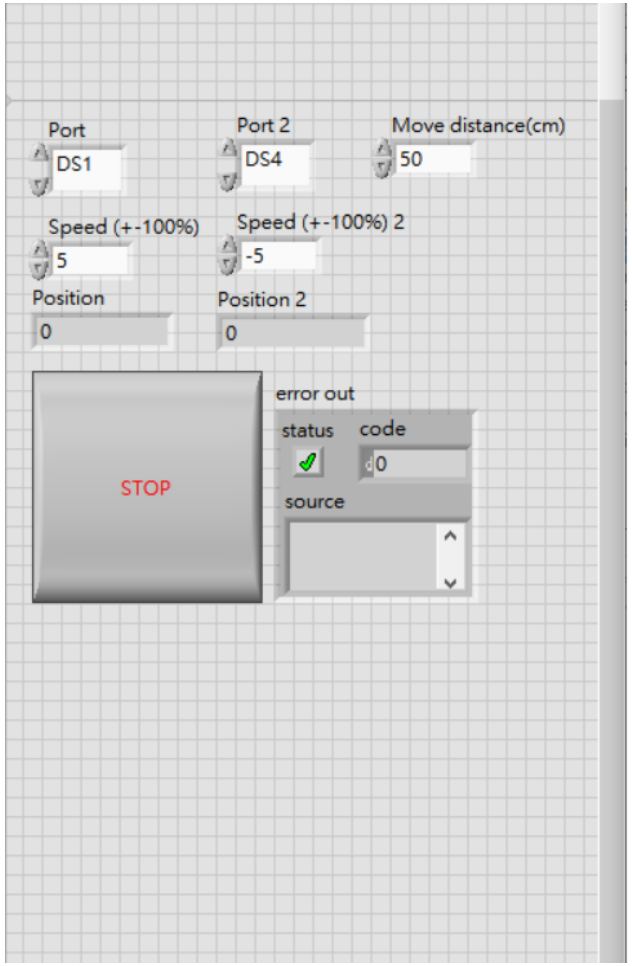
- KNR3 Close
- 結束KNR連線

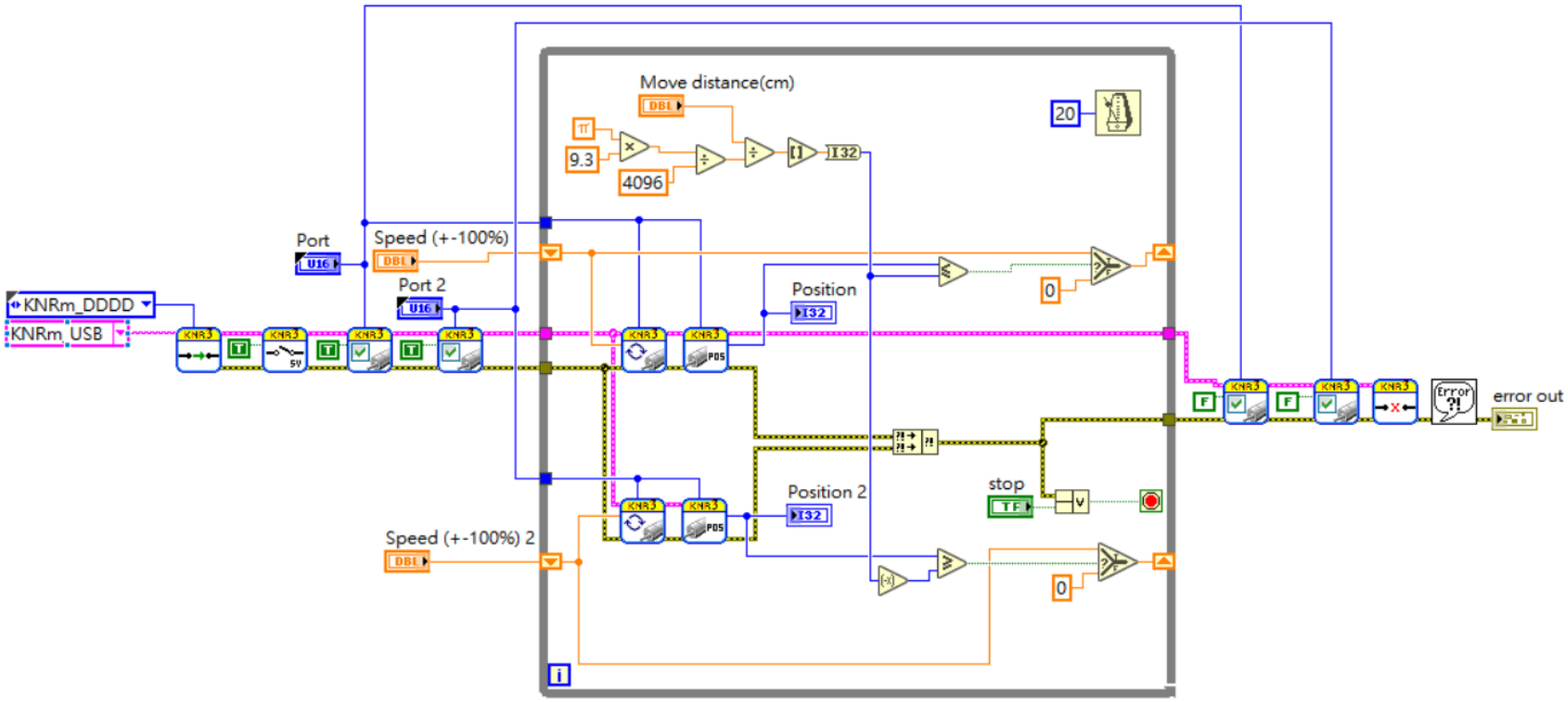
DC motor控制

如何讓基本車前進50cm?

DC motor控制

- 前進50cm範例



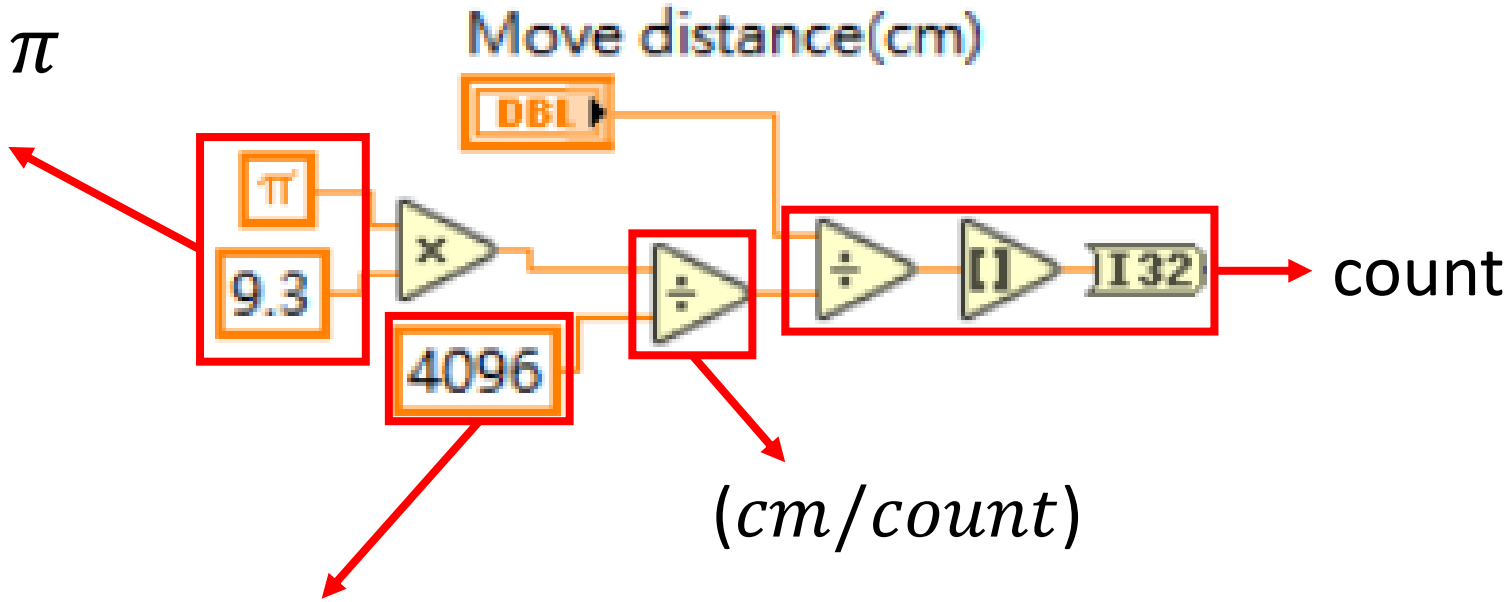


DC motor控制

- 前進50cm範例

$9.3(cm) \times \pi$

=輪圓周長



$4096(count) = 4 \times 16(PPR) \times 64(Ratio)$

無線控制

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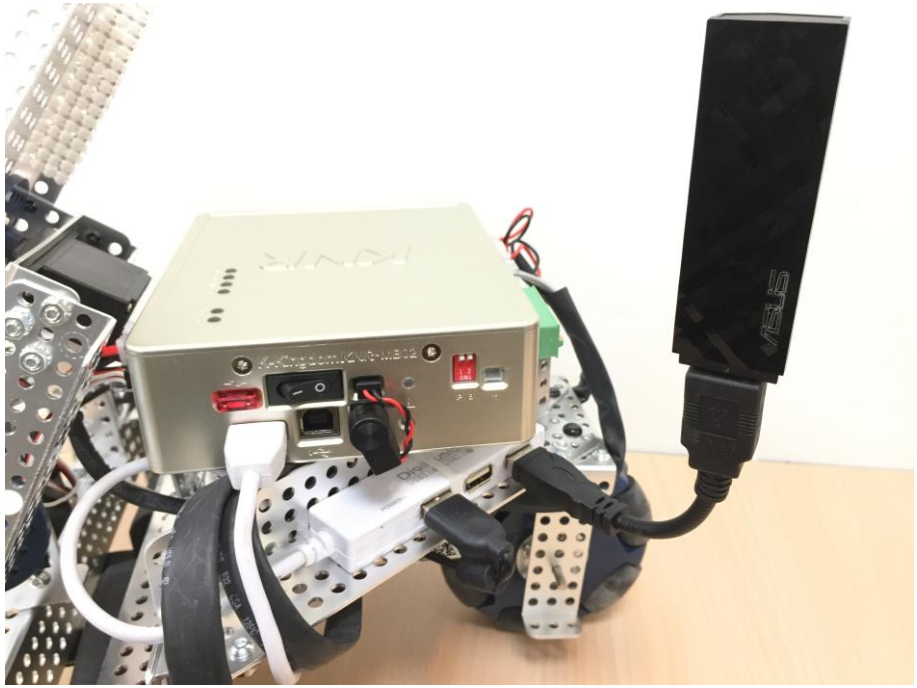
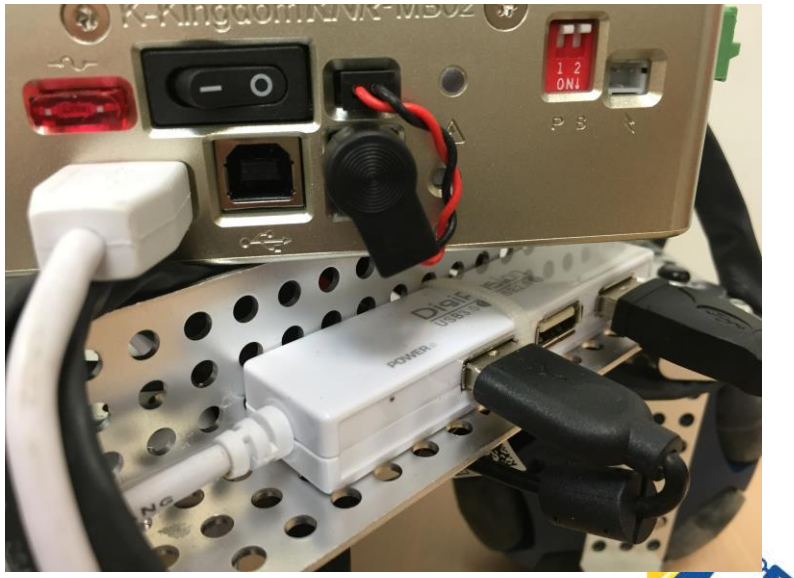
無線控制

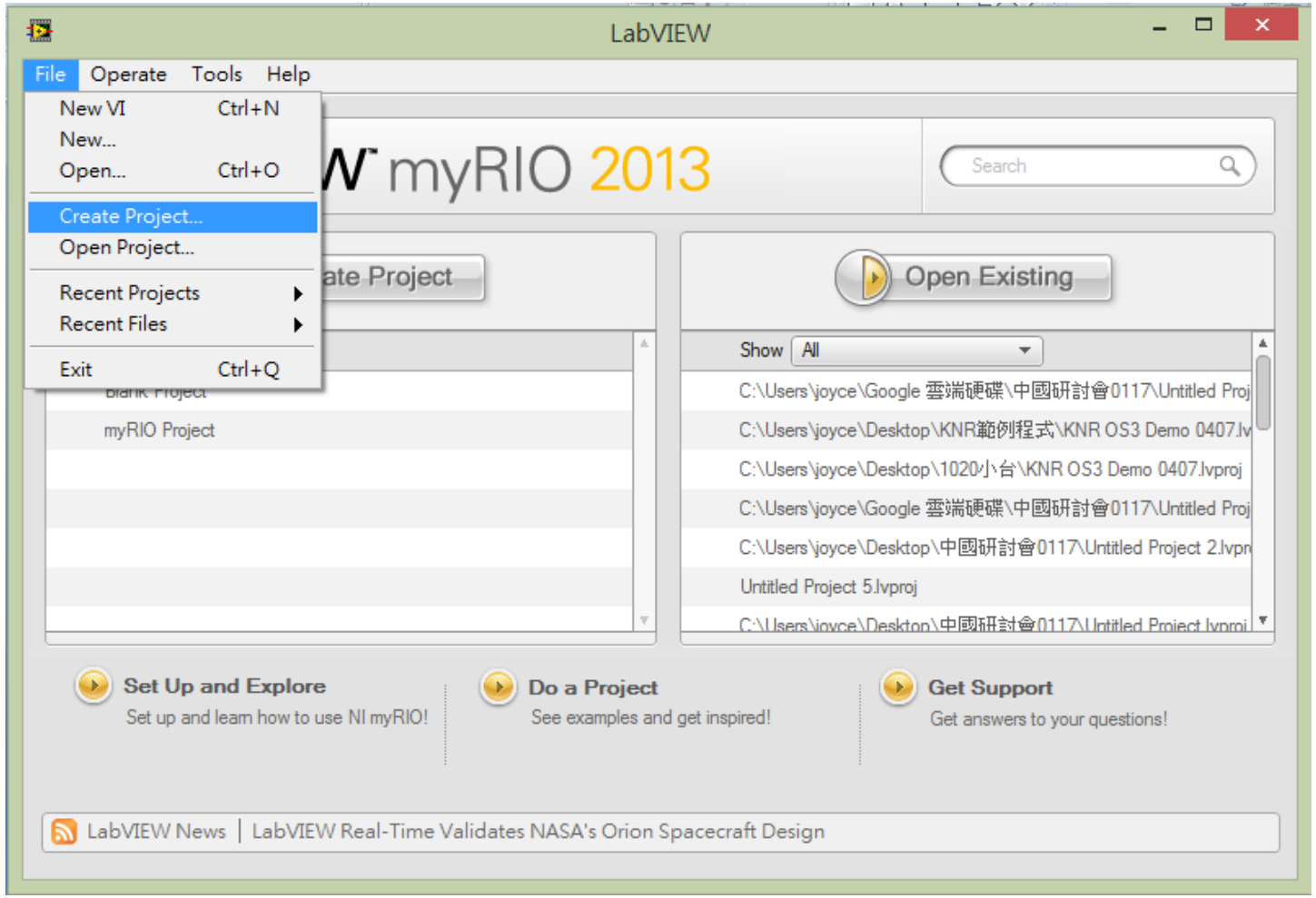
- 在KNR裝上無線網卡。





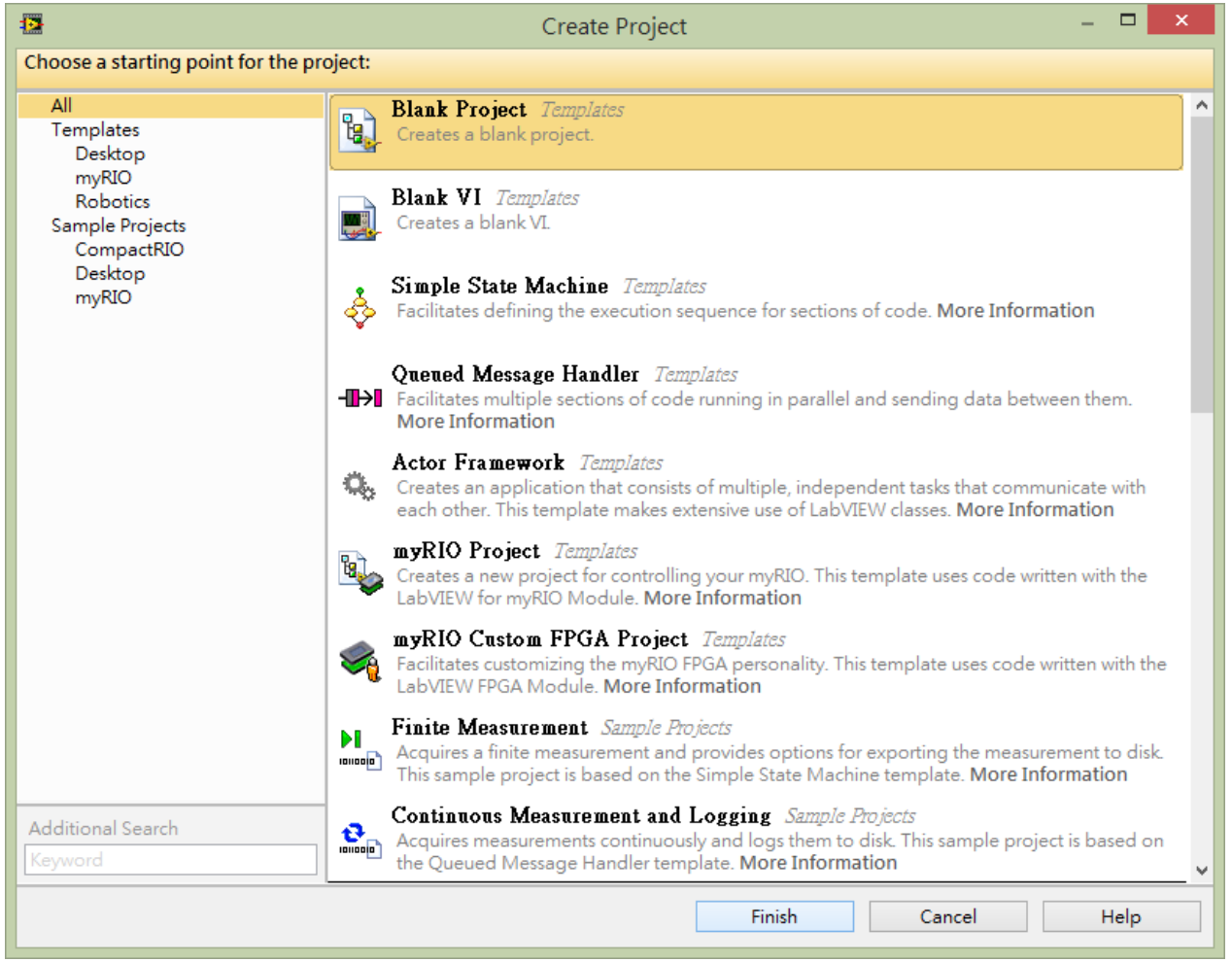
無線控制

- 開啟新的專案。


LabVIEW
File
Operate
Tools
Help
New VI Ctrl+N
New...
Open... Ctrl+O
Create Project...
Open Project...
Recent Projects
Recent Files
Exit Ctrl+Q
myRIO 2013
Search
Open Existing
Show All
myRIO Project
C:\Users\joyce\Google 雲端硬碟\中國研討會0117\Untitled Proj
C:\Users\joyce\Desktop\KNR範例程式\KNR OS3 Demo 0407.lv
C:\Users\joyce\Desktop\1020小台\KNR OS3 Demo 0407.lvproj
C:\Users\joyce\Google 雲端硬碟\中國研討會0117\Untitled Proj
C:\Users\joyce\Desktop\中國研討會0117\Untitled Project 2.lvpr
Untitled Project 5.lvproj
Set Up and Explore
Set up and learn how to use NI myRIO!
Do a Project
See examples and get inspired!
Get Support
Get answers to your questions!
LabVIEW News | LabVIEW Real-Time Validates NASA's Orion Spacecraft Design

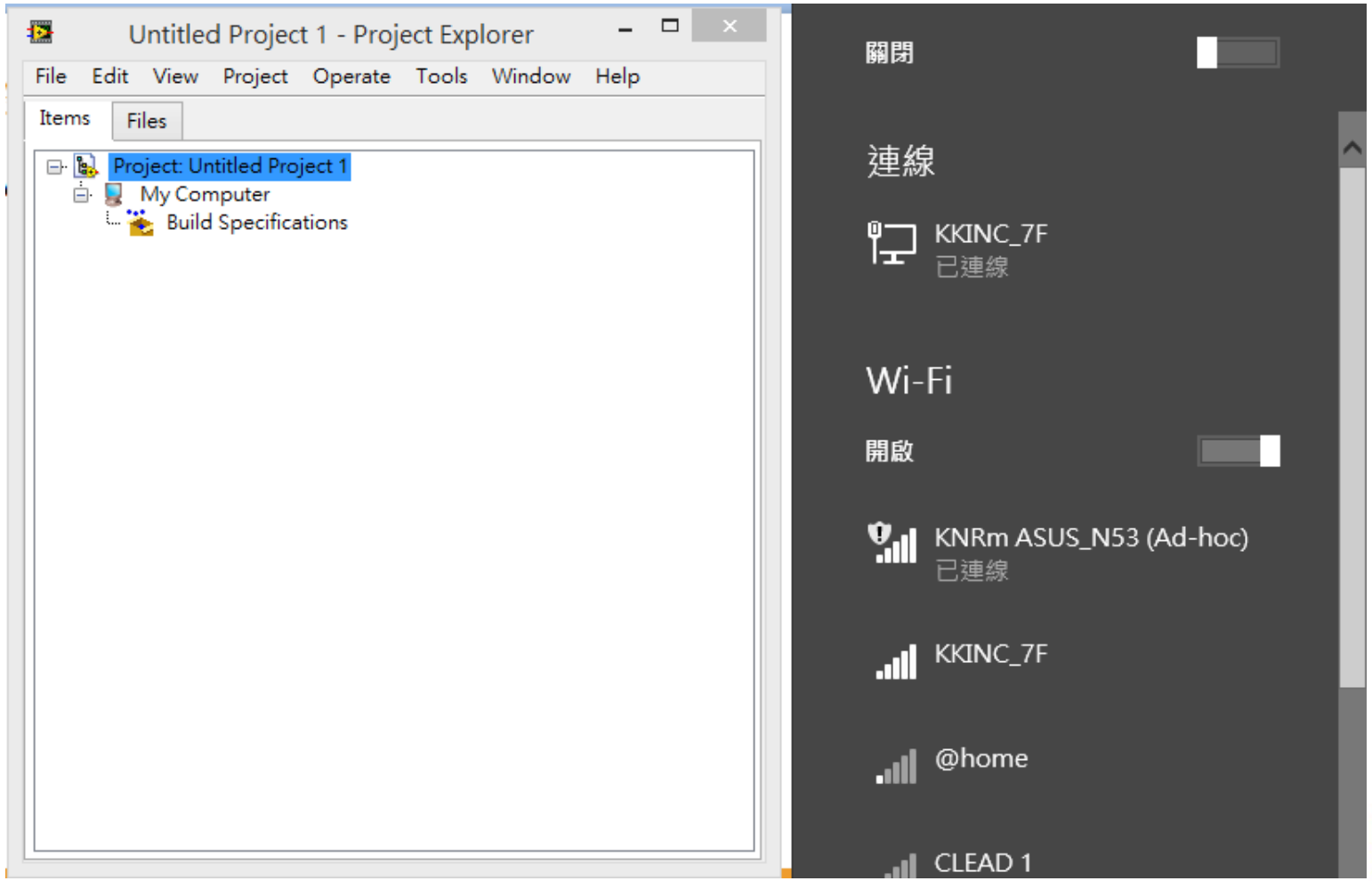
無線控制

- 建立一個空白的Project。



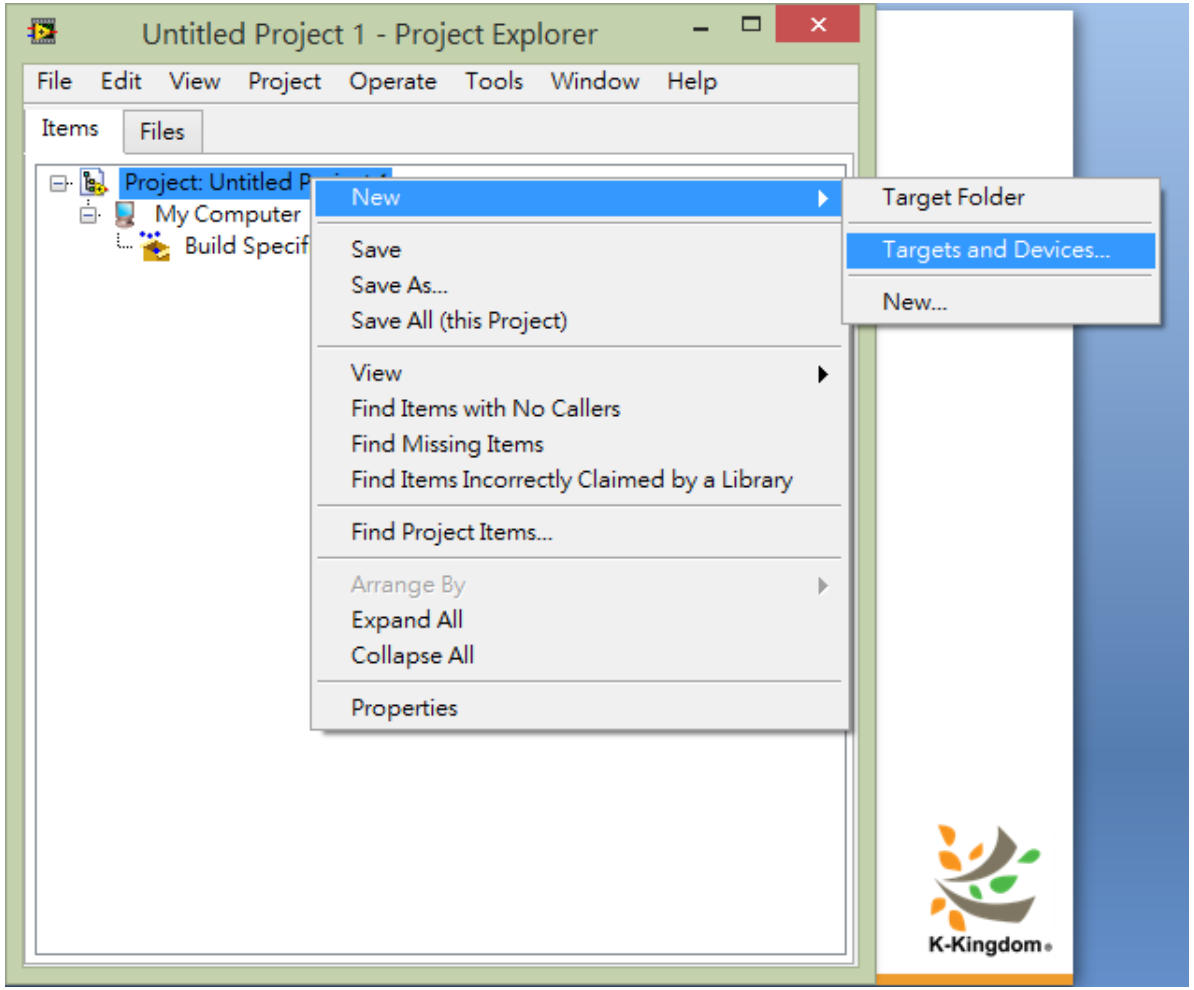
無線控制

- 運用Wi-Fi與KNR連線。



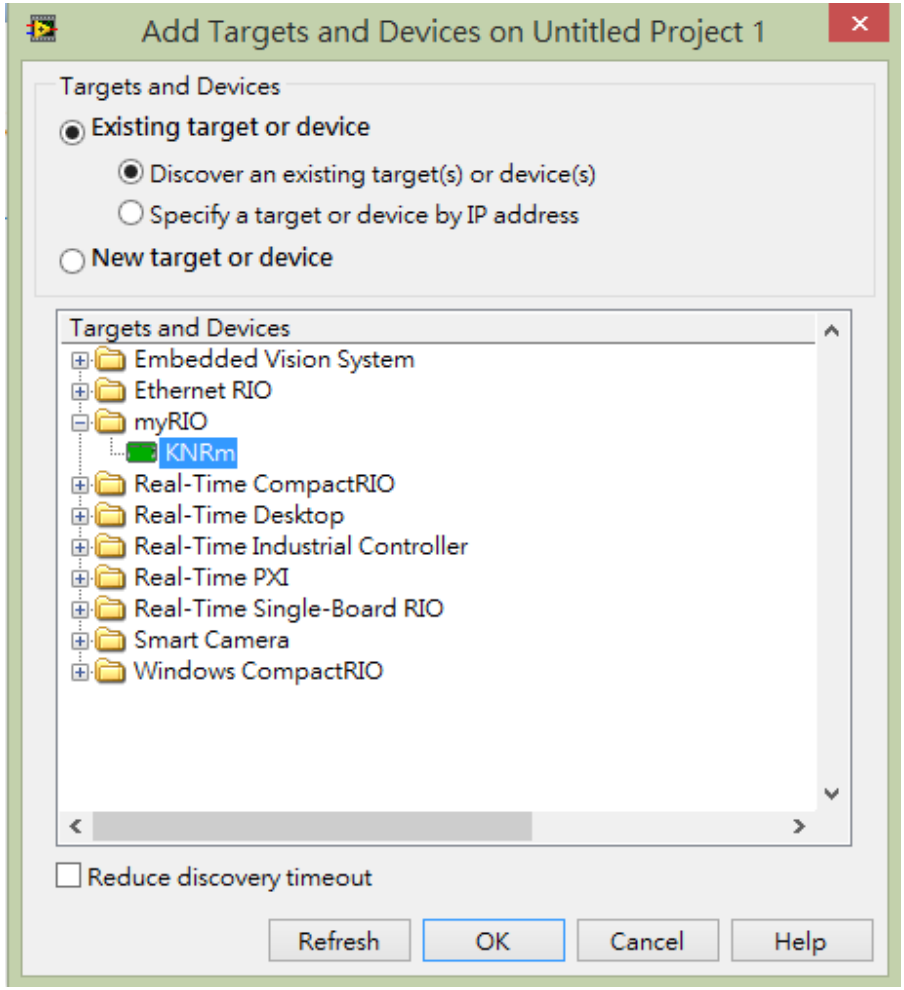
無線控制

- 新增KNR設備。



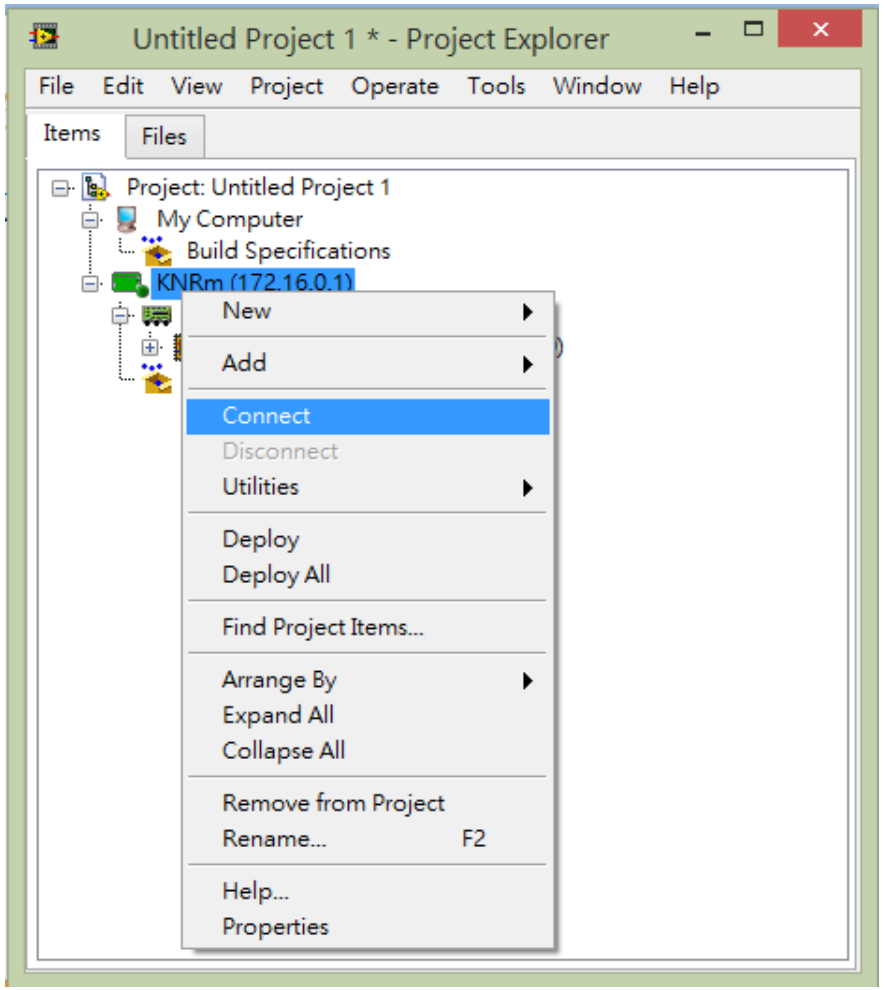
無線控制

- 選擇myRIO下的KNRm。



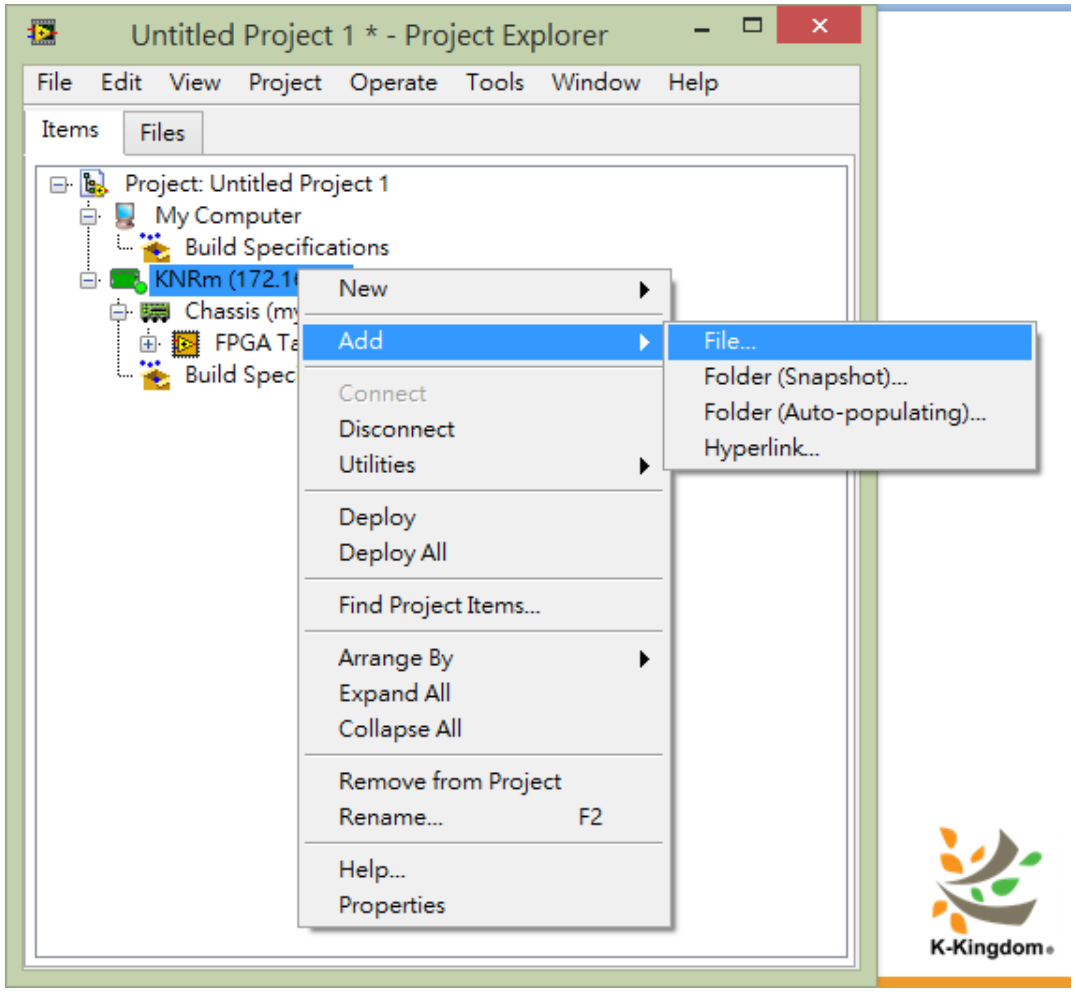
無線控制

- 把Project與KNR連線。



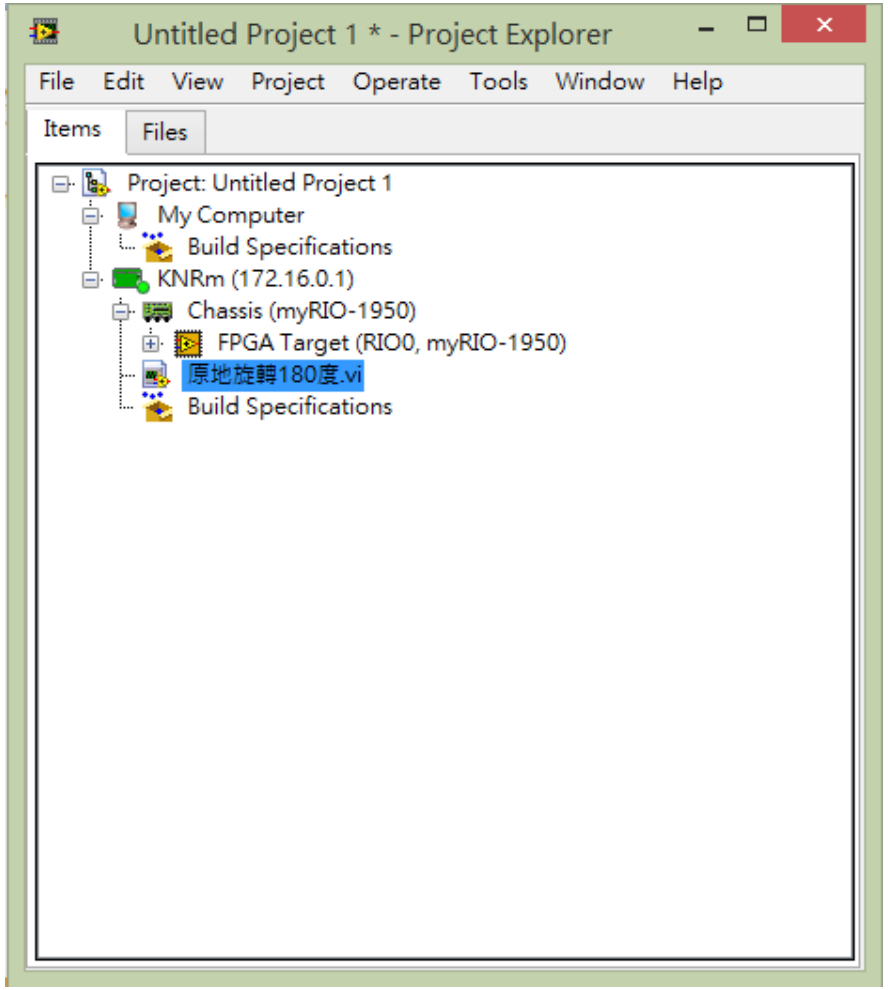
無線控制

- 加入剛剛寫好的程式。



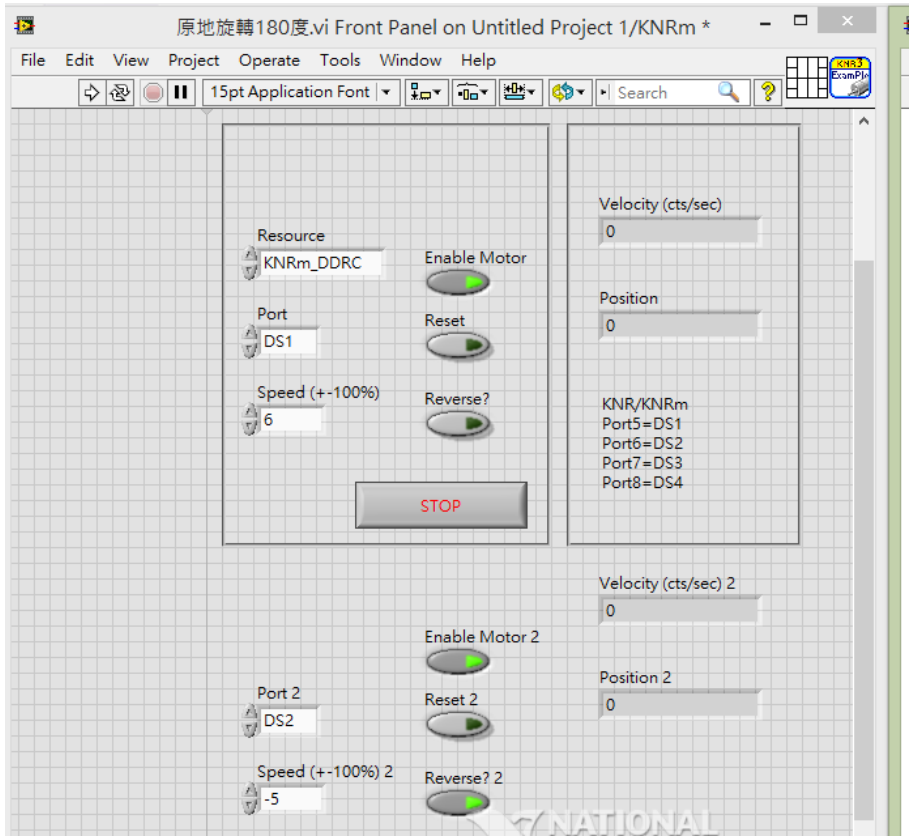
無線控制

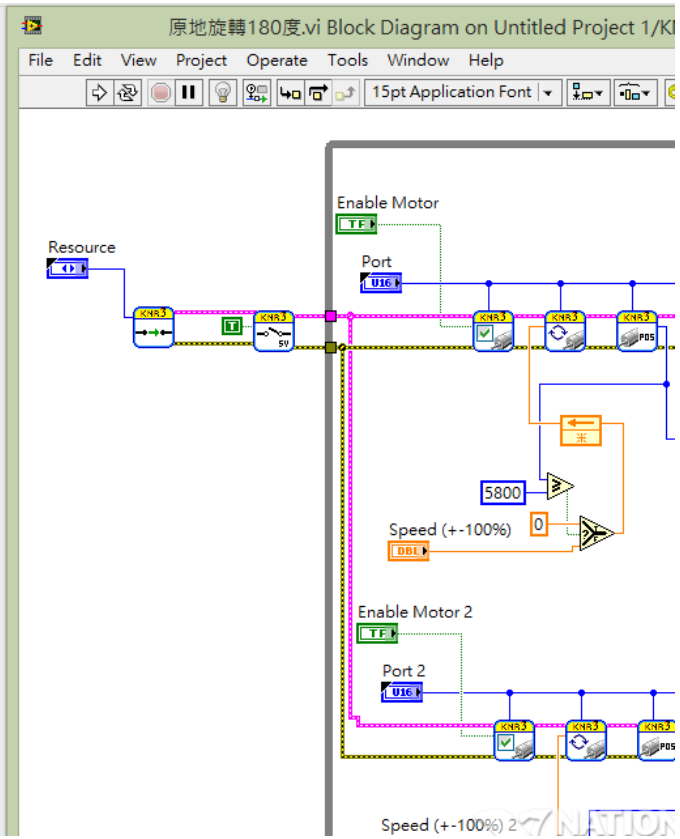
- 加入剛剛寫好的程式。



無線控制

- 完成!


原地旋轉180度.vi Front Panel on Untitled Project 1/KNRm *
File Edit View Project Operate Tools Window Help
15pt Application Font
Search
Resource
KNRm_DDRC
Enable Motor
Port
DS1
Reset
Speed (+-100%)
6
Reverse?
STOP
Velocity (cts/sec)
0
Position
0
KNR/KNRm
Port5=DS1
Port6=DS2
Port7=DS3
Port8=DS4
Velocity (cts/sec) 2
0
Enable Motor 2
Position 2
0
Port 2
DS2
Reset 2
Speed (+-100%) 2
-5
Reverse? 2


原地旋轉180度.vi Block Diagram on Untitled Project 1/KI
File Edit View Project Operate Tools Window Help
15pt Application Font
Resource
Enable Motor
Port
5800
Speed (+-100%)
0
Enable Motor 2
Port 2
Speed (+-100%) 2

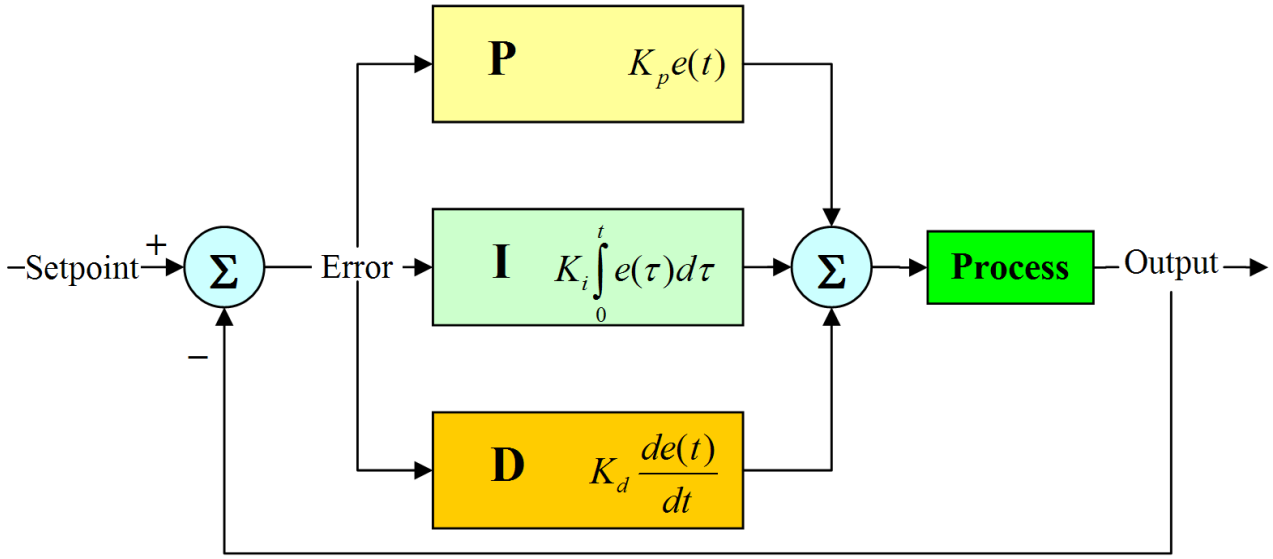
課堂五 ：馬達控制（二）—PID控制器

貝登堡智能
KK Intelligent Service,Inc.

PID控制器

PID控制器可以追溯到1890年代的調速器設計。PID控制器是在船舶自動操作系統中漸漸發展。第一個發表PID控制器理論分析論文的是俄裔美國工程師尼古拉斯·米諾爾斯基（Minorsky 1922）。

米諾爾斯基當時在設計美國海軍的自動操作系統，他的設計是基於對舵手的觀察，控制船舶不只是依目前的誤差，也考慮過去的誤差以及誤差的變化趨勢，後來米諾爾斯基也用數學的方式加以推導。他的目的是在於穩定性，而不是泛用的控制，因此大幅的簡化了問題。比例控制可以在小的擾動下有穩定性，但無法消除穩態誤差，因此加入了積分項，後來也加入了微分項。



PID控制器方塊圖

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

PID控制器之數學模型

K_p：比例增益，是調適參數

K_i：積分增益，也是調適參數

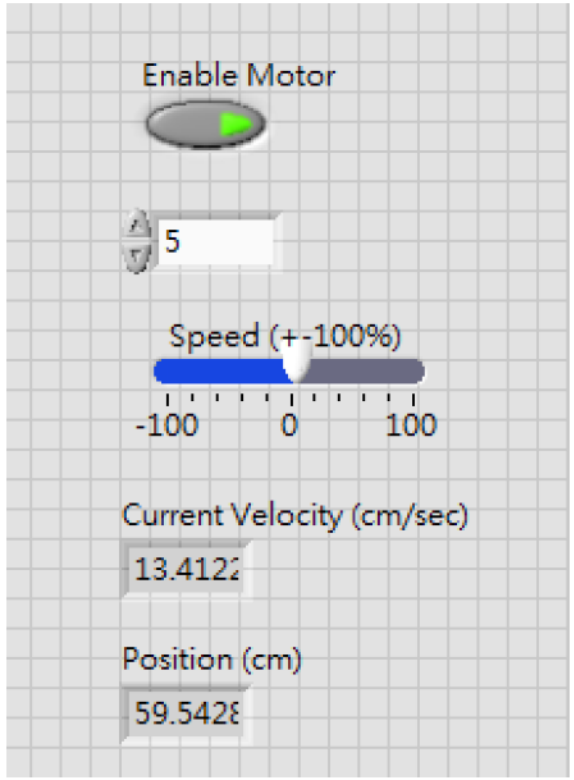
K_d：微分增益，也是調適參數

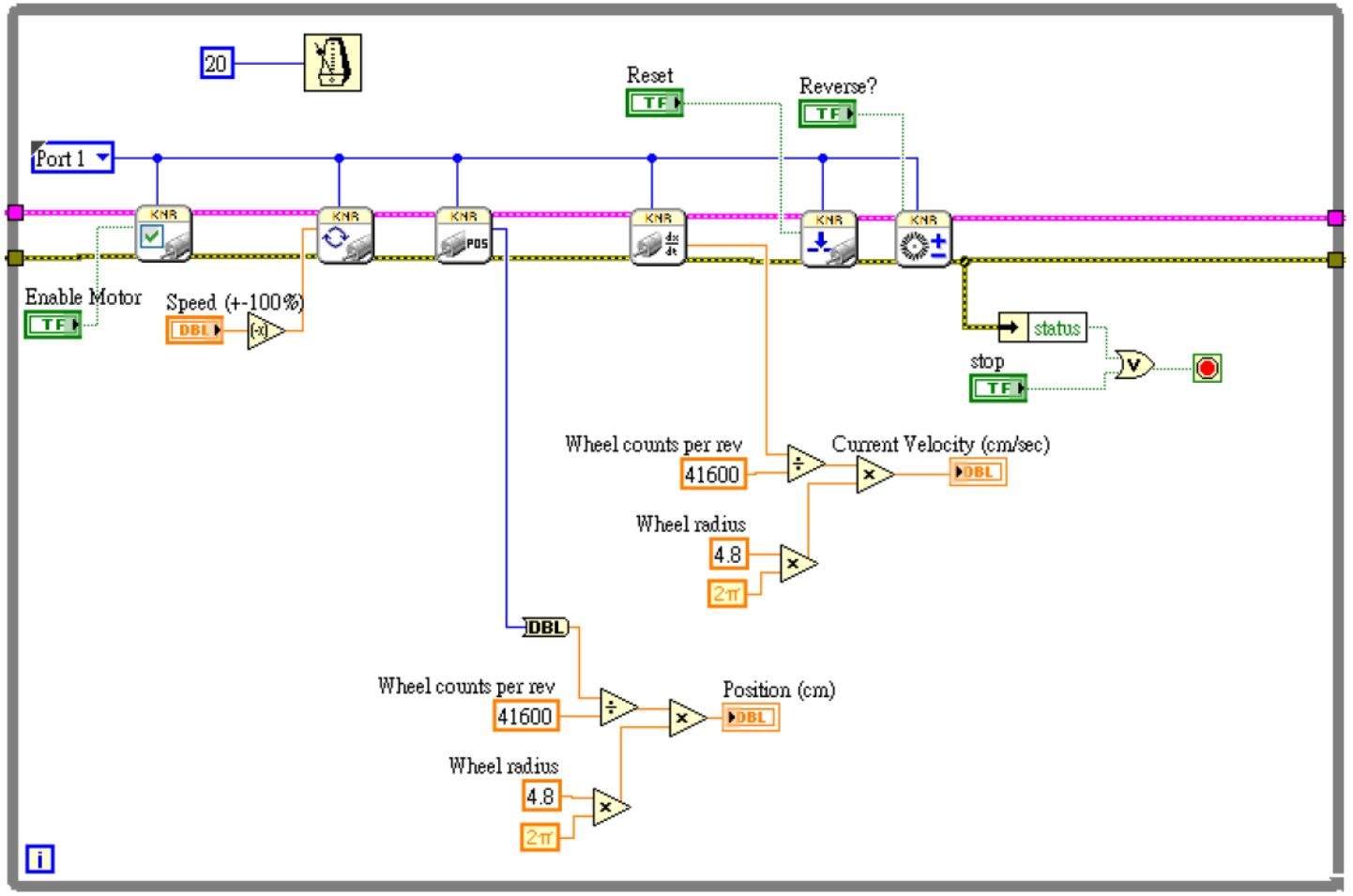
e：誤差=設定值（SP）- 回授值（PV）

t：目前時間

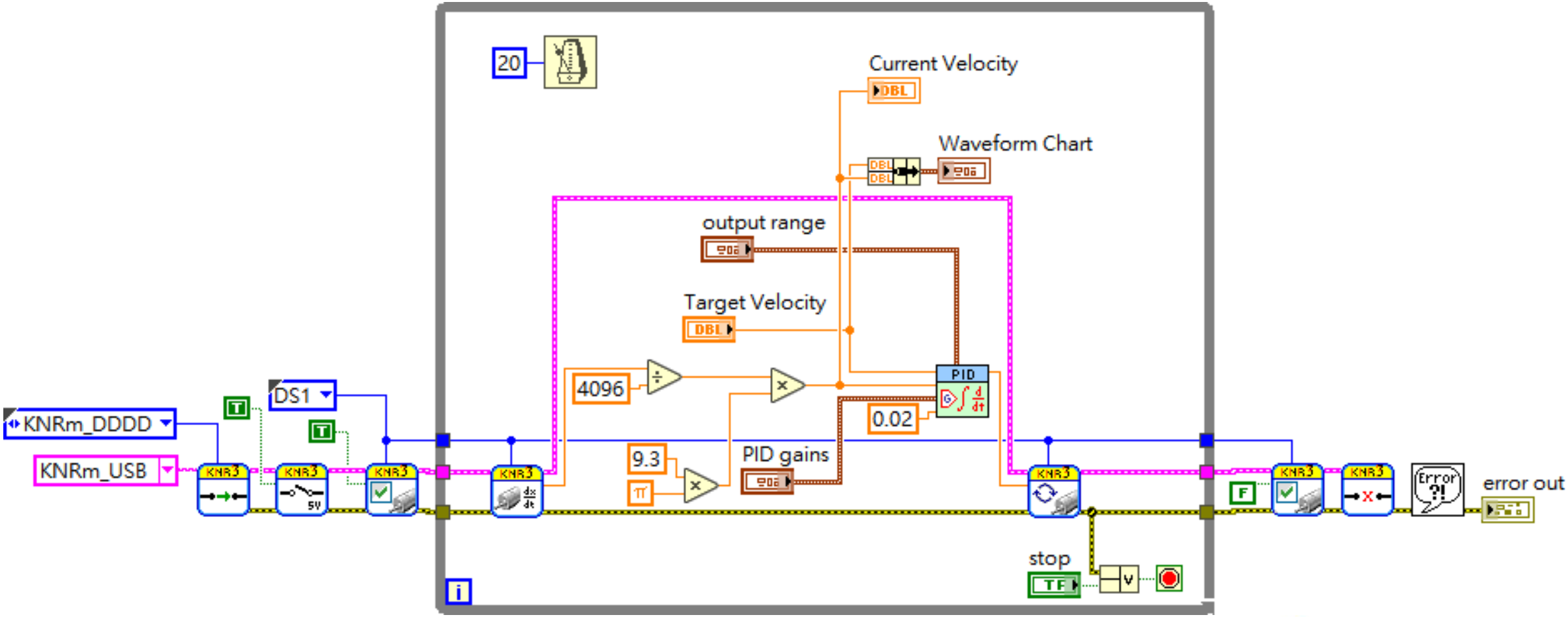
τ：積分變數，數值從0到目前時間t

將編碼器的計數結果轉為輪子轉動的距離及速度

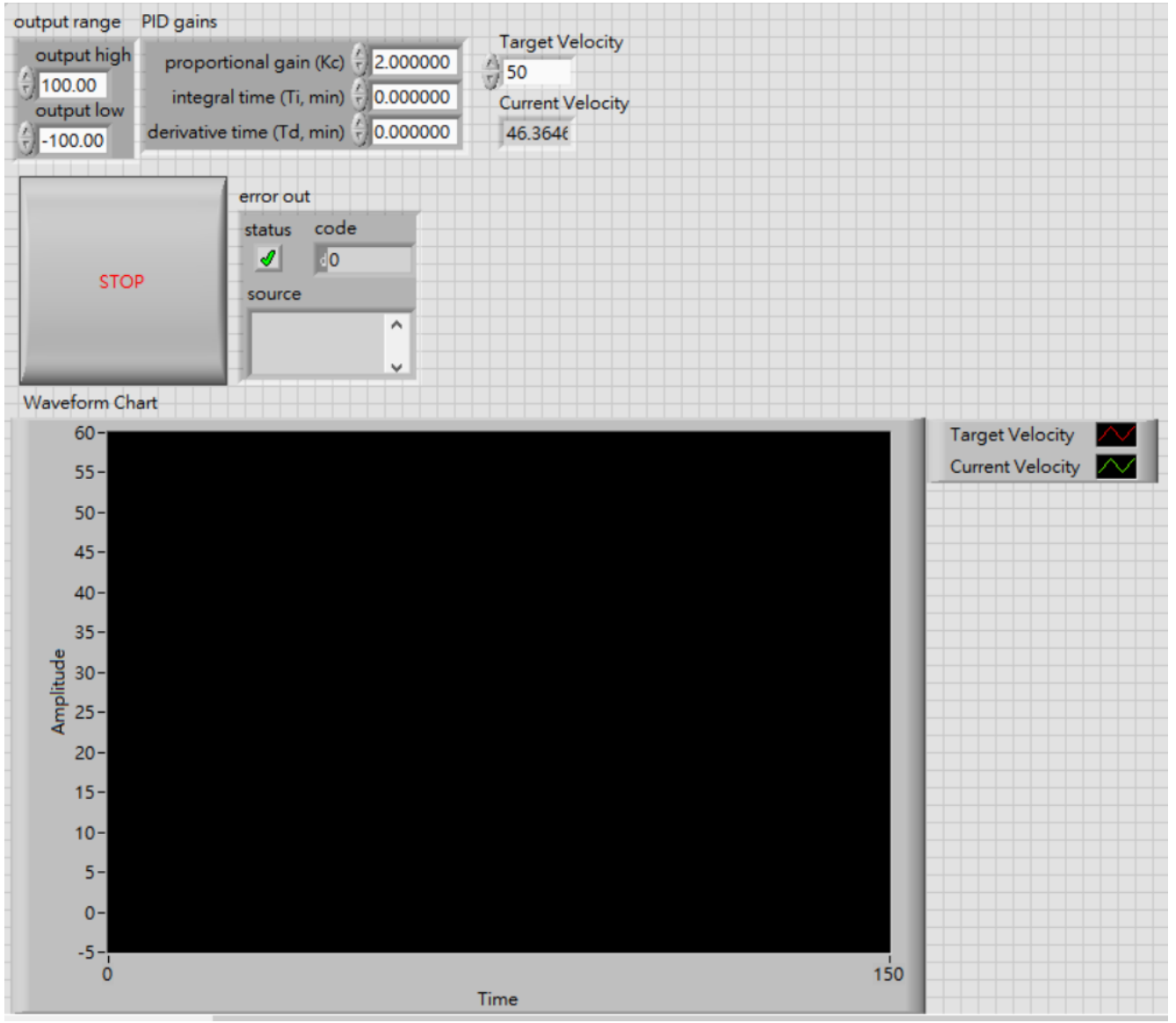


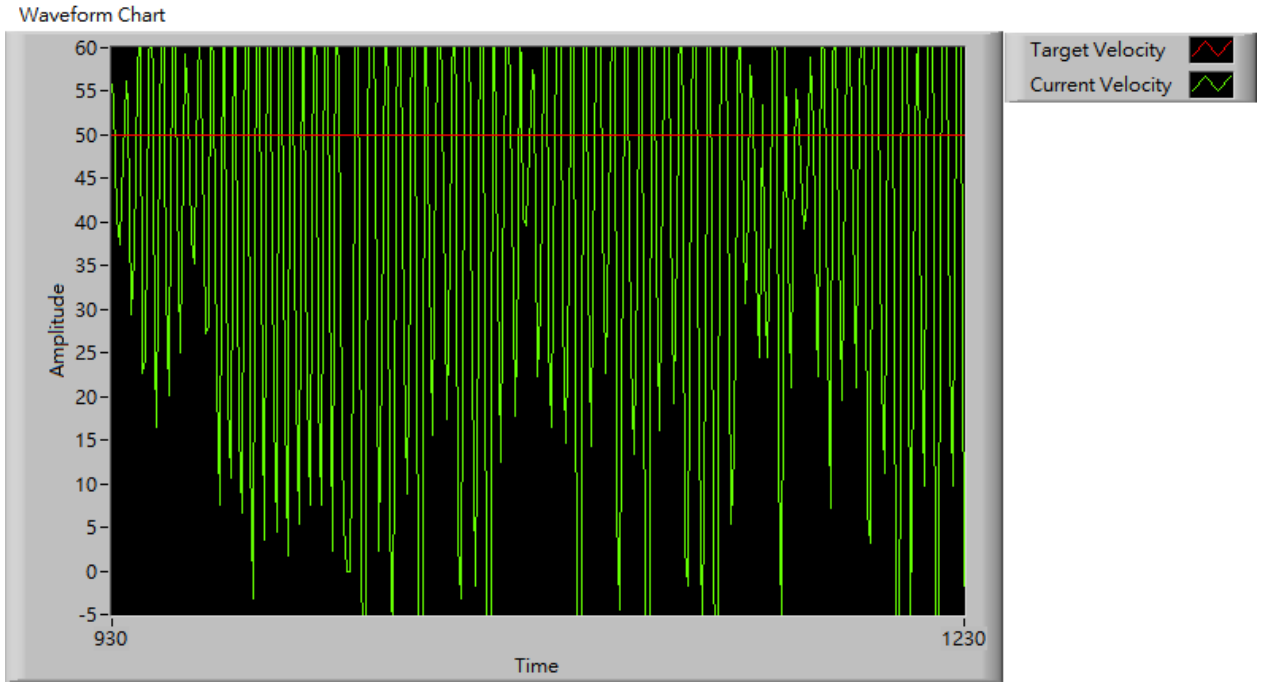


將PID控制器帶入馬達控制

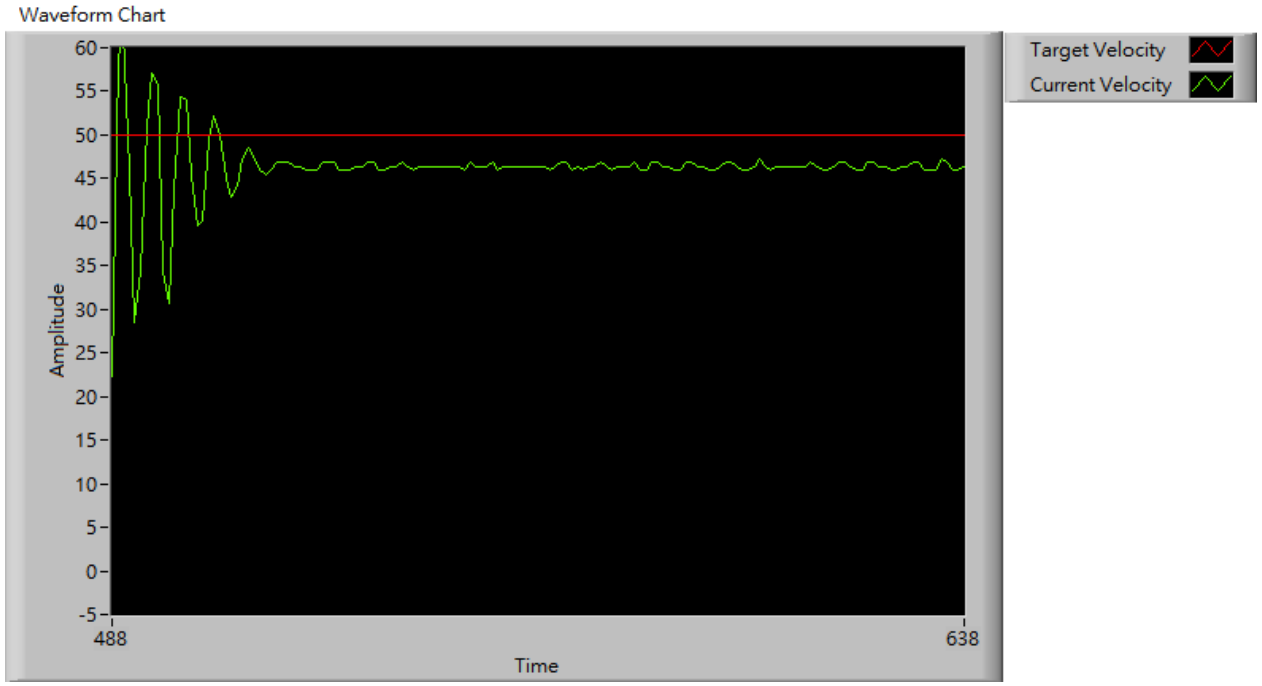


將PID控制器帶入馬達控制——人機介面

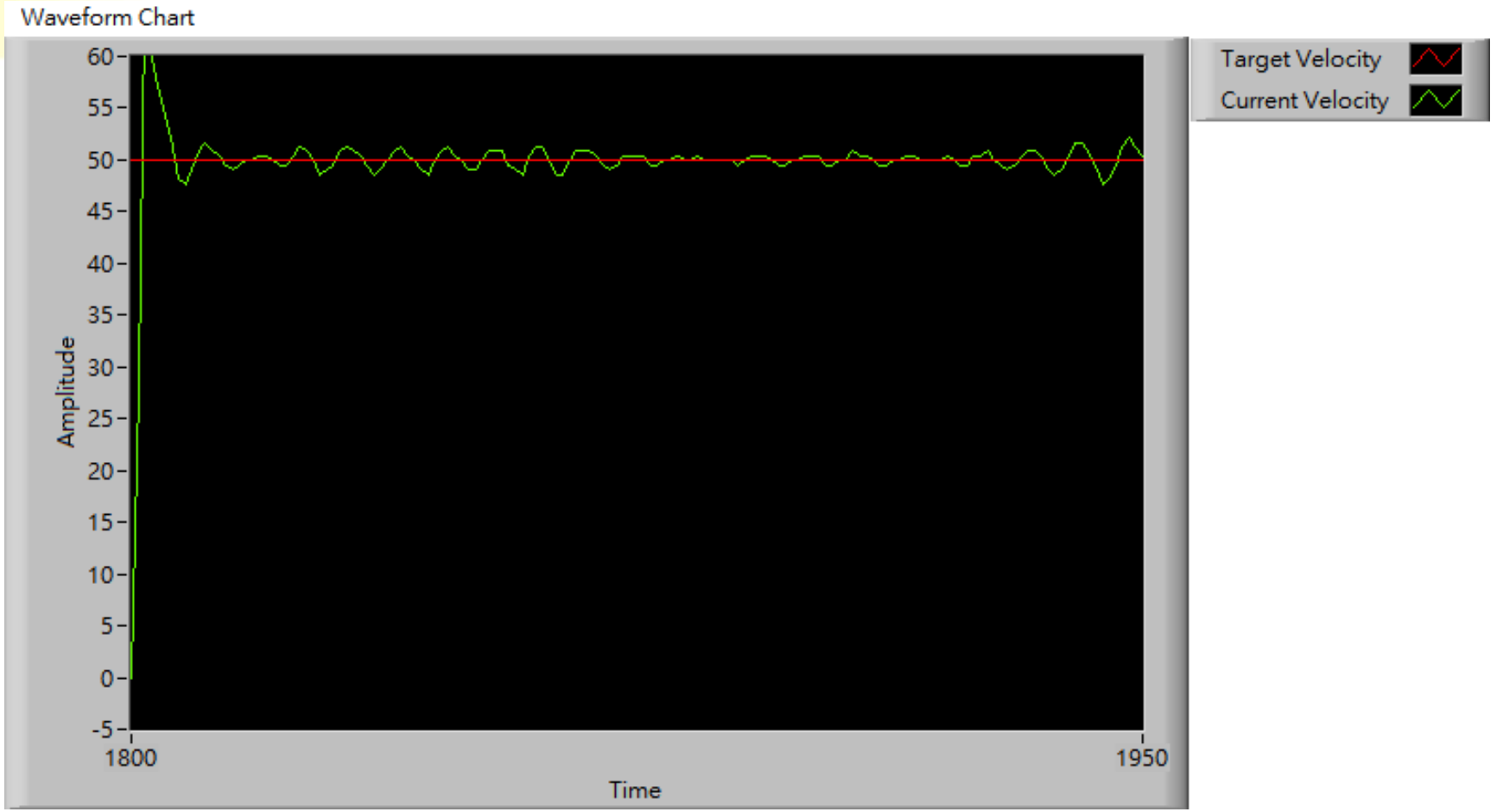




kp過大會使馬達產生震盪



kp調整後會使馬達穩定，但具有穩態誤差



調整ki可減少穩態誤差，讓目標轉速與實際轉速達到一致

嘗試將機器人的兩輪分別加入速度控制，使機器人可以在地面進行前進、後退的運動。

小挑戰

- 利用PID控制讓平台車走正方形。

課堂六 ：追紅球機器人（一）
——LabVIEW影像處理

貝登堡智能
KK Intelligent Service,Inc.

影像概論

貝登堡智能
KK Intelligent Service,Inc.

像素與解析度

- 像素

　　像素是數位影像的最小單位，基本上一個像素是一個顏色點，而一個影像是由許多點所構成，如果說一個像素尺寸為480X640，代表其影像的寬為640像素與高為480像素

- 解析度

　　解析度為像素的數量，同樣單位面積中像素越多則解析度越高，影像品質也越好。

影像色彩類型

影像色彩主要可以分為黑白、灰階、16色、256色、全彩等等。

- 黑白

像素陣列內的資料僅使用1bit，故只能記錄0或1，以影像輸出則是黑與白。

- 灰階

灰階影像內的資料使用8bit存取，故影像中每點像素能以0到255表現不同深淺的灰色。

- 16色與256色

影像內像素分別以4bit和8bit存取，再將不同的數值分配到不同的顏色上，其優點是能表現彩色的影像，但其缺點是像素值只代表顏色而不能表達深淺的強度。

影像色彩類型

全彩影像中的像素由三組8bit存取，但是代表的意思不盡相同，主要介紹RGB、HSV兩種

- RGB

RGB分別代表紅色RED、綠色GREEN和藍色BLUE三種顏色的強度，優點是直觀且容易理解，為簡單的加法混合，且是一般顯示器的運作方式，與人類眼睛也是對這三色特別敏感，但其缺點是這三個分量接與顏色相關，在影像辨色時容易受到明暗影響。

- HSV

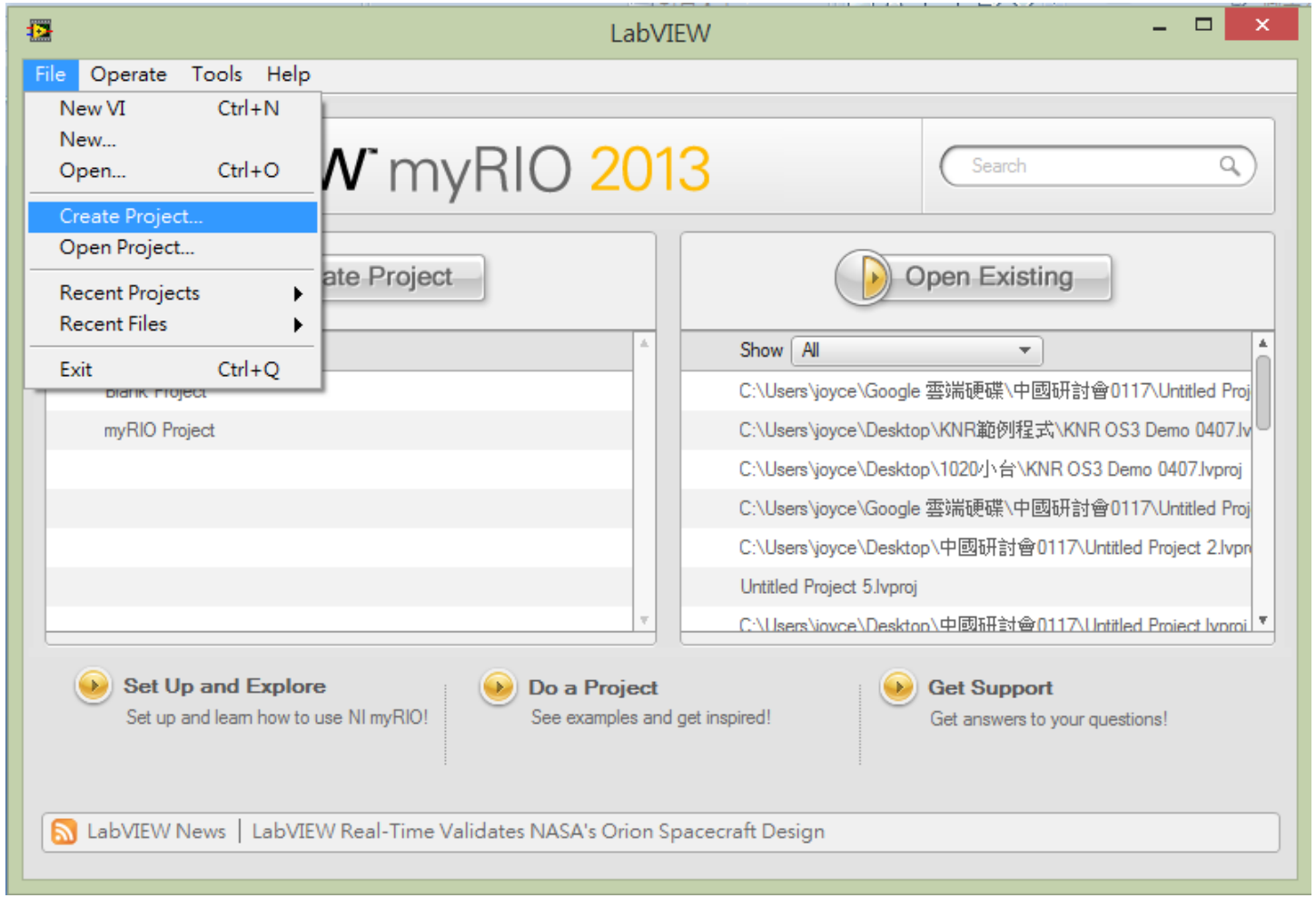
HSV即色相、飽和度、明度，色相（H）是色彩的基本屬性，就是平常所說的顏色名稱，如紅色、黃色等。飽和度（S）是指色彩的純度，越高色彩越純，低則逐漸變灰，取0-100%的數值。明度（V），取0-100%，其優點是三個分量獨立，在影像辨色可以屏除明亮度的影響。

LabVIEW影像辨識

貝登堡智能
KK Intelligent Service,Inc.

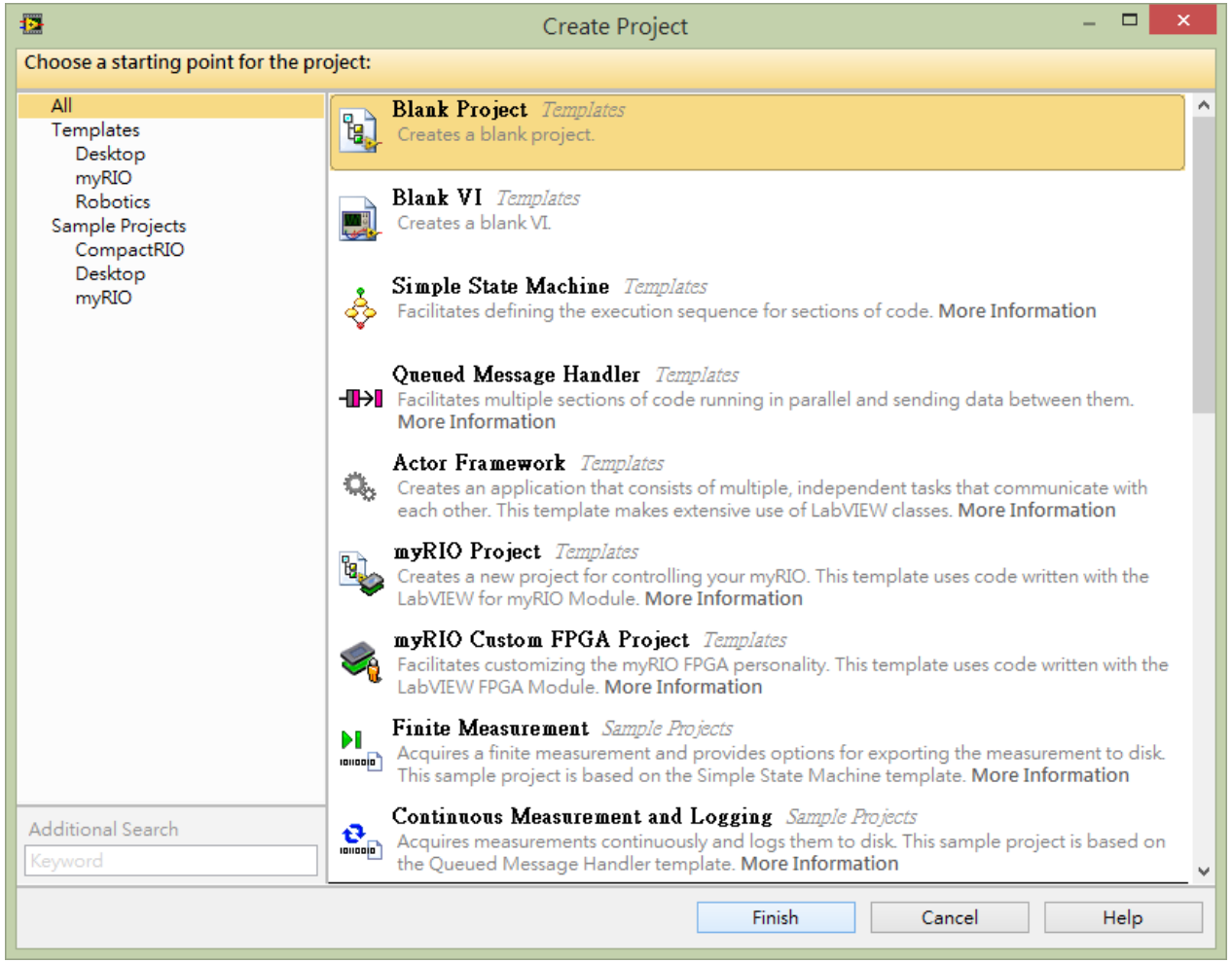
影像辨識

- 開啟新的專案。


LabVIEW
File
Operate
Tools
Help
New VI Ctrl+N
New...
Open... Ctrl+O
Create Project...
Open Project...
Recent Projects
Recent Files
Exit Ctrl+Q
myRIO 2013
Search
Open Existing
myRIO Project
Show All
C:\Users\joyce\Google 雲端硬碟\中國研討會0117\Untitled Proj
C:\Users\joyce\Desktop\KNR範例程式\KNR OS3 Demo 0407.lv
C:\Users\joyce\Desktop\1020小台\KNR OS3 Demo 0407.lvproj
C:\Users\joyce\Google 雲端硬碟\中國研討會0117\Untitled Proj
C:\Users\joyce\Desktop\中國研討會0117\Untitled Project 2.lvpr
Untitled Project 5.lvproj
Set Up and Explore
Set up and learn how to use NI myRIO!
Do a Project
See examples and get inspired!
Get Support
Get answers to your questions!
LabVIEW News | LabVIEW Real-Time Validates NASA's Orion Spacecraft Design

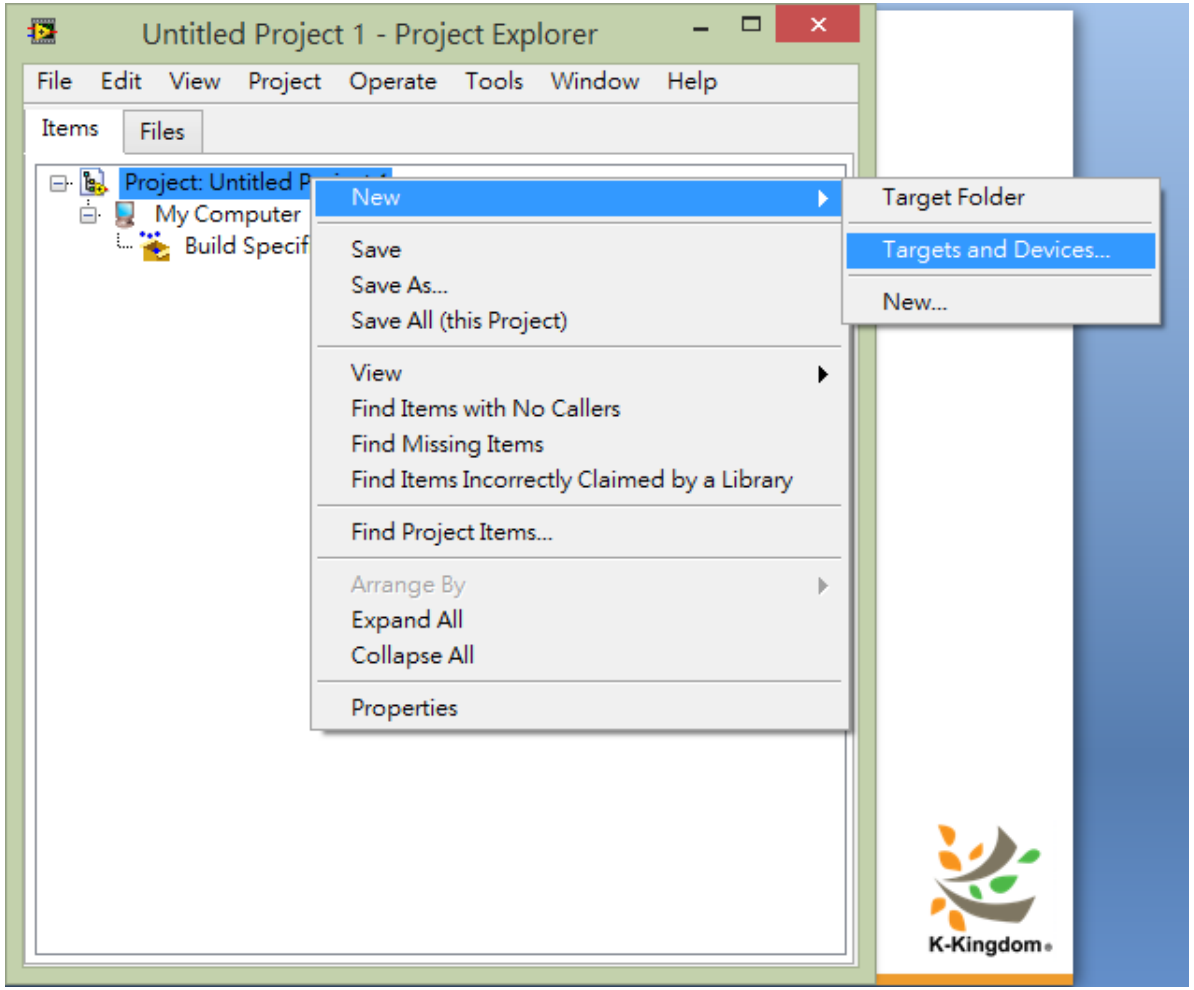
影像辨識

- 建立一個新的Project。



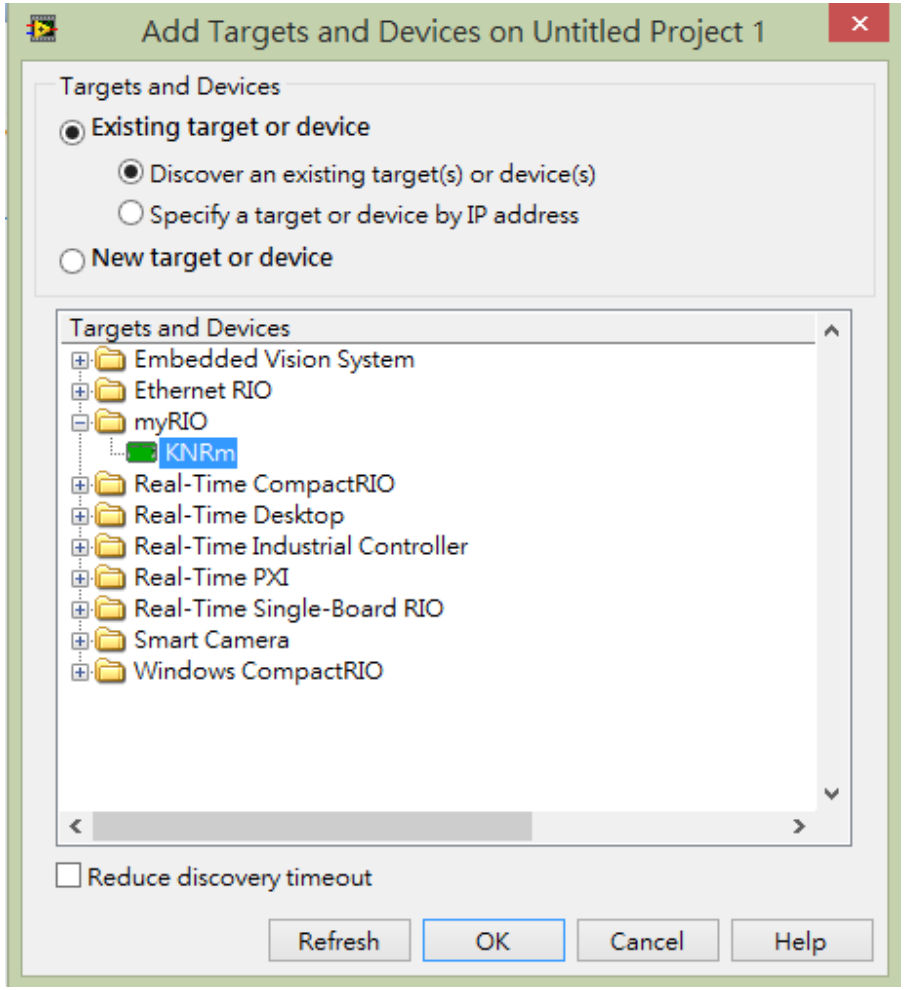
影像辨識

- 新增KNR設備。



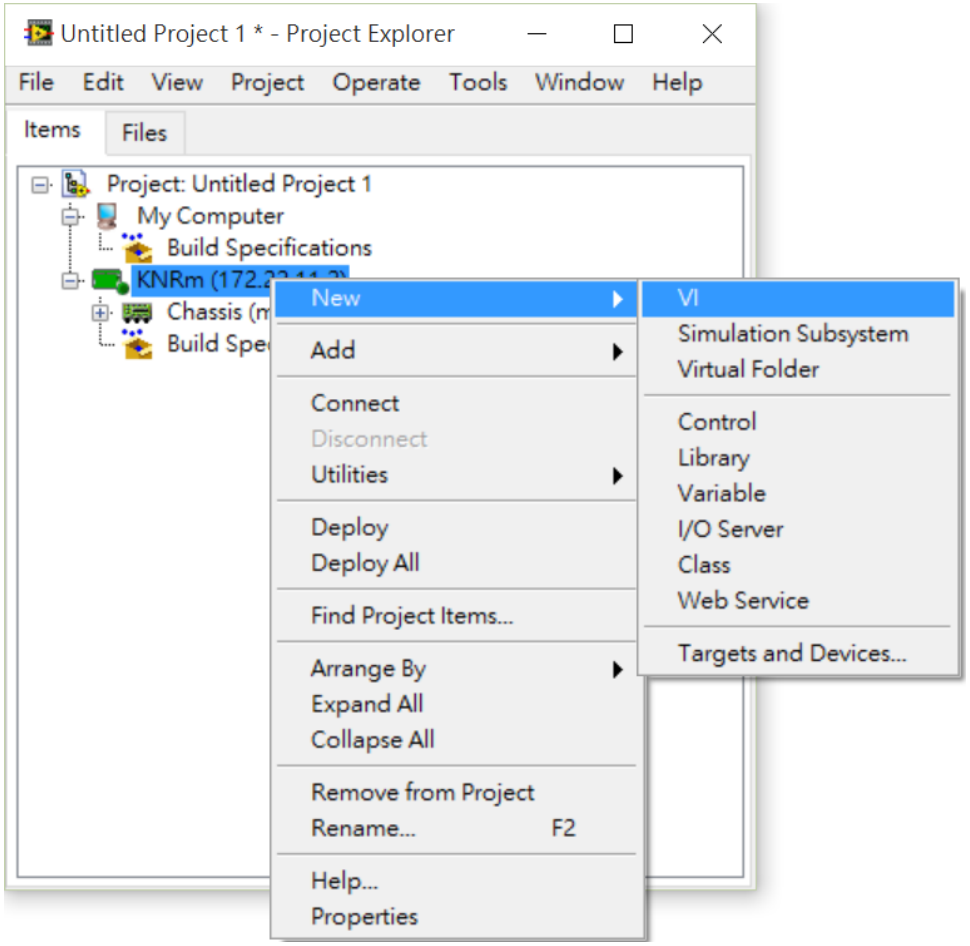
影像辨識

- 新增KNR設備。



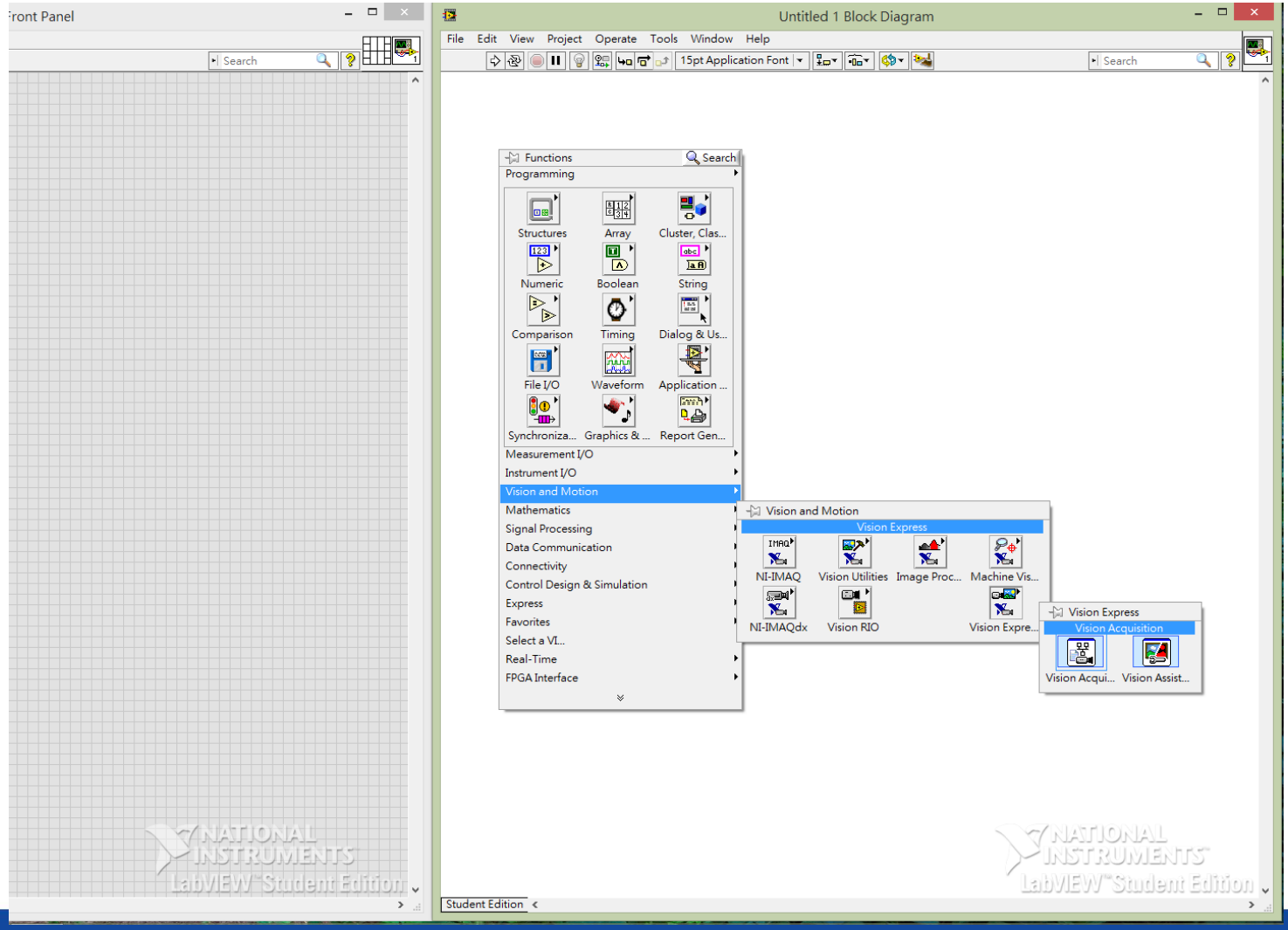
影像辨識

- 在KNRm下面開啟新的VI。



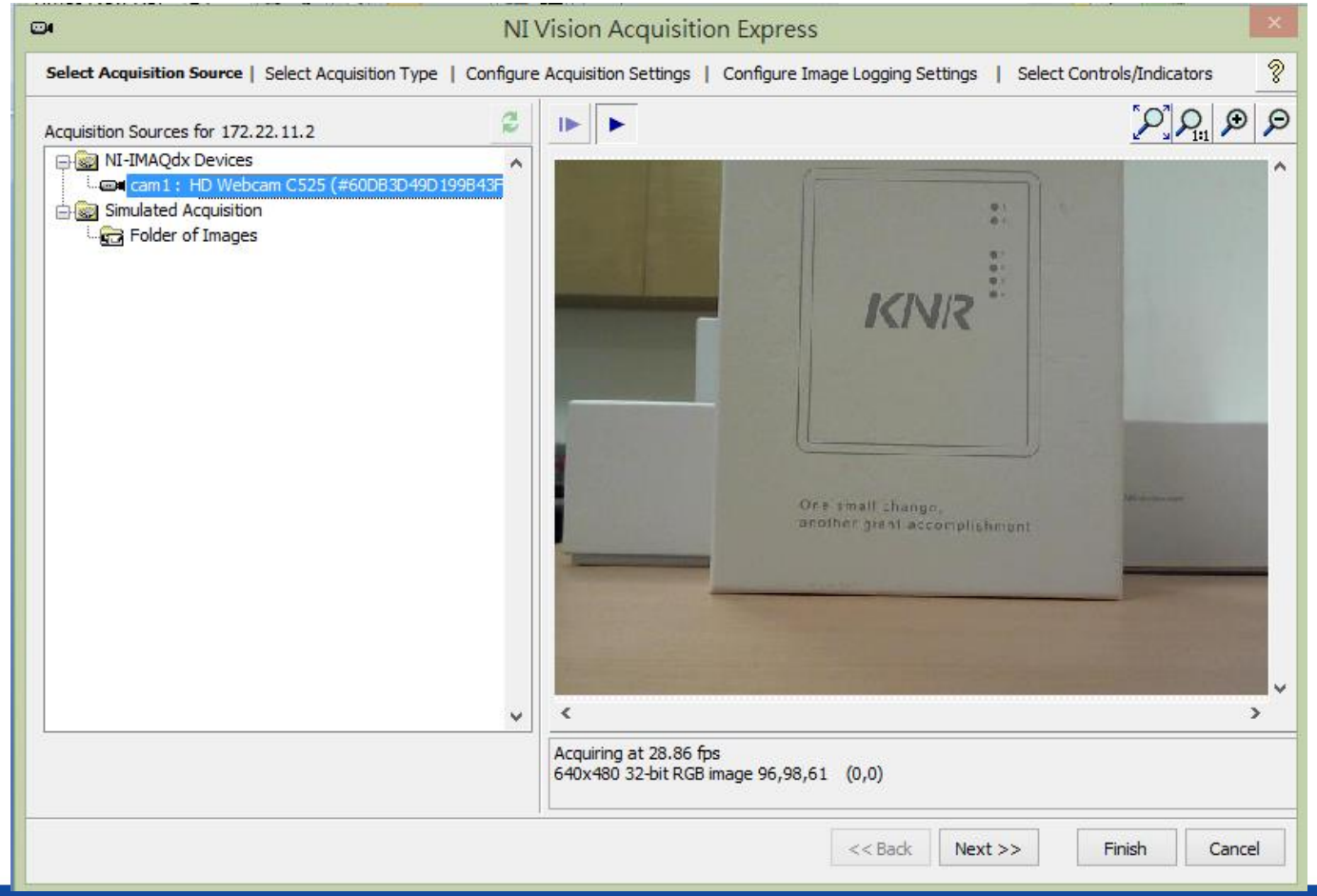
影像辨識

- 點右鍵後選擇Vision Acquisition。



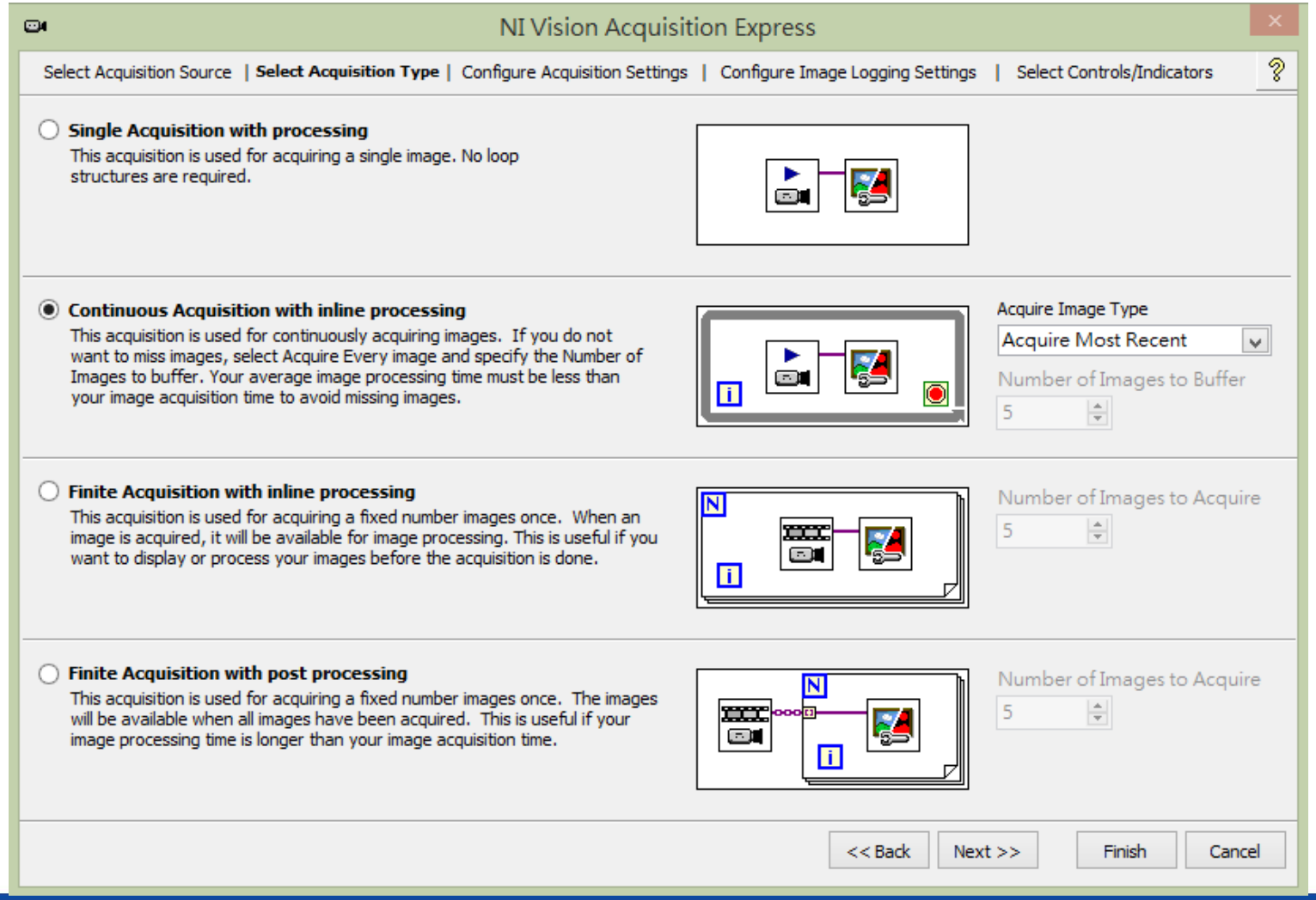
影像辨識

- 出現Vision Acquisition介面。
- 點選Webcam C310>>撥放鍵>> next 。



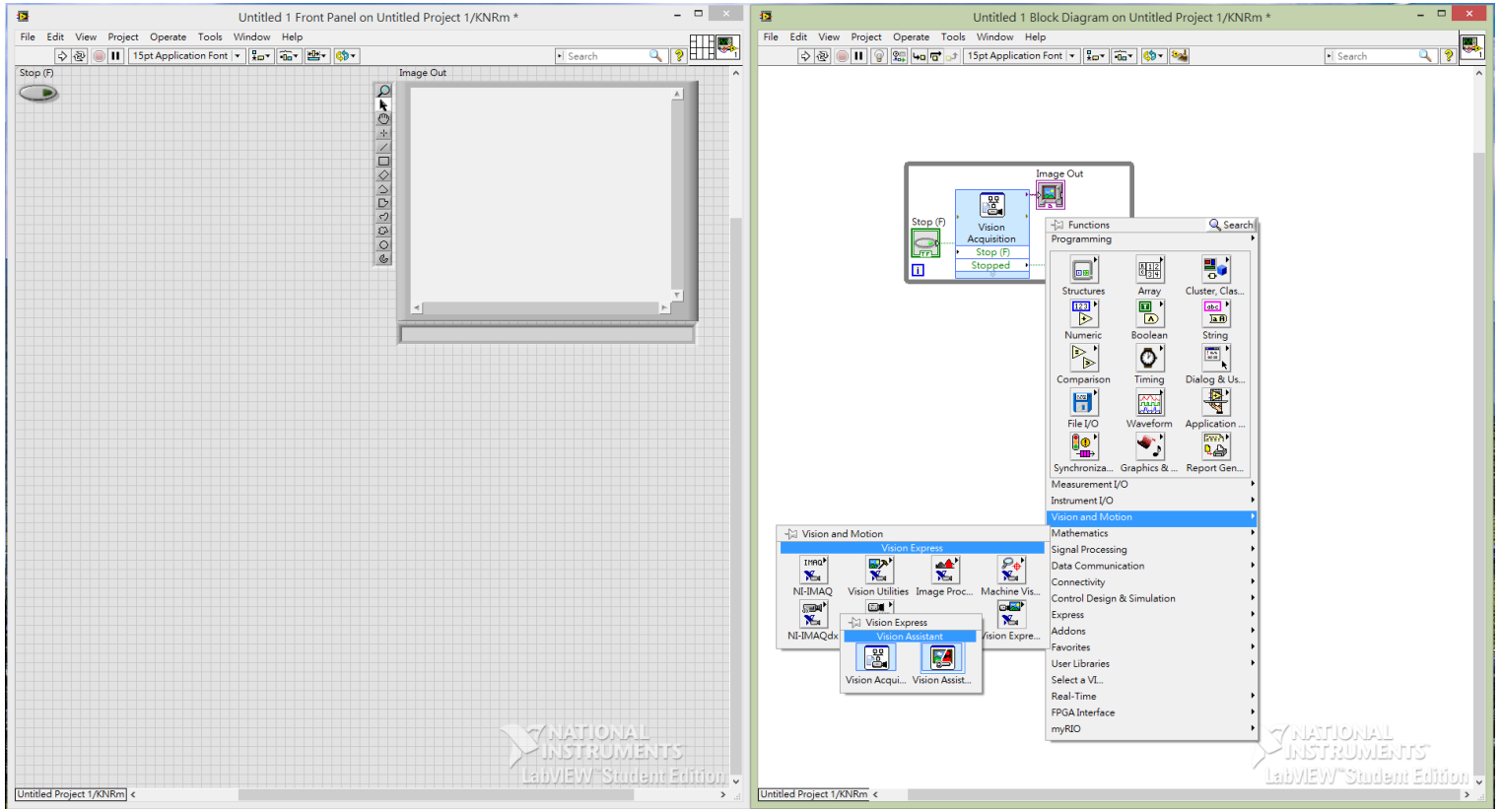
影像辨識

- 點選Continuous Acquisition>>右下方Finish 。



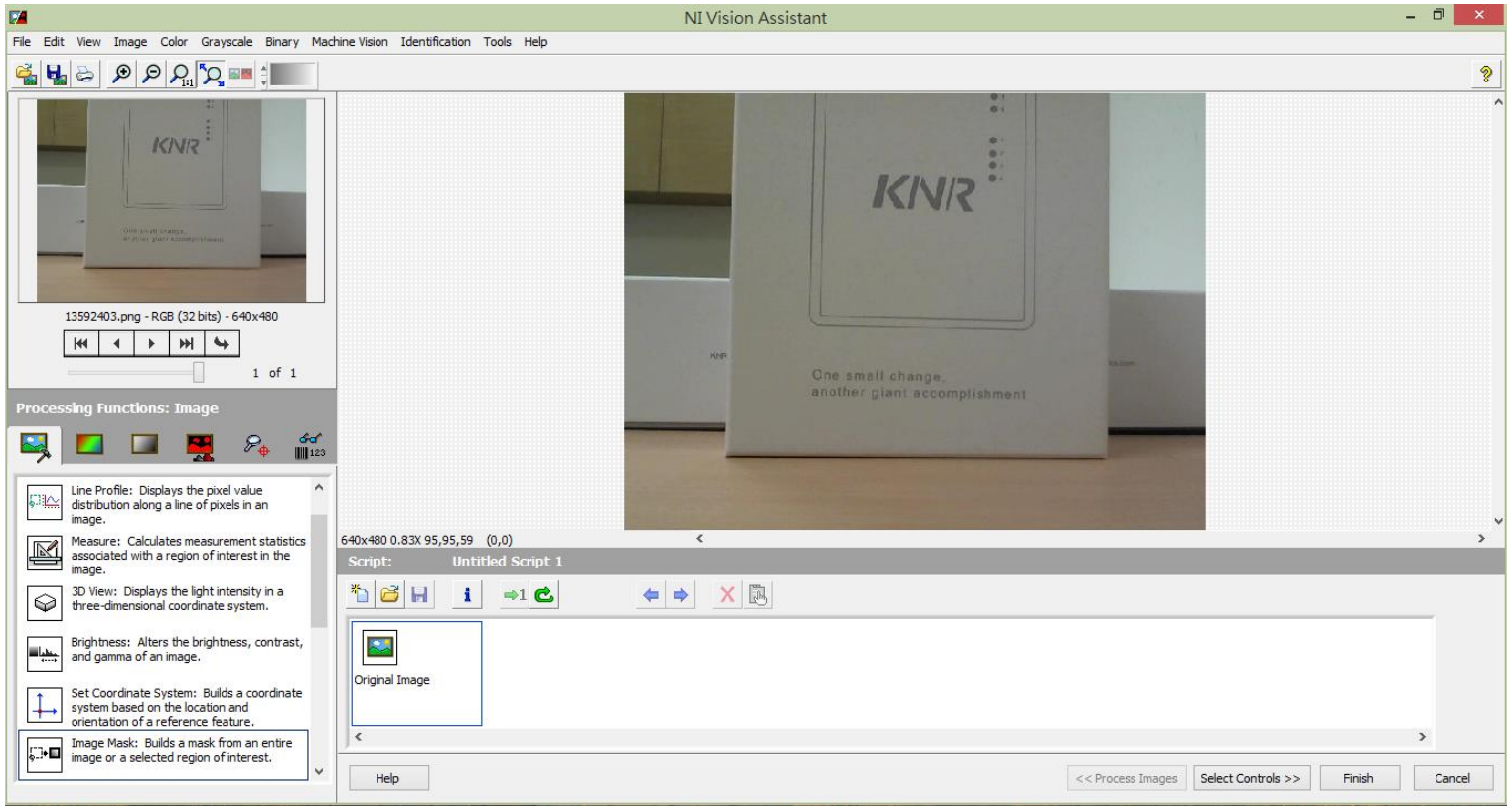
影像辨識

- 點右鍵選擇Vision Assistant。



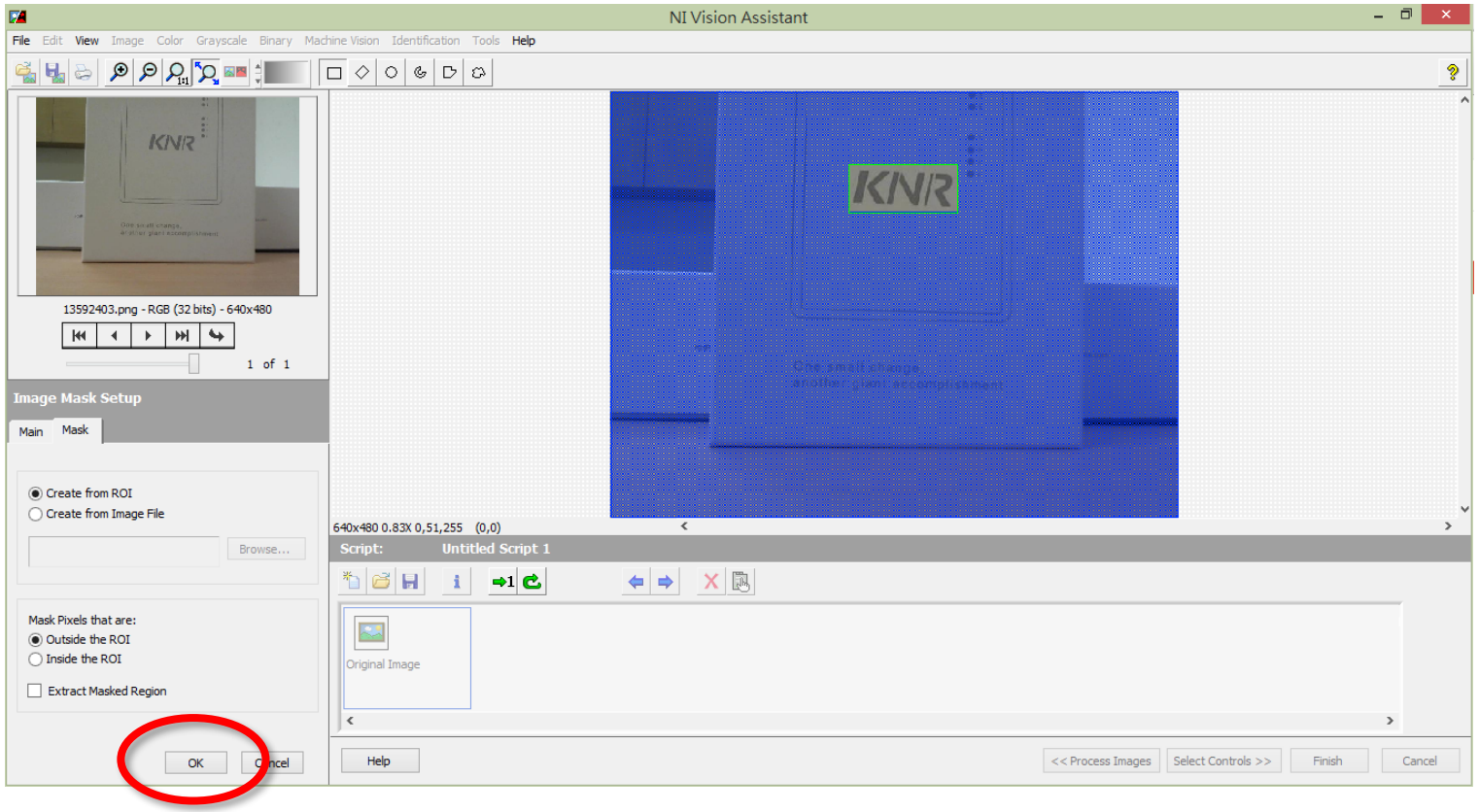
影像辨識

- 出現Vision Assistant介面並點選Image Mask。



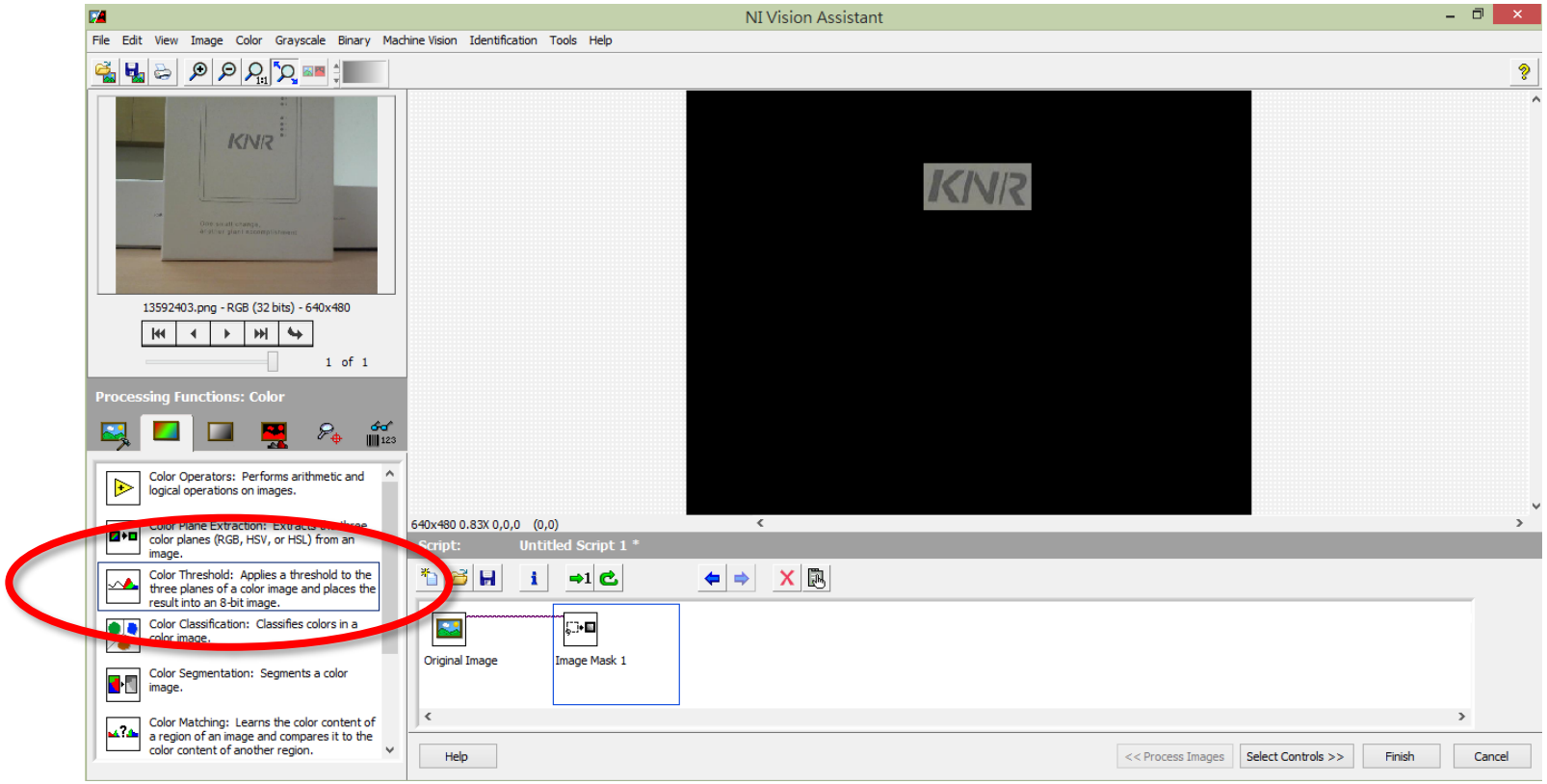
影像辨識

- 框選要做影像處理的位置，並按下OK 。



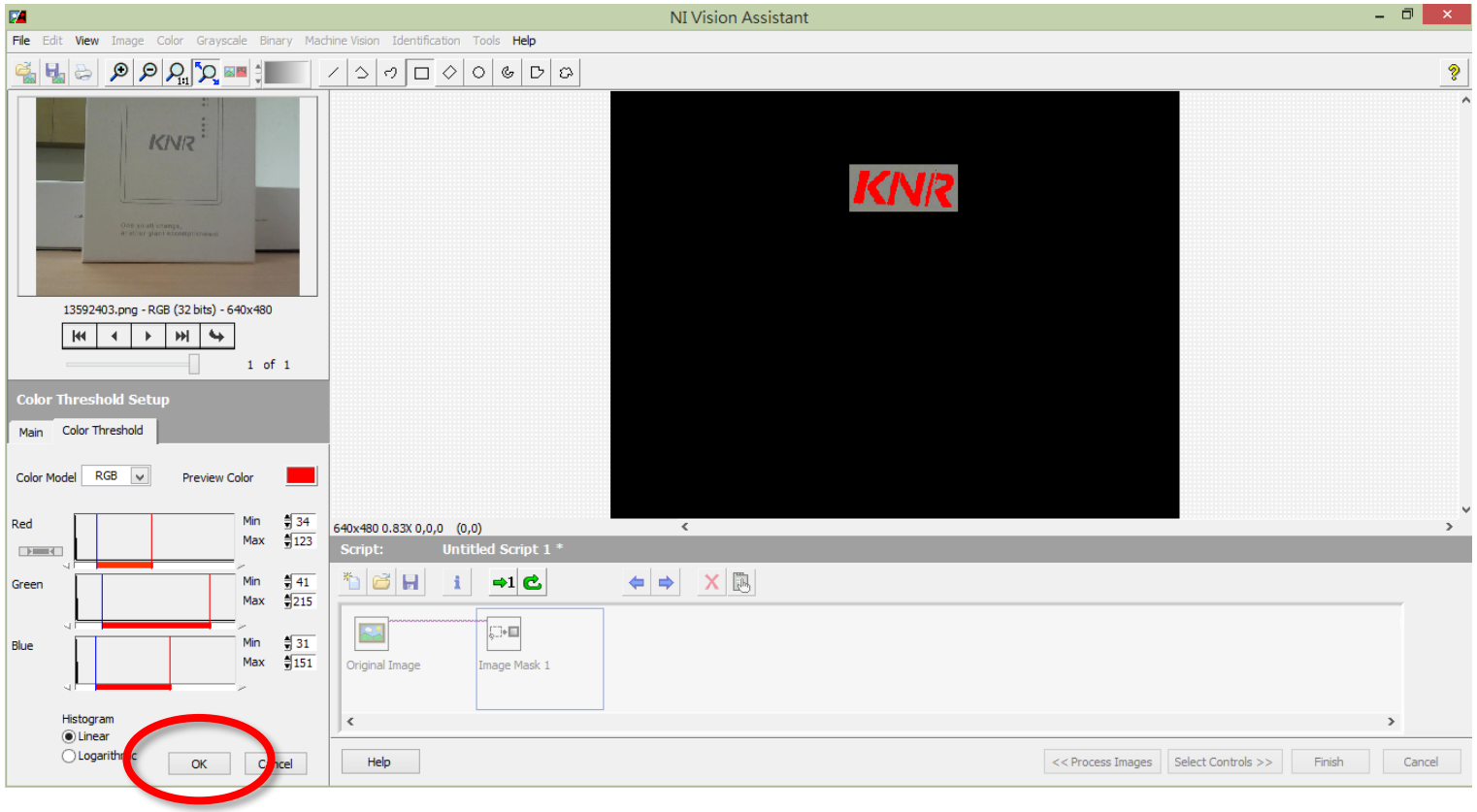
影像辨識

- 點選Color Threshold。



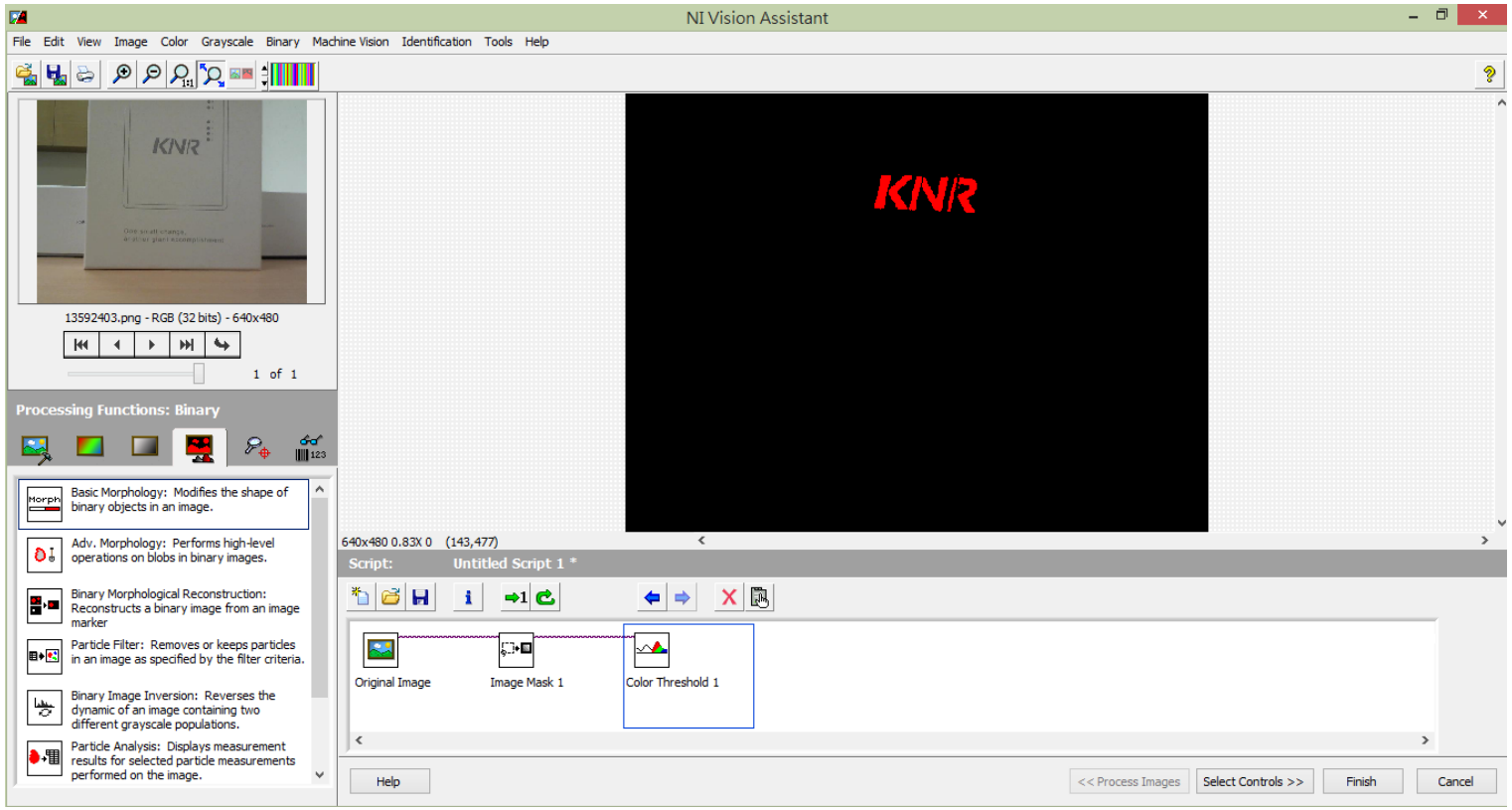
影像辨識

- 調整RGB到自己想要的位置，並按下OK。



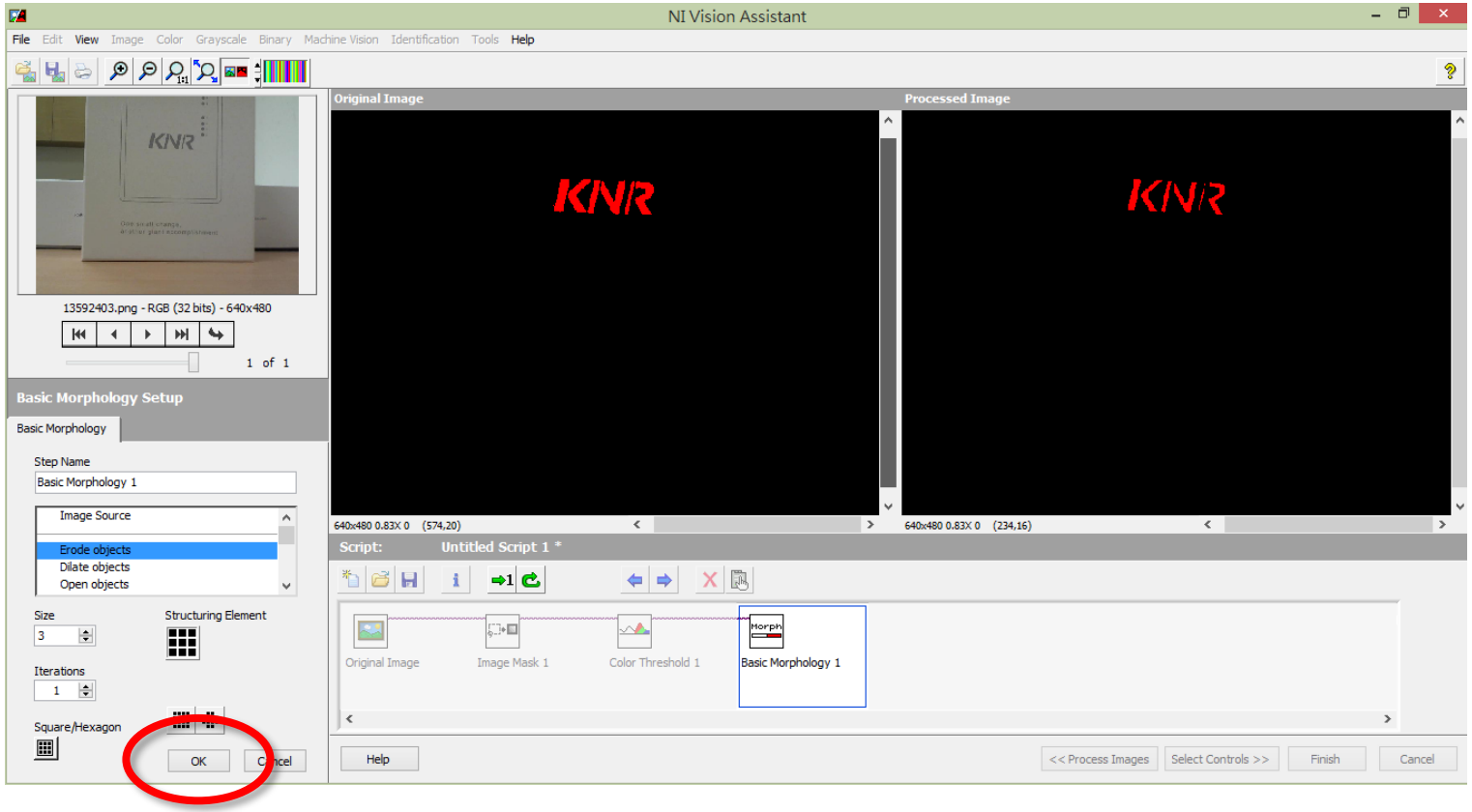
影像辨識

- 點選Basic Morphology。



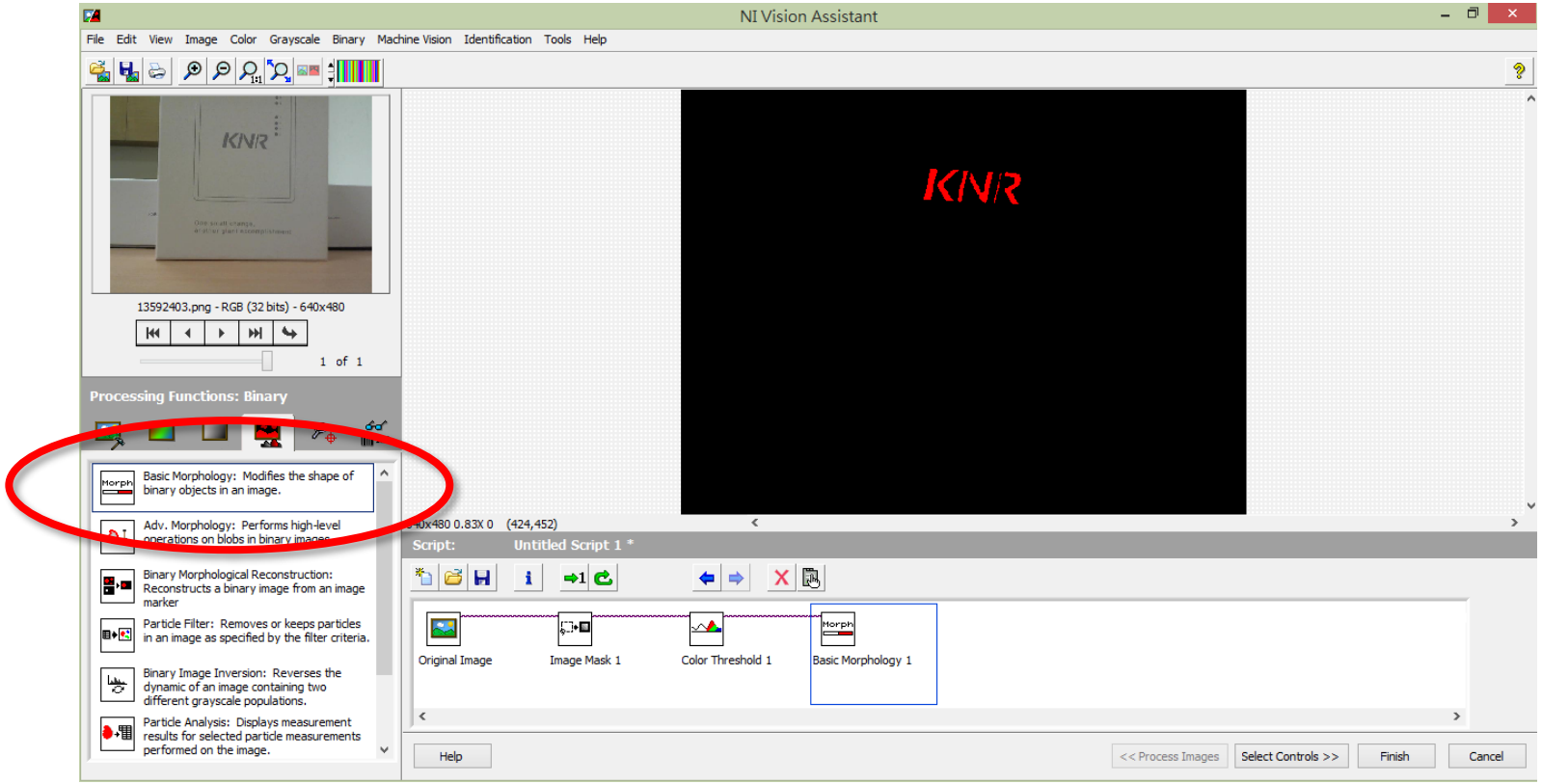
影像辨識

- 點選Erode objects>>OK。



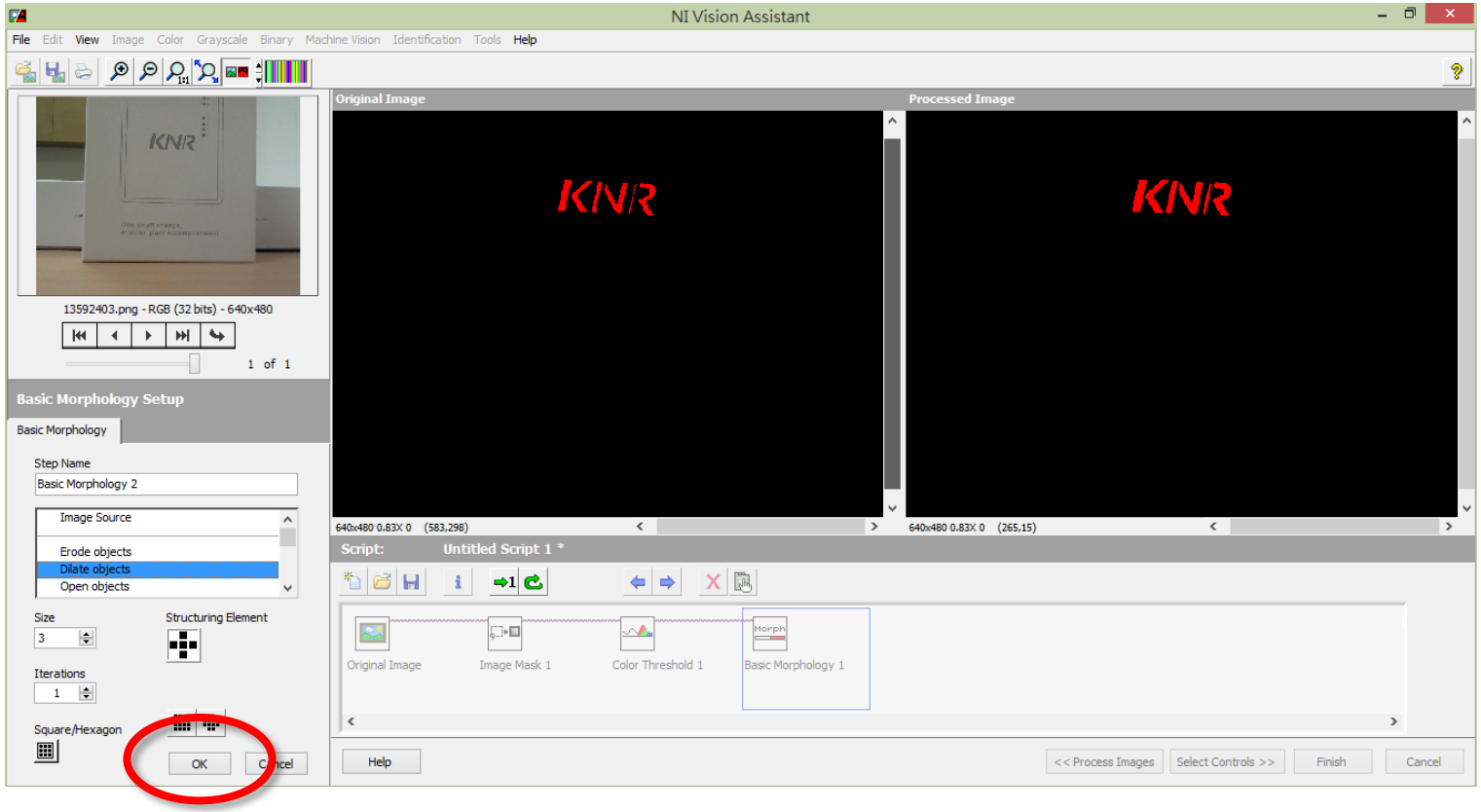
影像辨識

- 再點選Basic Morphology 。



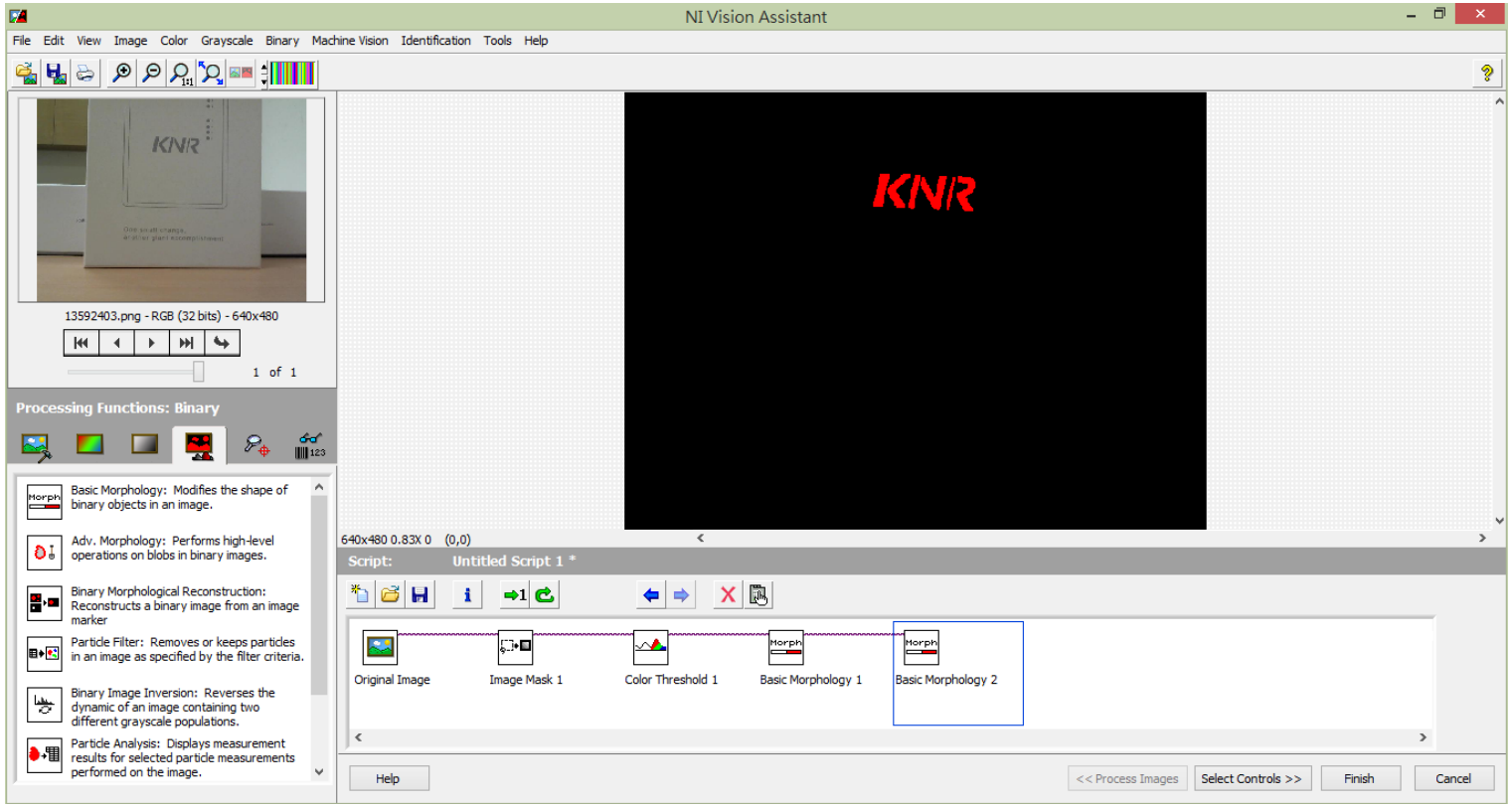
影像辨識

- 點選 Dilate objects>>OK。



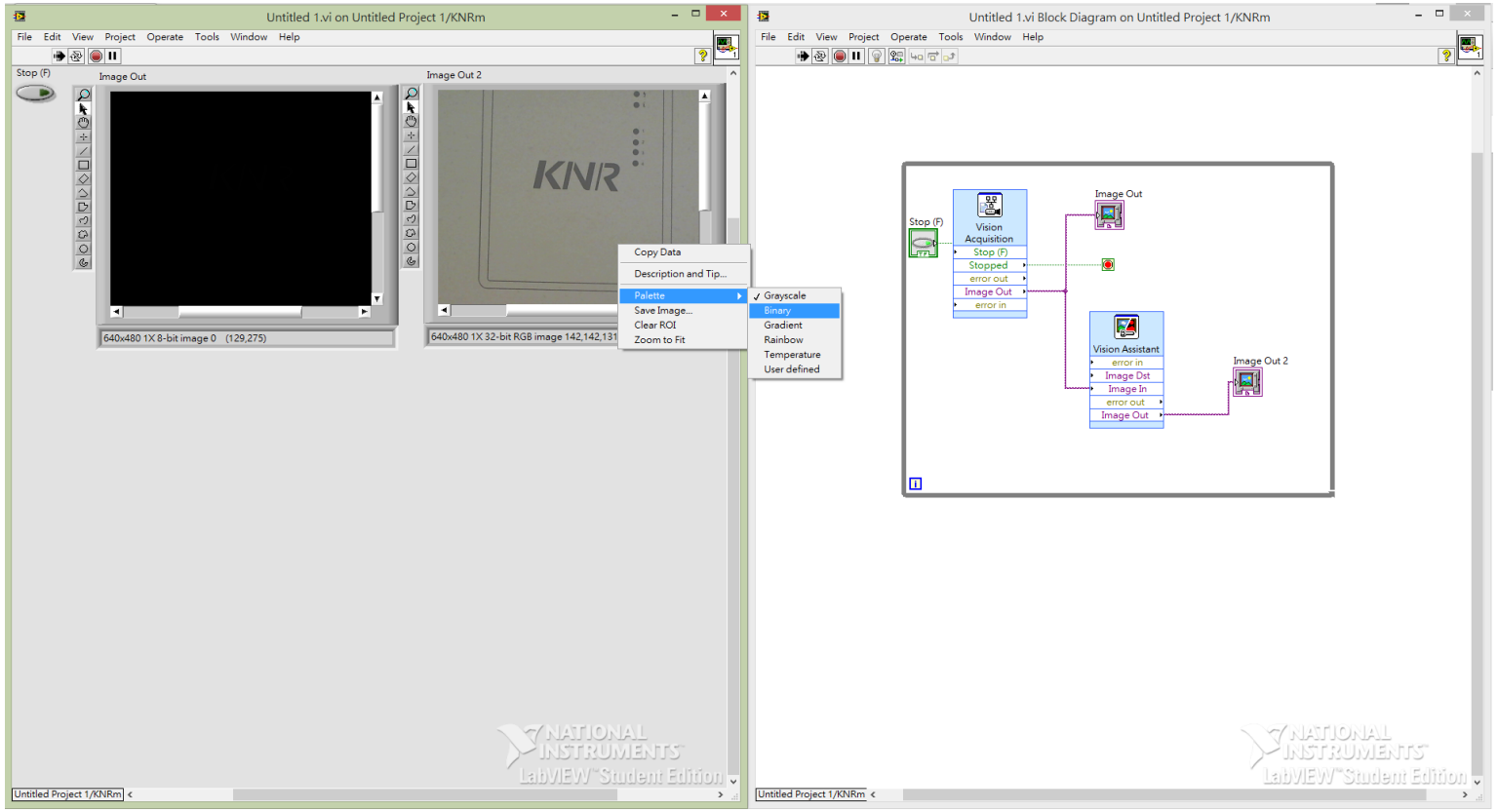
影像辨識

- 點選 右下角Finish。



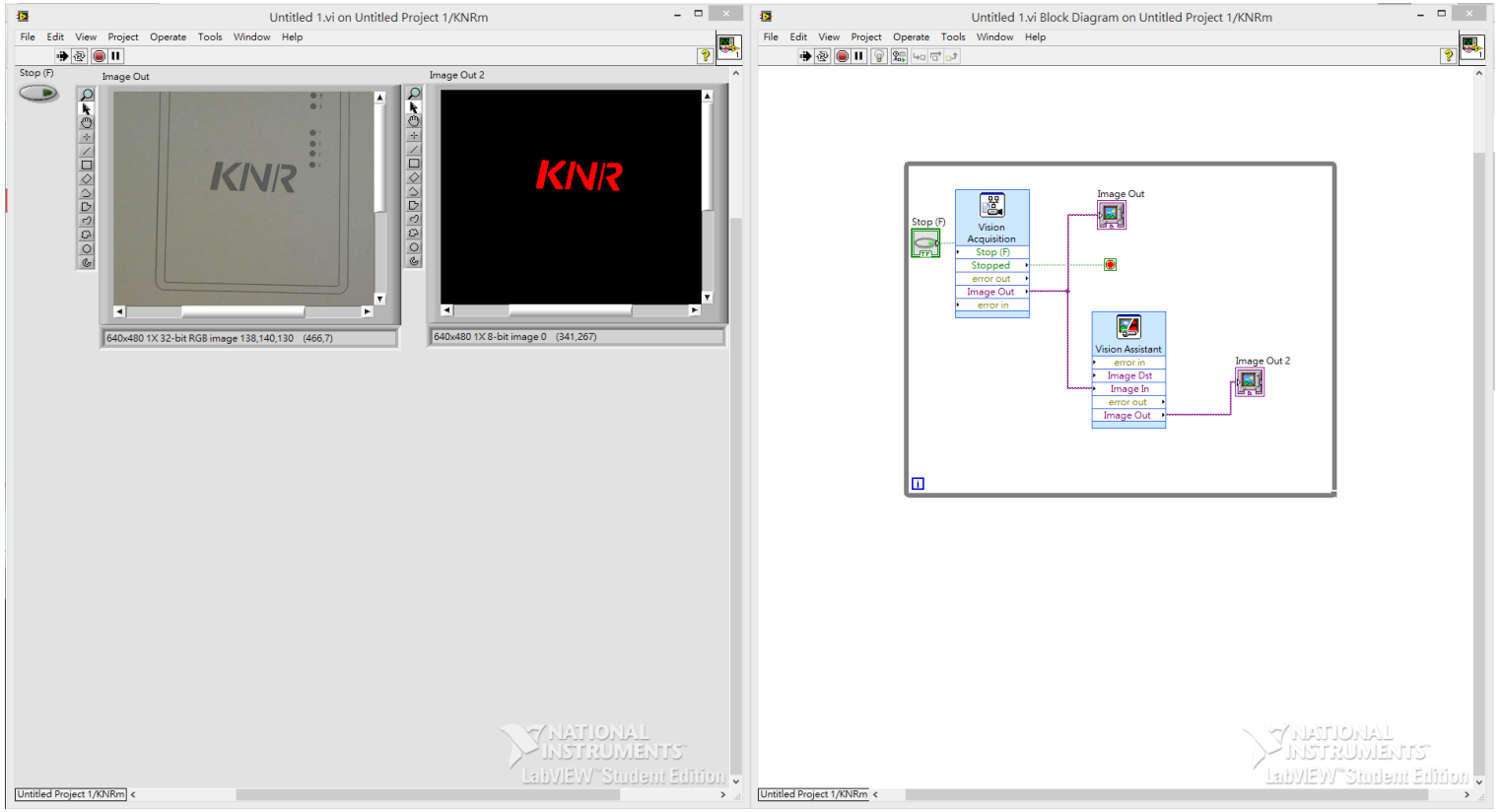
影像辨識

- 調整好程式>>執行>>Binary。



影像辨識

- 影像辨識完成。


Untitled 1.vi on Untitled Project 1/KNRm
File Edit View Project Operate Tools Window Help
Stop (F)
Image Out
Image Out 2
KNR
640x480 1X 32-bit RGB image 138,140,130 (466,7)
640x480 1X 8-bit image 0 (341,267)
Untitled Project 1/KNRm
Untitled 1.vi Block Diagram on Untitled Project 1/KNRm
Vision Acquisition
Stop (F)
Stopped
error out
Image Out
error in
Vision Assistant
Image Dst
Image In
Image Out 2
NATIONAL INSTRUMENTS
LabVIEW Student Edition

課堂七 ：追紅球機器人（二）
——RC servo控制

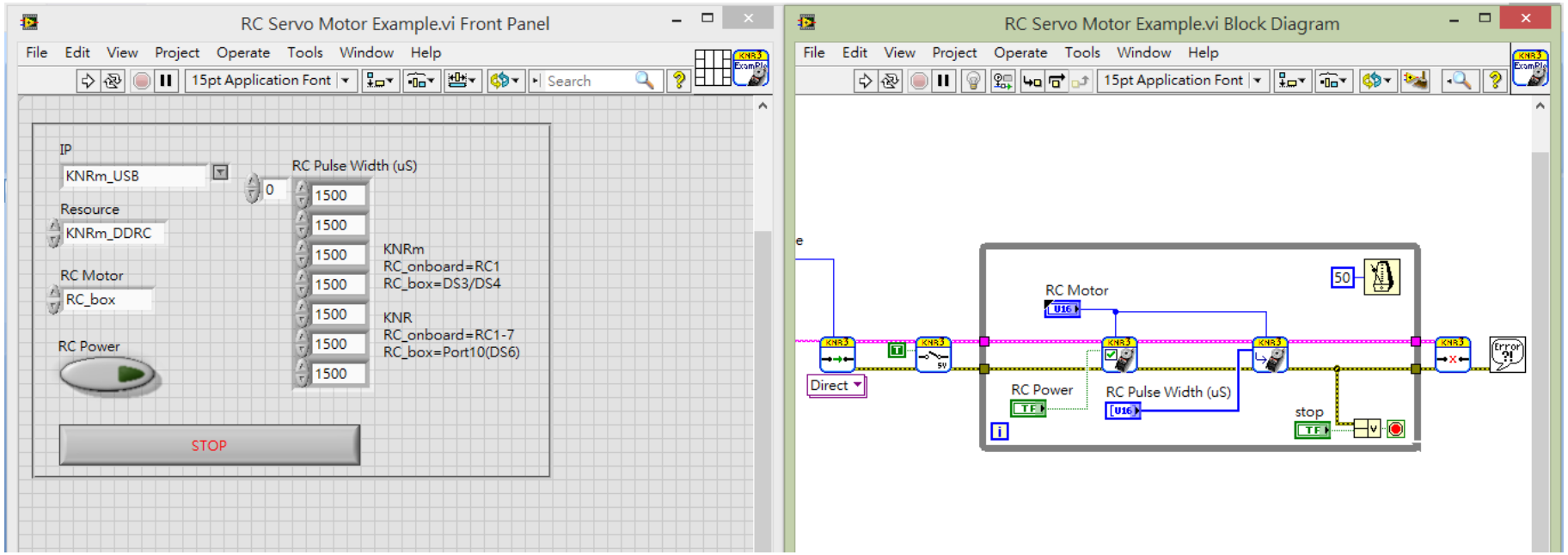
貝登堡智能
KK Intelligent Service,Inc.

伺服馬達控制

貝登堡智能
KK Intelligent Service,Inc.

RC servo控制

- 開啟範例程式RC Servo Motor Example.vi

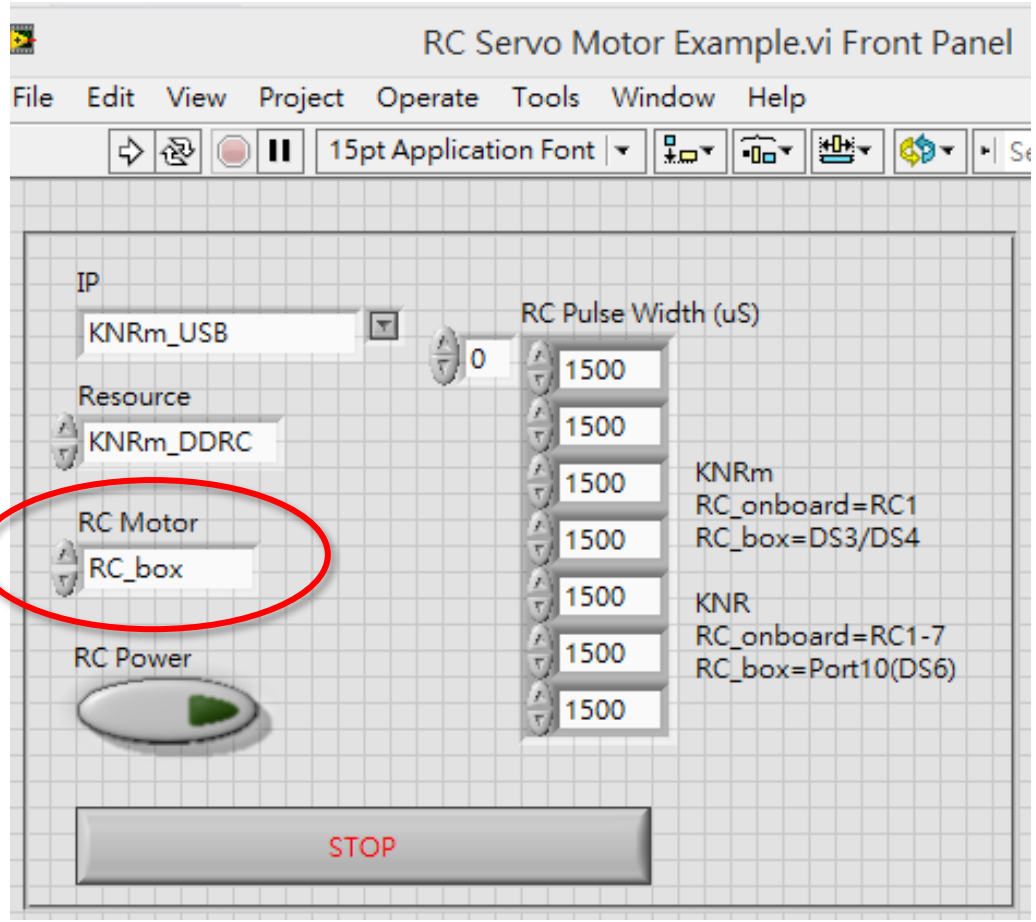


RC servo控制

- RC Motor

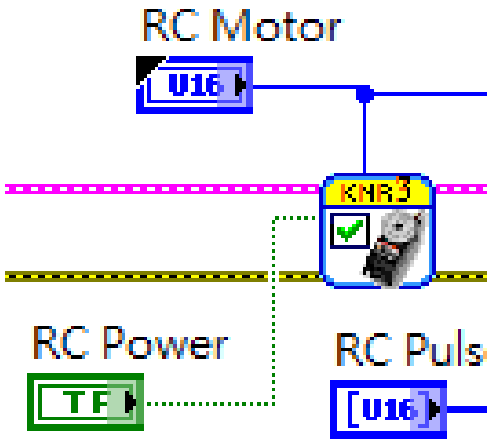
- RC_box：
- RC擴充模組

- RC_onboard：
- KNR 控制器



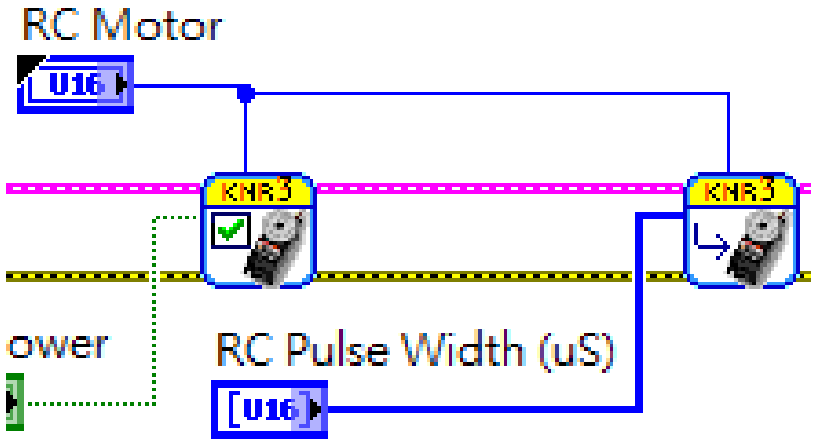
RC servo控制

- RC Servo Motor RC Port Power
- 選擇RC馬達Port
- 啟動馬達



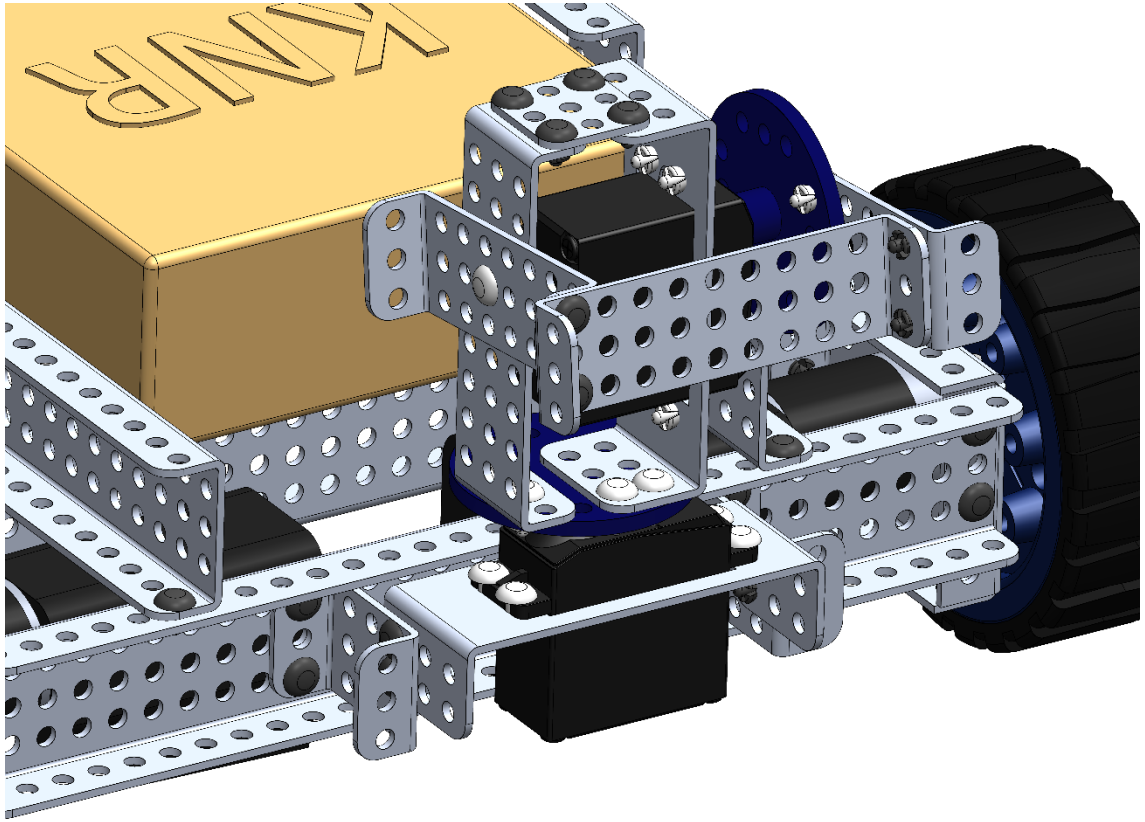
RC servo控制

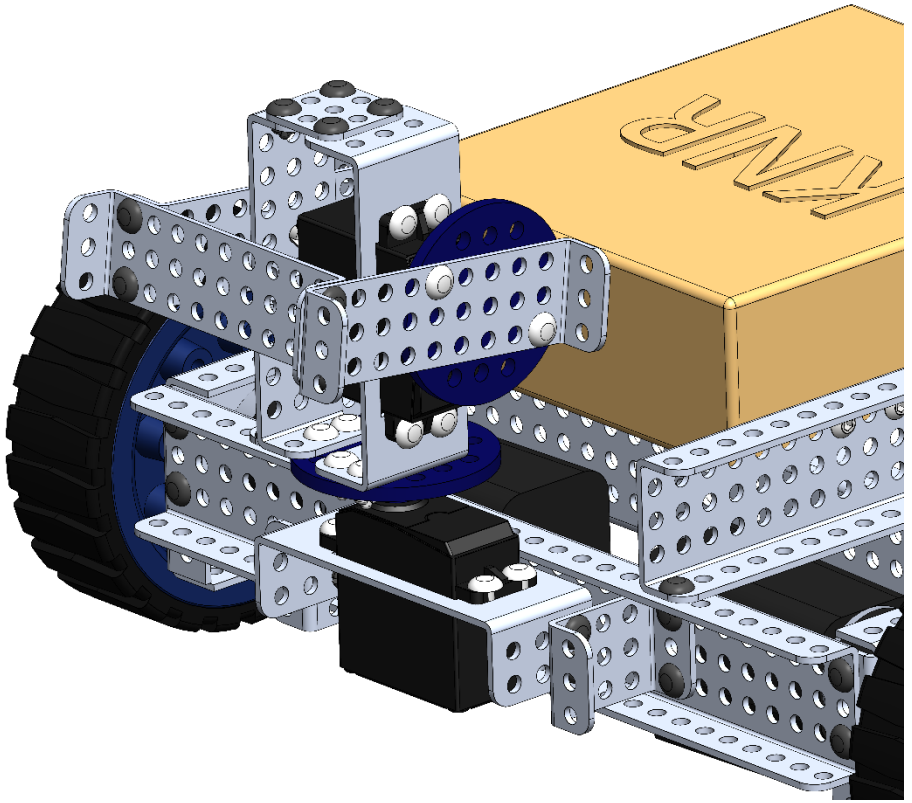
- RC Servo Motor Set RC Position
- 選擇RC馬達Port
- 設定馬達位置

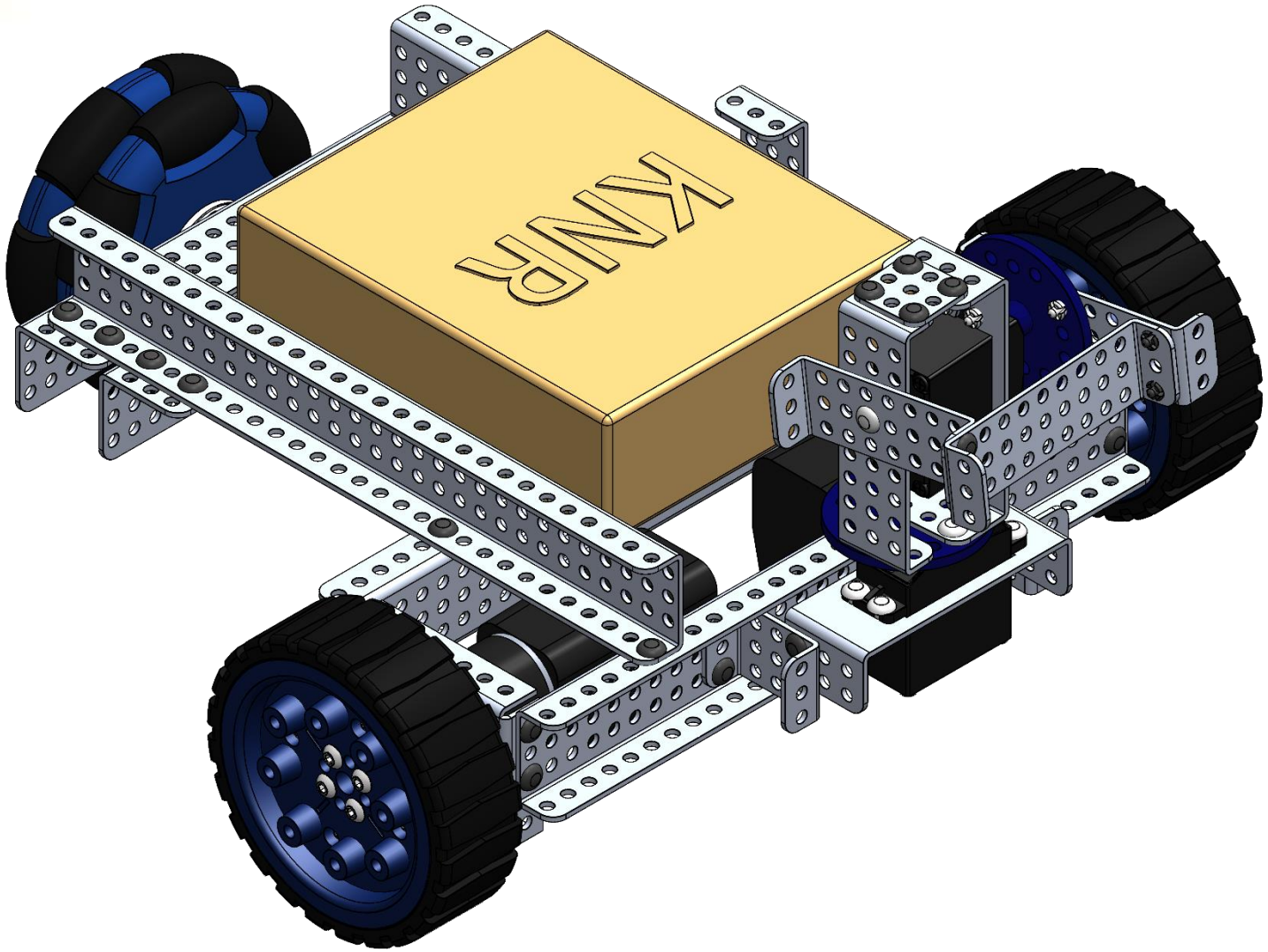


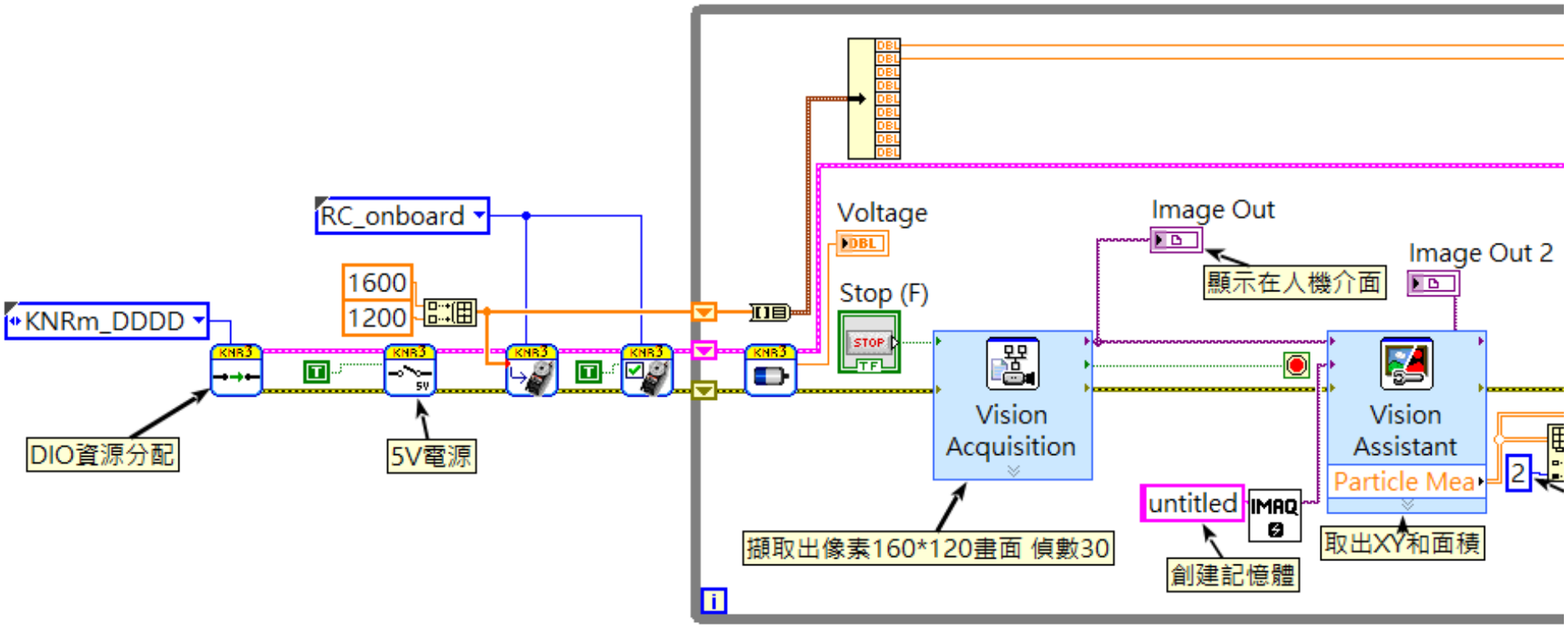
追紅球機器人

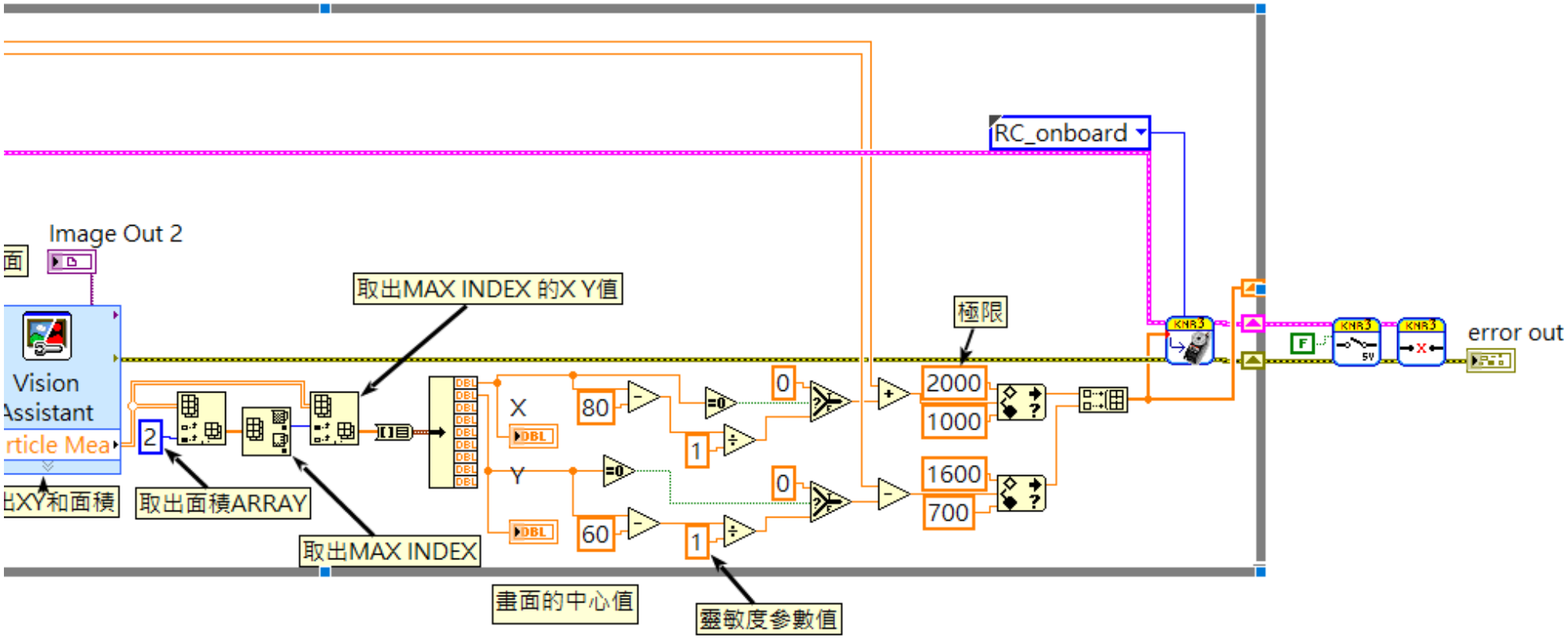
貝登堡智能
KK Intelligent Service,Inc.


KMR

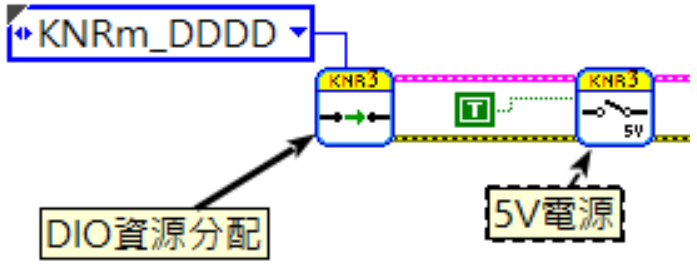

KMR


KNR

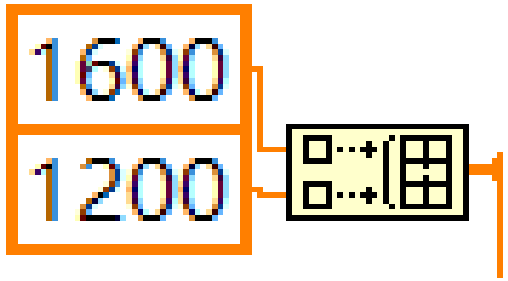

RC_onboard
1600
1200
KNRm_DDDD
DIO資源分配
5V電源
Voltage
Stop (F)
Image Out
顯示在人機介面
Image Out 2
Vision Acquisition
擷取出像素160*120畫面 偵數30
Vision Assistant
Particle Mea
取出XY和面積
untitled
創建記憶體


RC_onboard
Image Out 2
面
Vision
Assistant
rticle Mea
出XY和面積
2
取出面積ARRAY
取出MAX INDEX 的X Y值
取出MAX INDEX
畫面的中心值
X
Y
DBL
80
60
=0
0
1
極限
2000
1000
1600
700
KNR3
F
5V
error out

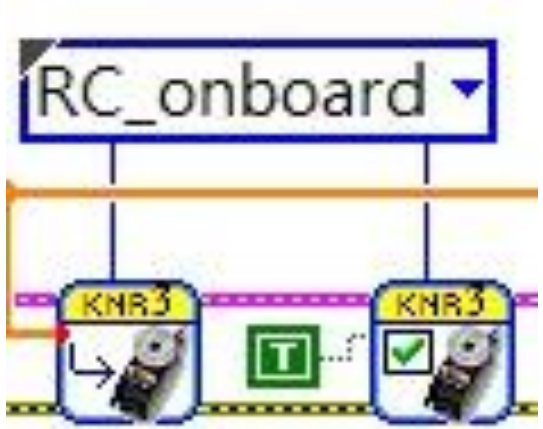
開始程式



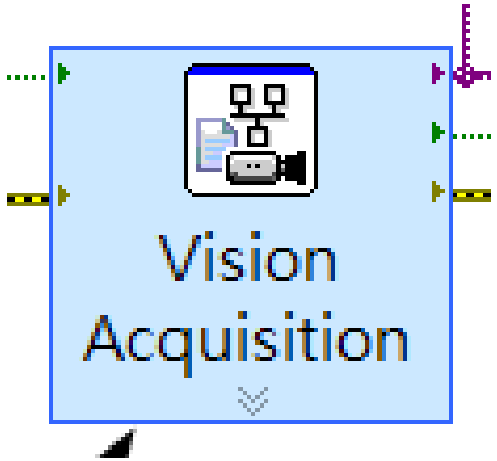
設定RC馬達起始位置



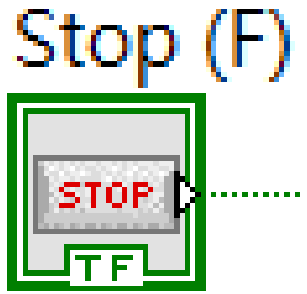
(左)控制RC馬達位置,(右)啟動RC馬達



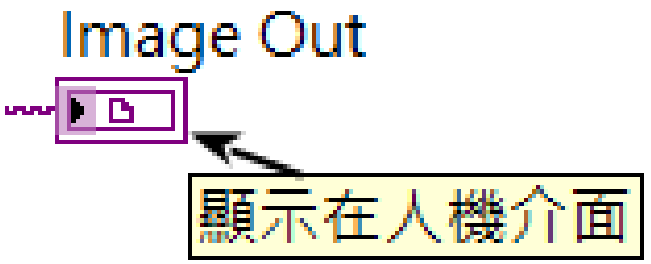
擷取出160*120的畫面(偵數30)



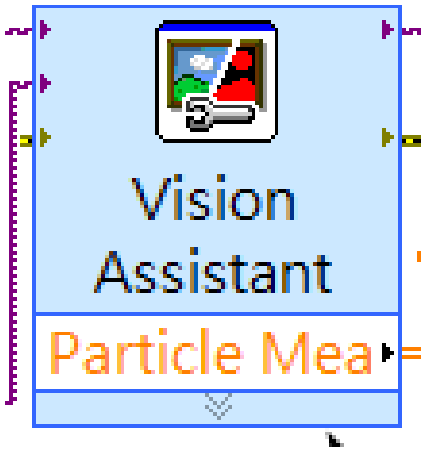
關閉攝影機並關閉程式



顯示於人機介面

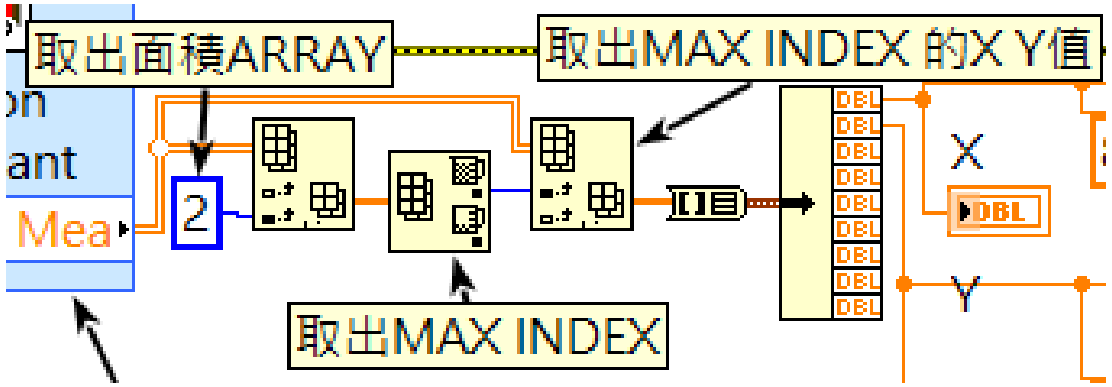


擷取影像的X軸Y軸與面積值

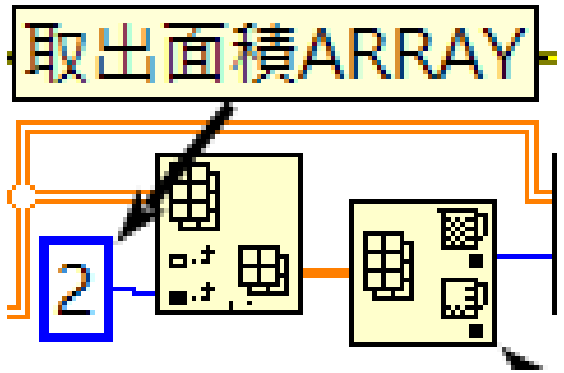


創建記憶體用來儲存影像

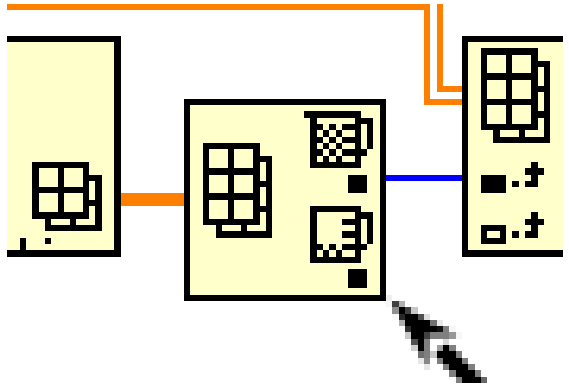
判別追蹤物的程式區塊



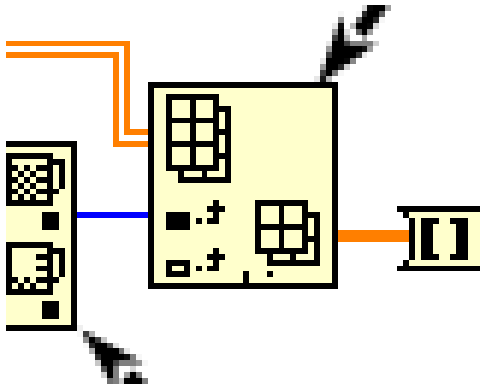
取出在陣列中的所有面積值



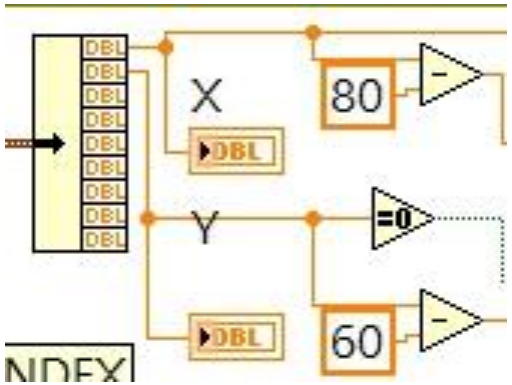
從所有面積值當中取出最大值



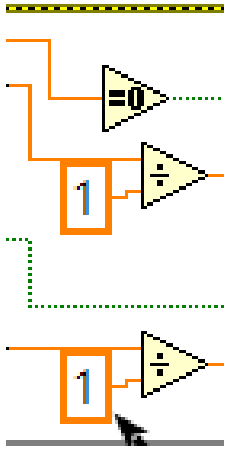
從最大面積值的陣列中取出X和Y值



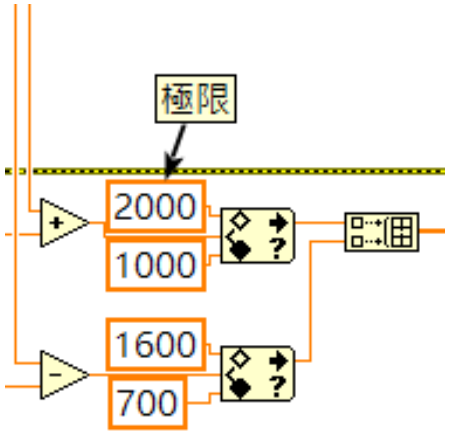
設定影像(160*120)中間值



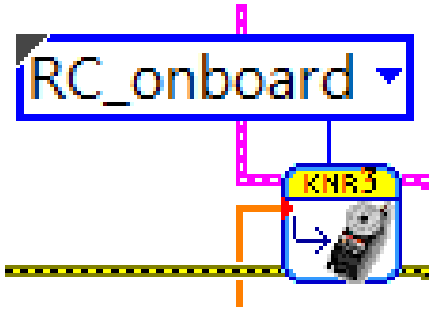
攝影機靈敏度參數



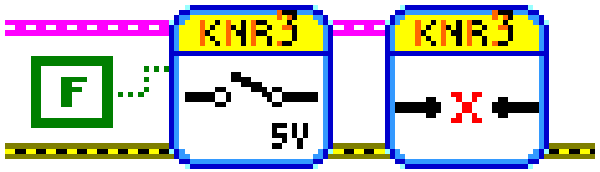
設定兩個RC馬達最大和最小的轉動角度



將資料輸出至RC馬達



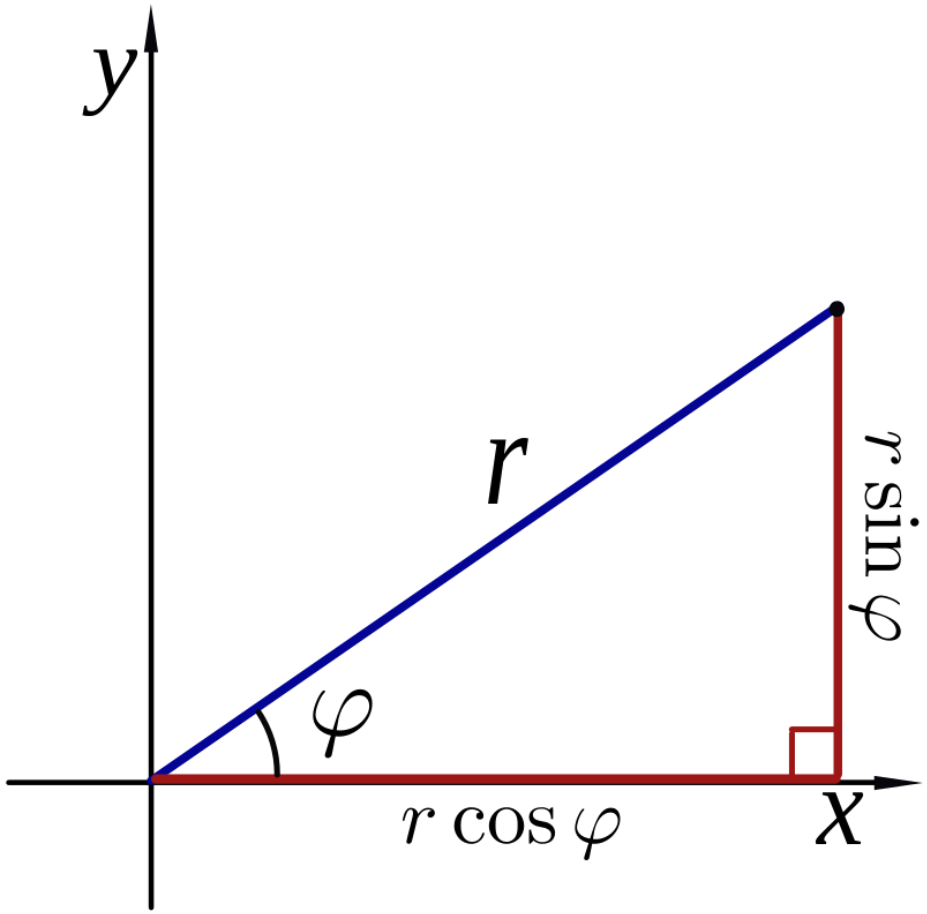
關閉5V電源輸出 PC和控制器斷線



課堂八 ：探索機器人（一）——極座標與地圖創建概論

貝登堡智能
KK Intelligent Service,Inc.

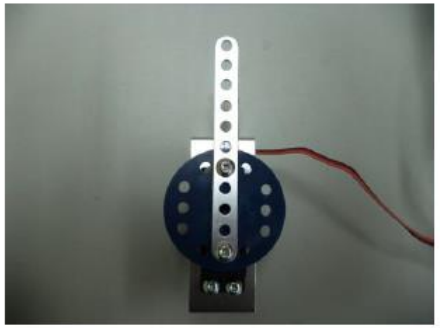
極座標與地圖創建概論



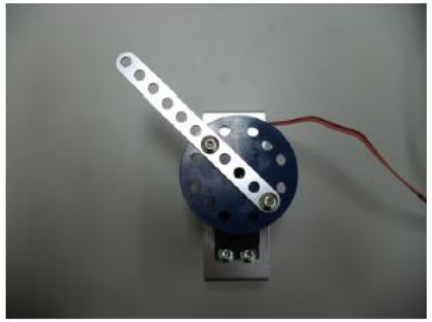
由畢氏定理可知$r = \sqrt{x^2 + y^2}$，再藉由三角函數可知$\varphi = arctan\frac{y}{x}$因此可以將原先的直角座標改為(r,$\varphi$)為變數的極坐標系。

相反的我們亦能使用 $x = r\ cos\varphi$ ， $y = r\ sin\varphi$將極座標改為直角坐標系，如右圖所示，因此只要能有轉角與距離便能描繪一組地圖。

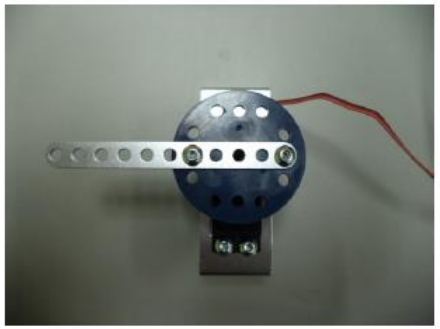
極座標與地圖創建概論



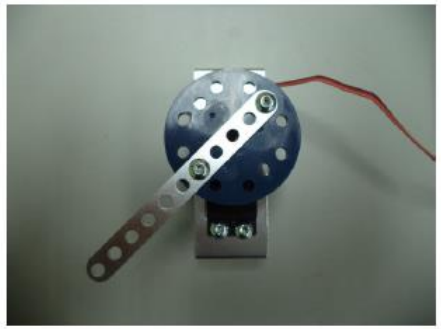
(a)700 μs，0°



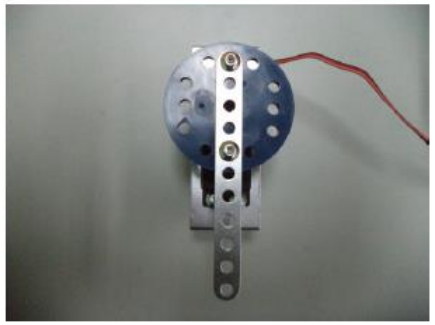
(b)1100 μs，45°



(c)1500 μs，90°



(d)1900 μs，135°



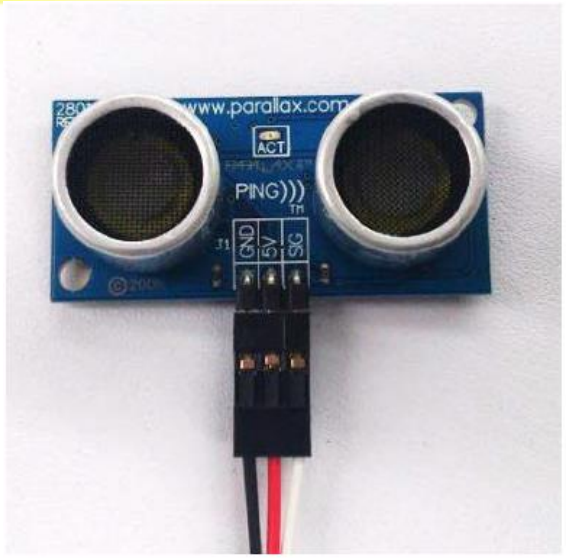
(e)2300 μs，180°

轉角可以利用之前學過的RC servo來指定，RC servo的最大轉角為180°，而能夠輸入的最高與最小高電壓秒數分別為2300μs和700μs，因此只要將180°分配在700-2300之間便能得到轉角了，其式子如下：

$$\text{RC Pulse Width(us)} = \frac{T_{max} - T_{min}}{range(deg.)} \times \text{Position(deg.)} + T_{min} \text{ (us)}$$

$$= \frac{2300-700}{180(deg.)} \times \text{Position(deg.)} + 700 \text{ (us)}$$

極座標與地圖創建概論

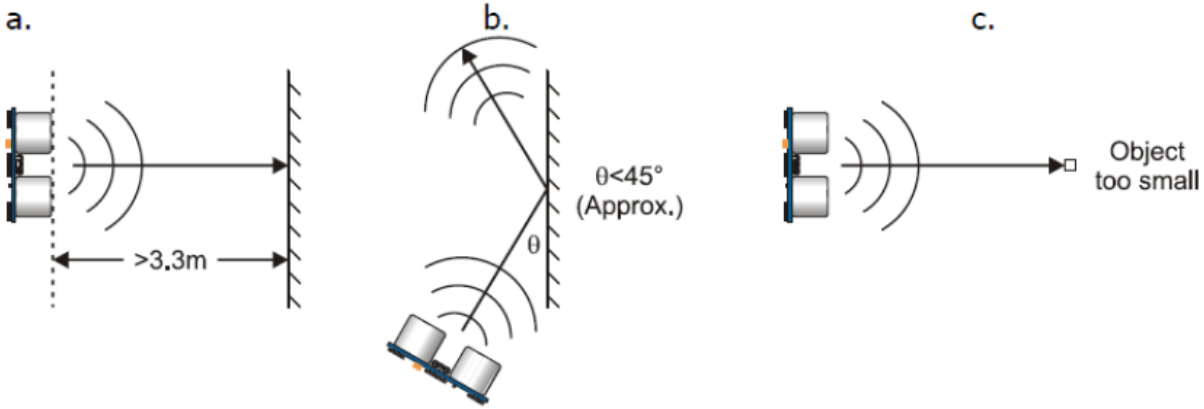


有了轉角之後，只要再有距離就能轉換到直角坐標開始創建地圖了，而我們取得距離的方式便是使用超音波感測器，如左圖，超音波感測器的測距原理是利用發射超音波碰觸到物體再接收超音波所經歷的時間計算距離，其公式如下：

$$V_s\,(\mathrm{m/s}) = 331 + 0.6 \times T$$

$$V_{25} = 331 + 0.6 \times 25 = 346\,(m/s)$$

$$\mathrm{D} = V_s \times (\Delta t/2)$$



利用常溫的音速計算距離，但是超音波感測器有其限制，如左圖，當超過3公尺以上便會失準，與物體接觸角度太小也會造成反射不足，或是當物體太小也會造成失準，這些情況需要特別注意。

地圖創建概論──超音波模組

函式名稱	使用及功能說明
Read Distances.vi 	讀取超音波感測器的距離值。 輸入端： **KNR In**：KNR 主機 ID cluster 輸入 **Port Number**：可選擇 US1-US4 或是 US5-US8 的連接埠位置。 輸出端： **Ultrasonic Output(cm)**：輸出距離資訊，以 array 的方式呈現，距離單位為公分。 **KNR Out**：KNR 主機 ID cluster 輸出。

課堂九 ：探索機器人（二）——地圖創建任務

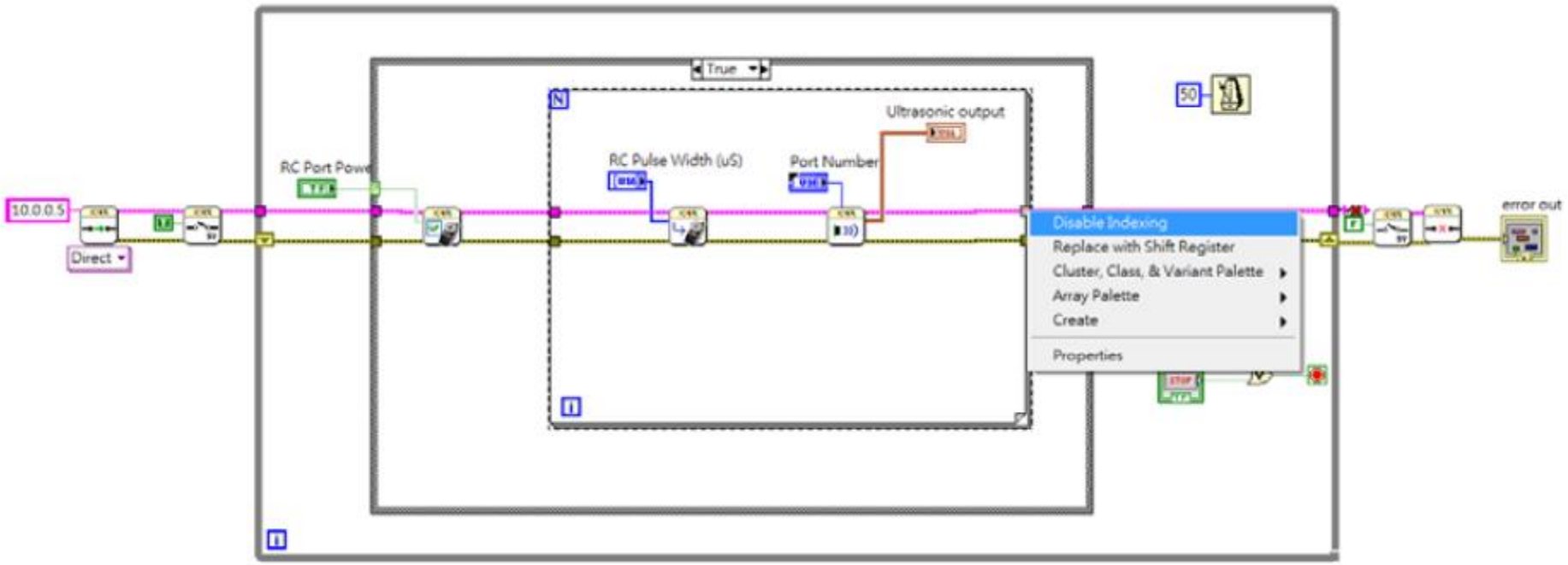
貝登堡智能
KK Intelligent Service,Inc.

地圖創建任務

- 此次任務需將超音波感測器設置在RC servo上，藉由RC servo的轉角與超音波感測器所測量到的距離進行地圖創建。

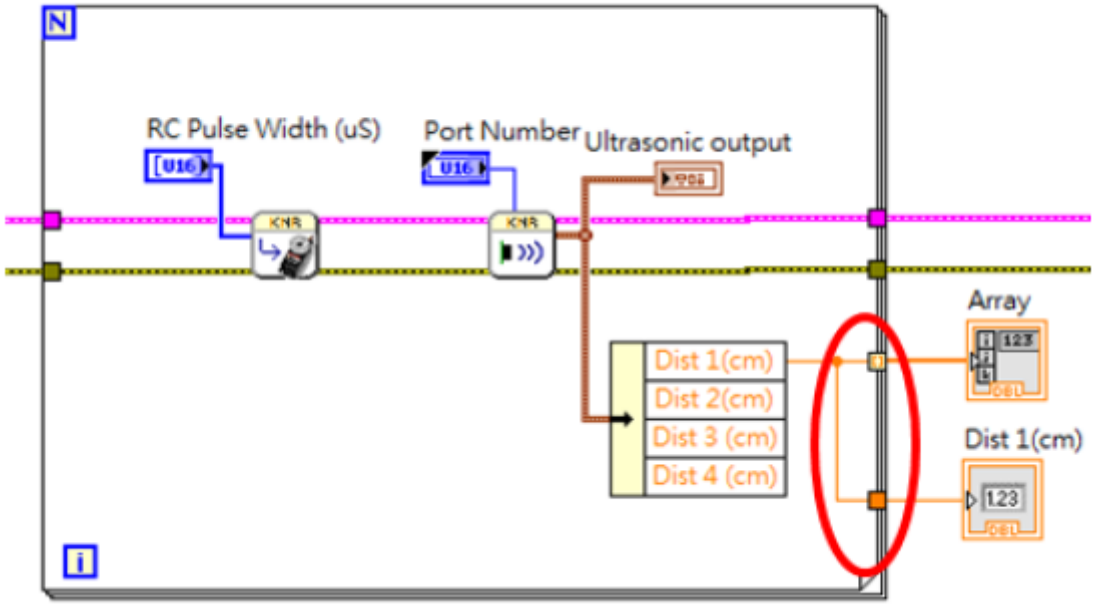
- 地圖創建時，以1度為單位從0度掃描至180度，並將掃描的距離繪製成地圖，完成地圖創建。

地圖創建任務



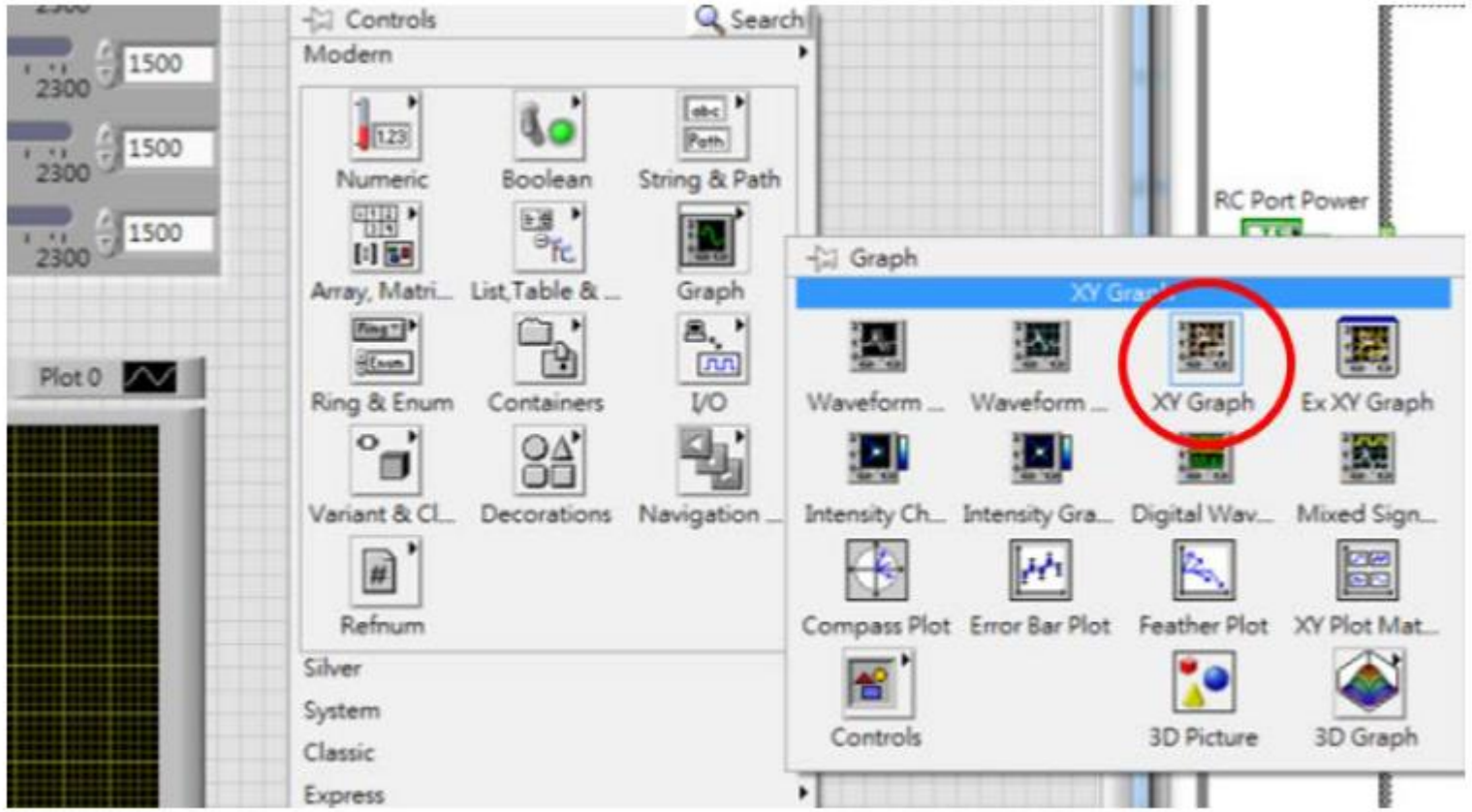
單行資料由for迴圈出去後會變成array，因此需要右鍵Disable Indexing才能繼續正常接線。

地圖創建任務

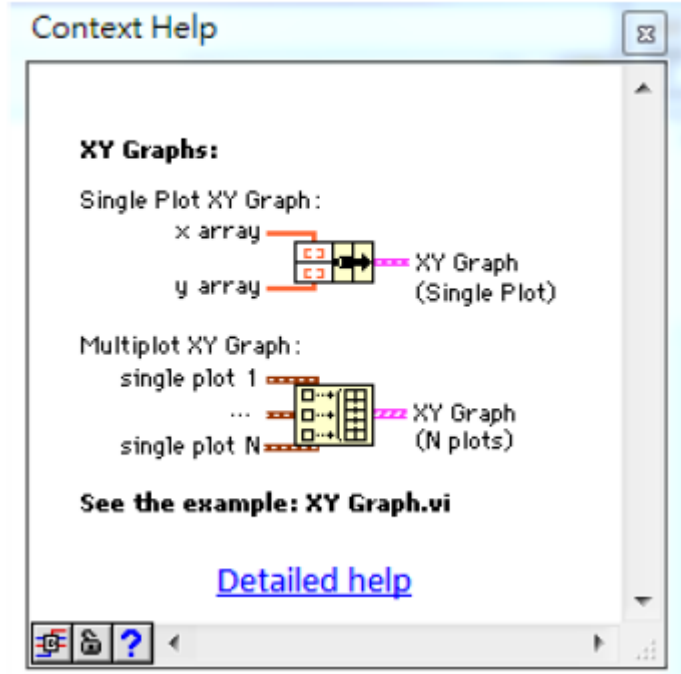


紅色圈便是Disable indexing的差異

地圖創建任務

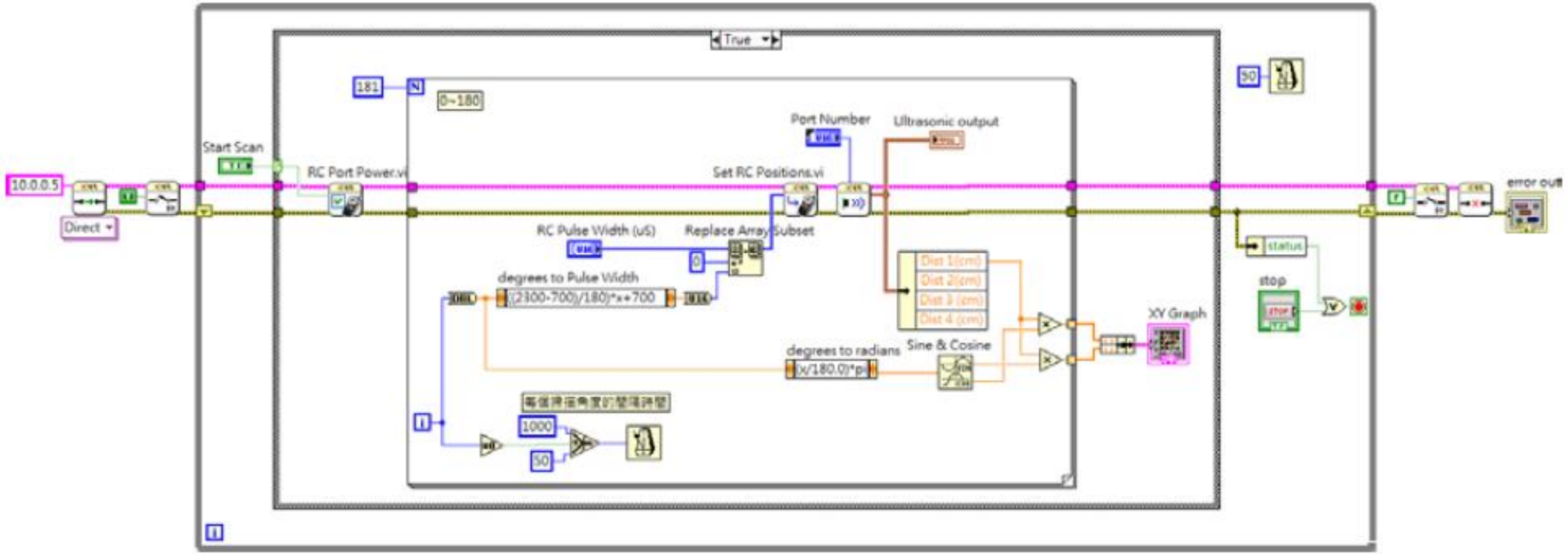


描繪地圖的Indicator需要使用 XY Graph



其連接方式

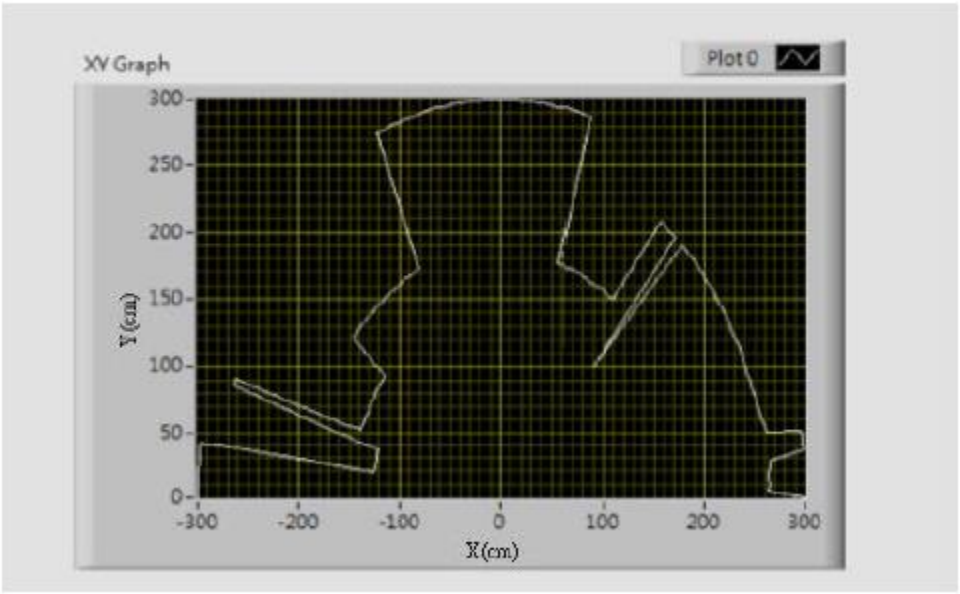
地圖創建任務


True
181
0~180
Port Number
Ultrasonic output
Start Scan
10.0.0.5
Direct
RC Port Power.vi
Set RC Positions.vi
RC Pulse Width (uS)
Replace Array Subset
degrees to Pulse Width
(2300-700)/180)*x+700
degrees to radians
x/180.0)*pi
Sine & Cosine
XY Graph
1000
50
50
status
stop
error out

完整程式

地圖創建任務

實際場景

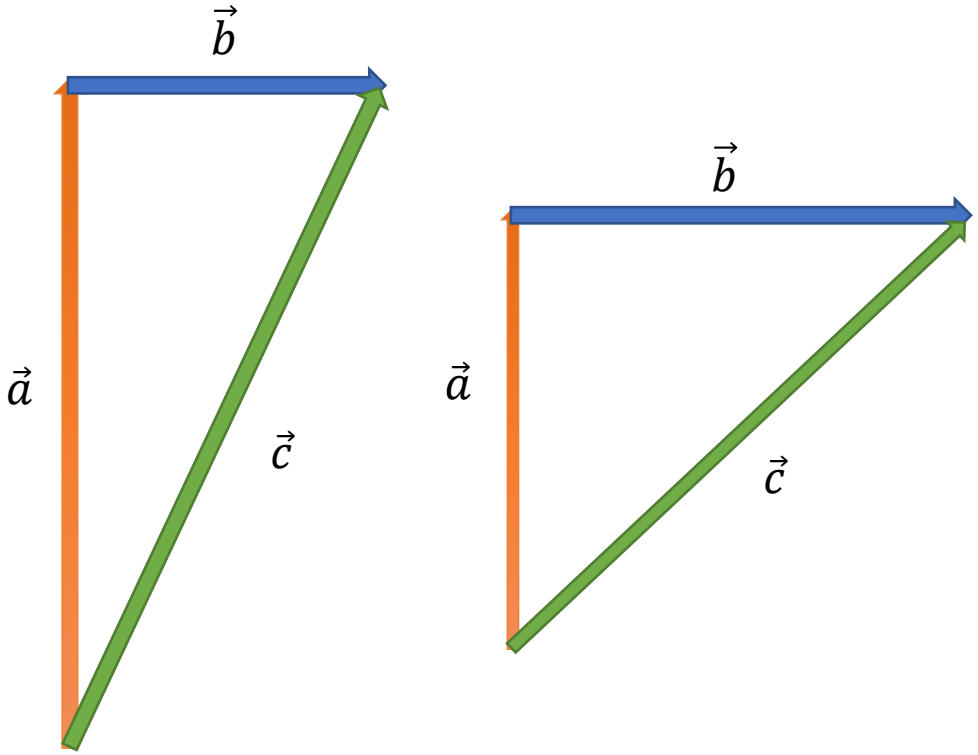


創建地圖

課堂十 ：全向機器人──向量

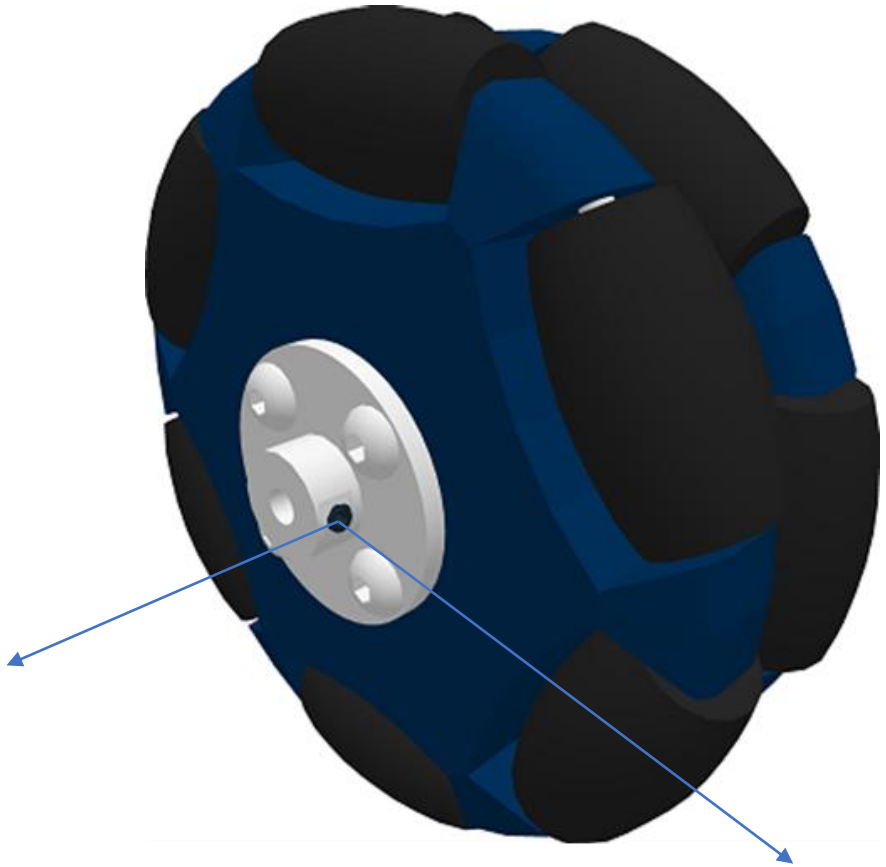
貝登堡智能
KK Intelligent Service,Inc.

向量



向量為一組具有方向及大小的幾何物件，大量用於數學、物理學和工程科學等多個自然科學中，可以使用向量呈現的物理量如速度、加速度、力等等，兩組向量可以經由相加或相減成為一組新的向量，如果再加上比例便能組成所有方向的向量，左圖為一組正交相量利用不同的比例相加成不同的向量，橘色和藍色分別為一組正交向量a和向量b，經由不同的比例搭配可以組成各個方向及大小的向量c。

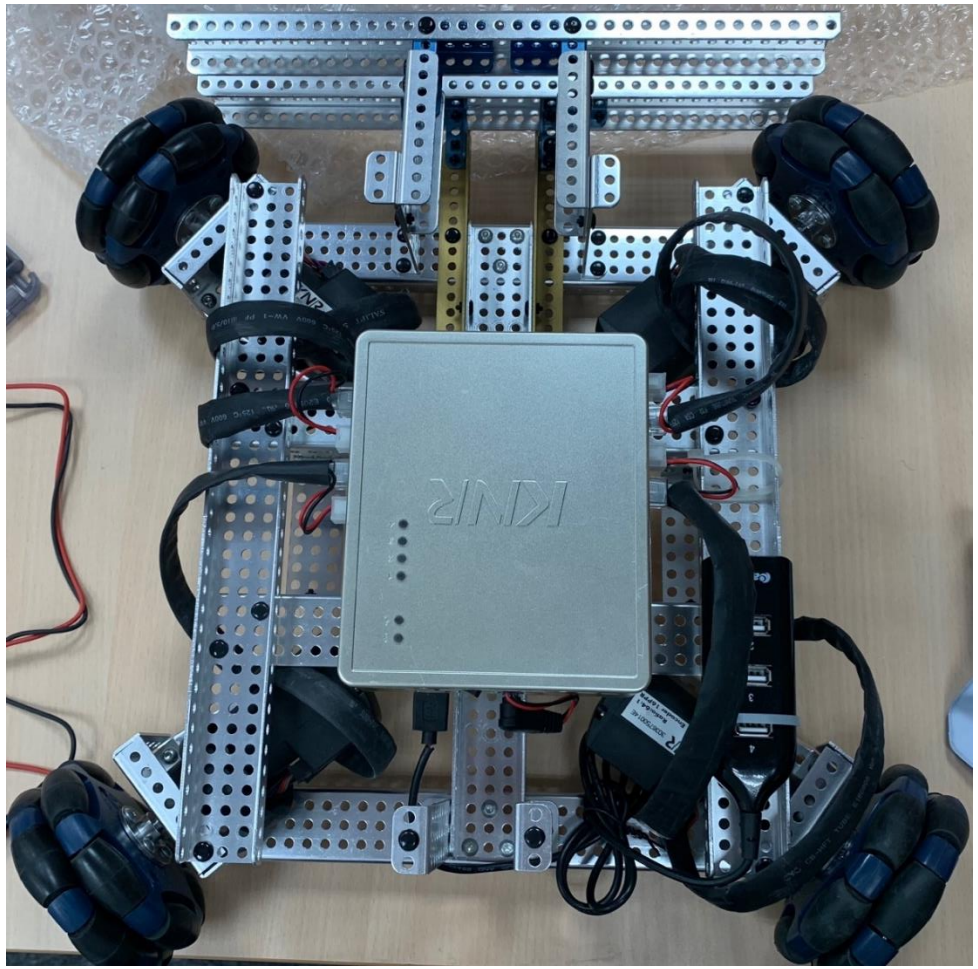
全向輪Omni wheel



Omni wheel本身可以提供兩個方向的自由度，一個垂直軸向的自由度，另一種是沿著軸向的自由度，如左示意圖，藉由這兩種正交向量的比例配比可以達到所有方向移動的要求，亦稱萬向輪。

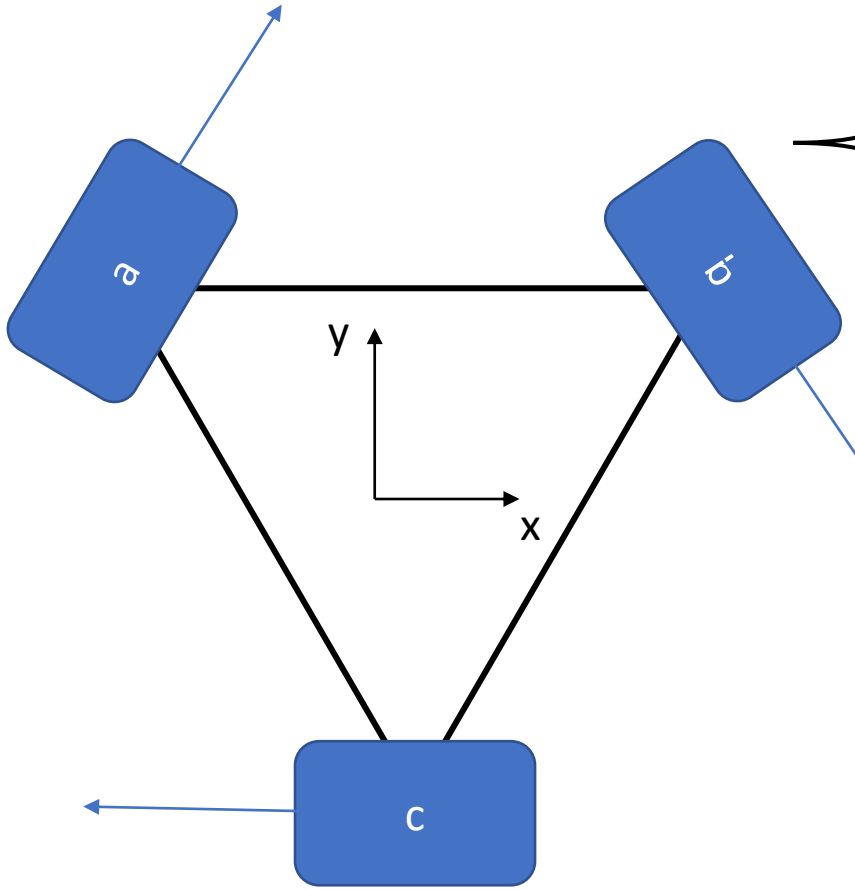
但由於馬達的連接方式，Omni wheel垂直軸向能藉由馬達做為主動或從動，而軸向只能從動。

全向機器人



全向機器人藉由3到4顆的全向輪的驅動做出全向的移動方式，相比之前做過的平台車移動更加靈活，常用於需要靈活移動的任務，以下提供輪子45度(4輪)及60度(3輪)的移動公式。

全向機器人(3輪)



$$x = a\,cos60° + b\,cos300° + c\,cos180°$$

$$y = a\,sin60° + b\,sin300° + c\,sin180°$$

$$r\theta = \quad a \quad + \quad b \quad + \quad c$$

$$\begin{bmatrix} x \\ y \\ r\theta \end{bmatrix} = \begin{bmatrix} cos60° & cos300° & cos180° \\ sin60° & sin300° & sin180° \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

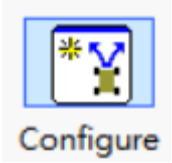
$$\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} cos60° & cos300° & cos180° \\ sin60° & sin300° & sin180° \\ 1 & 1 & 1 \end{bmatrix}^{-1} \begin{bmatrix} x \\ y \\ r\theta \end{bmatrix}$$

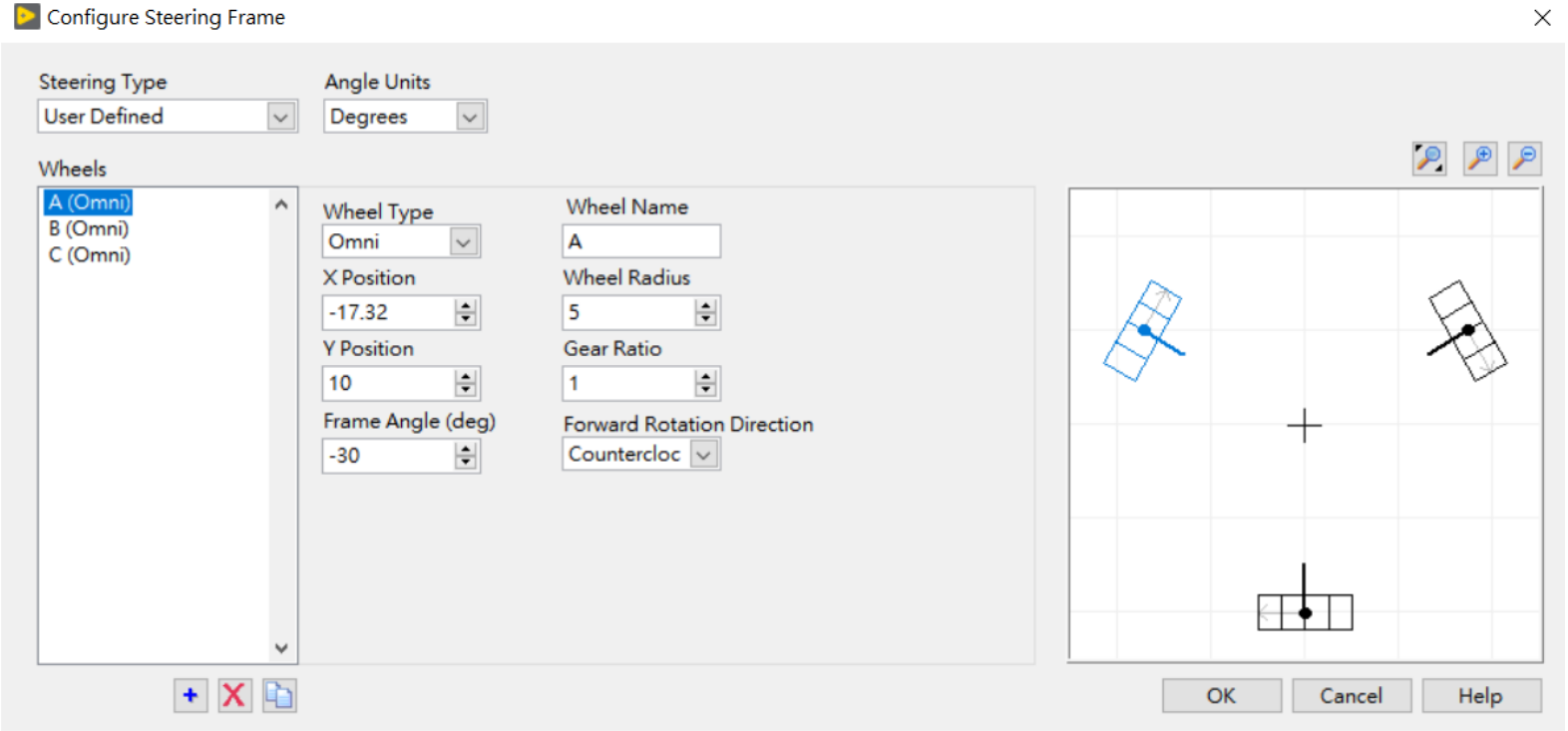
x y分別為讓機器人移動的水平與鉛質方向，a b c 為三個萬向輪所需要的比例，如左圖所示。

首先利用x方向與y方向的需求列出第一和第二式，在藉由合力矩為0列出第三式，利用此三是可以化為下列矩陣，再經由左右同乘反矩陣得到需要的比例。

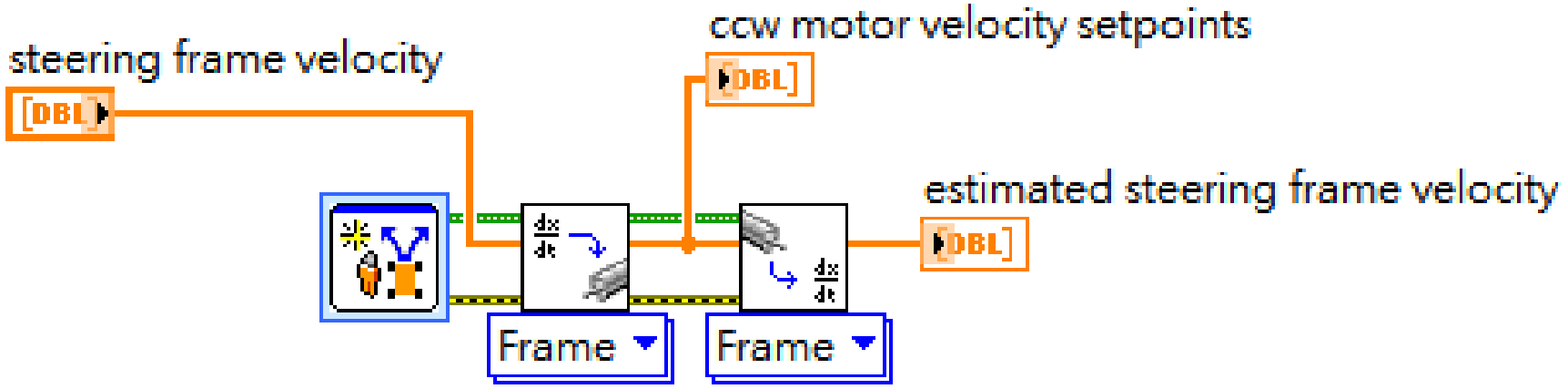
Steering

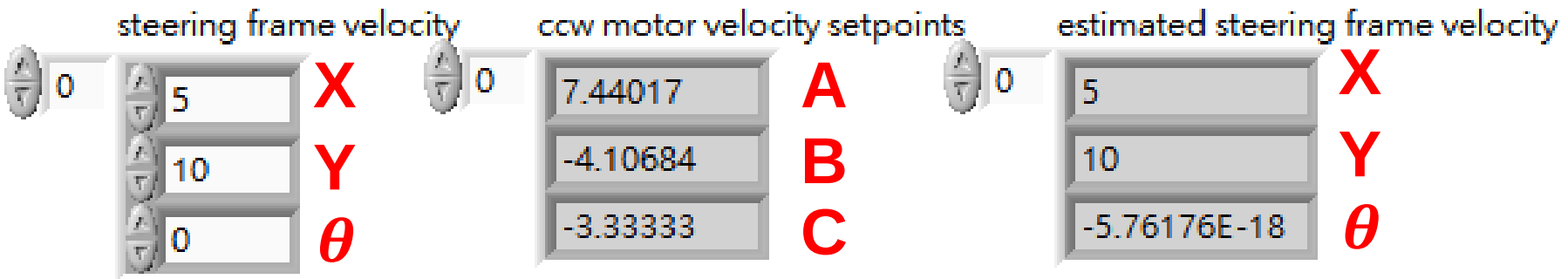
路徑1:Functions → Robotics → Steering
路徑2:Functions → myRIO → Steering





Steering

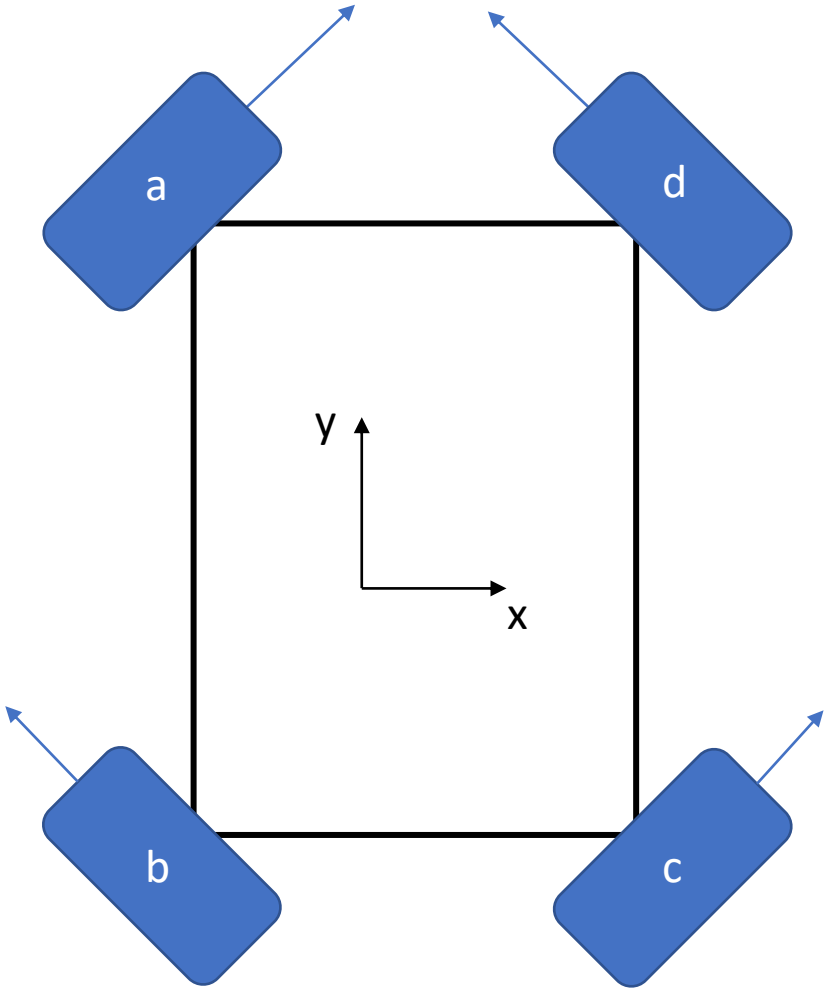




輸入X,Y,θ會自動轉換成A,B,C所需要旋轉量

透過馬達迴授值計算出機器人時實際移動量

全向機器人(4輪)



$$x = a\,cos45° + b\,cos135° + c\,cos45° + d\,cos135°$$

$$y = a\,sin45° + b\,sin135° + c\,sin45° + d\,sin135°$$

$$r\,\theta = \quad a \quad + \quad b \quad + \quad c \quad + \quad d$$

$$a = c \qquad b = d$$

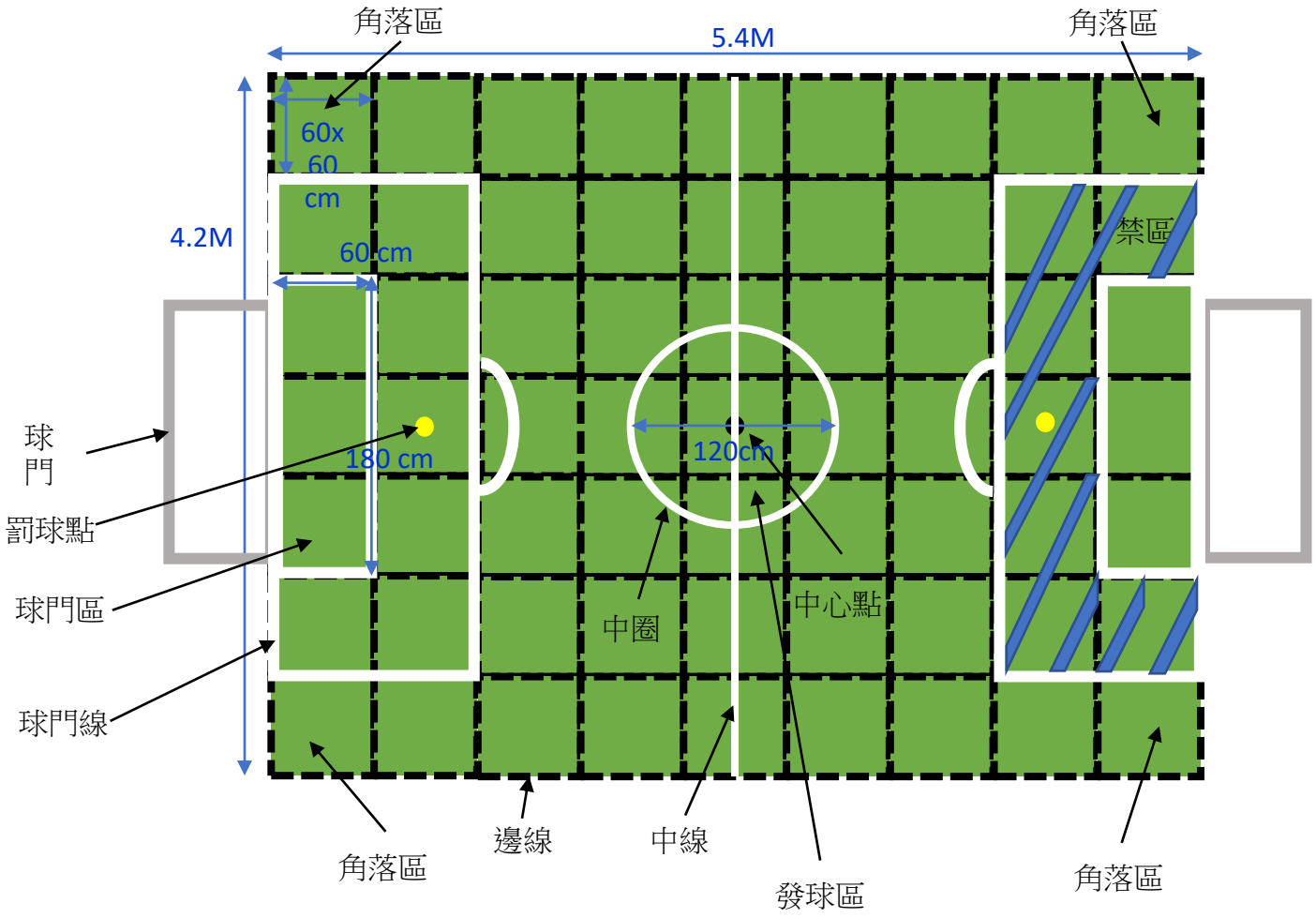
x y分別為讓機器人移動的水平與鉛質方向，a b c d為四個萬向輪所需要的比例，如左圖所示。經上頁敘述方法化簡可得：

$$\begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} cos45° & cos135° & cos45° & cos135° \\ sin45° & sin135° & sin45° & sin135° \\ 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \end{bmatrix}^{-1} \begin{bmatrix} x \\ y \\ r\theta \\ 0 \end{bmatrix}$$

課堂十一 ：自由設計──足球賽
（規則解說與分組討論）

貝登堡智能
KK Intelligent Service,Inc.

足球賽規則



足球賽分為幾種方式：

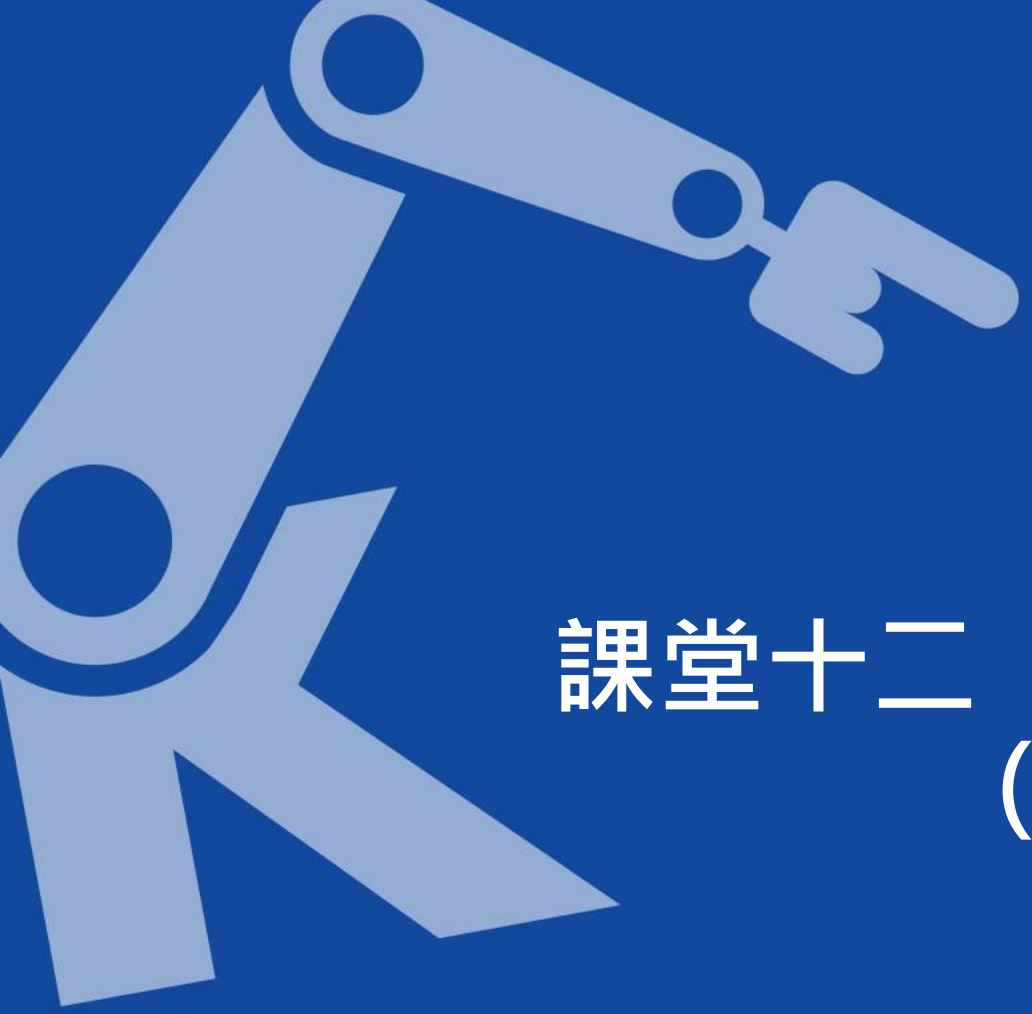
1. 一對一
2. 二對二
3. 三對三

場地如左圖所示，可以依照需求而增減修改，其中必要要件為球門與禁區，其中守門員的活動範圍為球門前至禁區，而前鋒則沒有活動範圍限制，前鋒目標便是將球攻進對方球門便得分，守門員目標則是阻擋對方將球攻進球門。

一對一的比賽方式可以僅使用半場，雙方輪流進攻直到進球或是出界再攻守轉換，進攻方擔任前鋒，防守方擔任守門員。

二對二的比賽為前鋒與守門員組成一個隊伍，三對三則是兩名前鋒與一名守門員組成一隊伍。

比賽時間則依據需求而定，建議一場比賽時間上半場5分鐘，休息調整10分鐘，下半場5分鐘，進球數多者勝。



課堂十二 ：自由設計──足球賽
（分組競賽）

貝登堡智能
KK Intelligent Service,Inc.

聯絡方式

Tom 程法彥

at 貝登堡智能

110信義區光復南路495號

02-8788-1658 #62

Tom@kkitc.net

Thank you!

貝登堡智能
KK Intelligent Service,Inc.

KNRm Controller

Specifications

The following specifications are typical for the 0 to 50 °C operating temperature range unless otherwise noted.

Processor

Processor type ..... Xilinx Z-7010

Processor speed ..... 667 MHz

Processor cores ..... 2 (ARM : Cortex-A9)

Memory

Nonvolatile memory ..... 512 MB

DDR3 memory ..... 256 MB

- DDR3 clock frequency ..... 533 MHz
- DDR3 data bus width ..... 16 bits

For information about the lifespan of the nonvolatile memory and about best practices for using nonvolatile memory, go to `ni.com/info` and enter the Info Code `SSDBP`.

FPGA

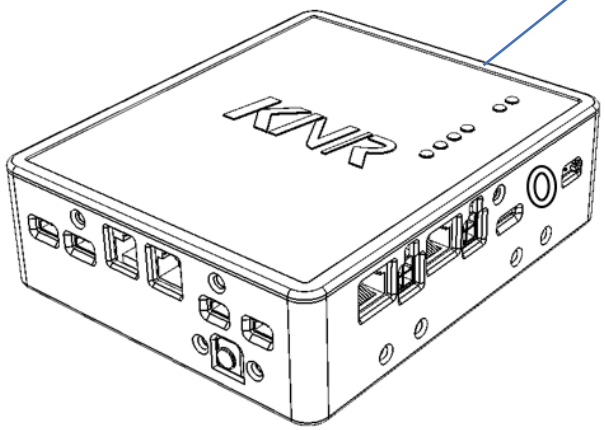
FPGA type ..... Xilinx Z-7010

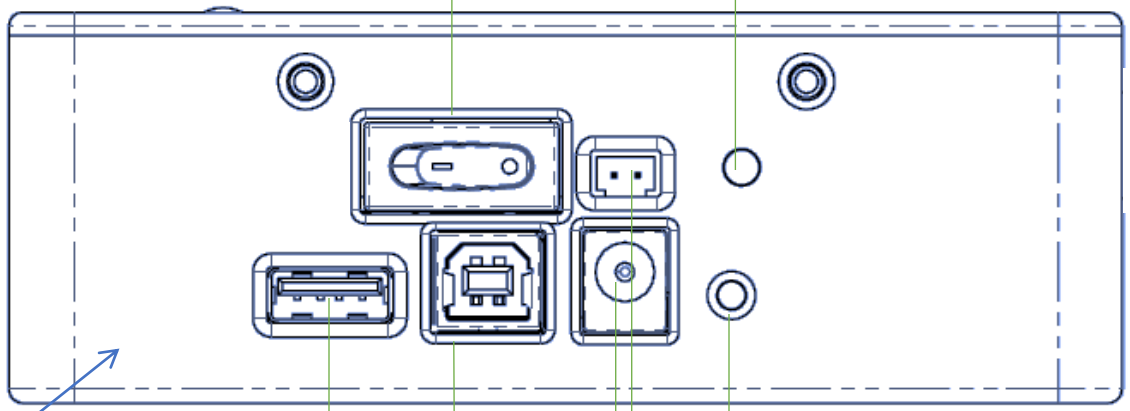
USB Ports

USB host port ..... USB 2.0 Hi-Speed

USB device port ..... USB 2.0 Hi-Speed

KNRm | back view





Power Switch (電源開關)

Battery Low LED
(電源指示燈)

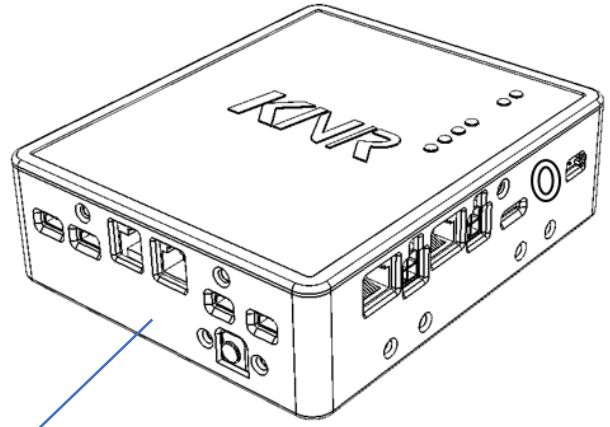
USB

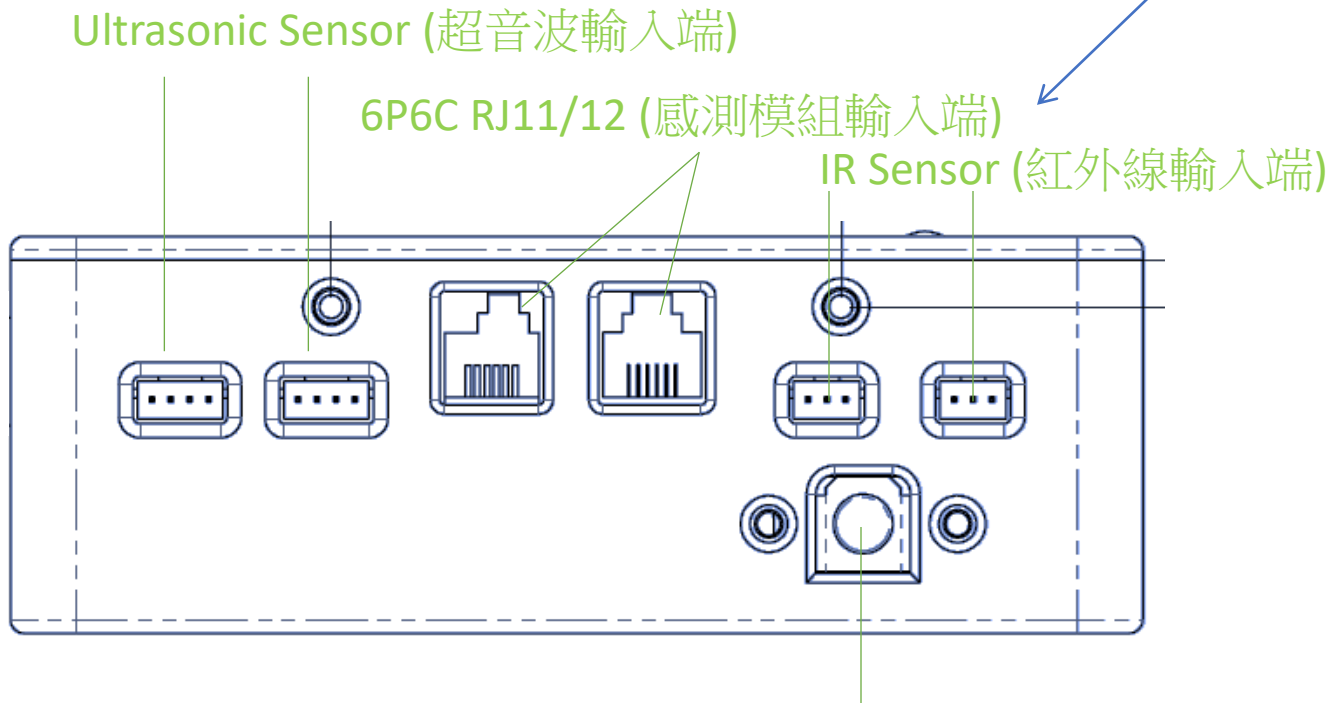
Reset

Power Bridge
(電源供應端子)

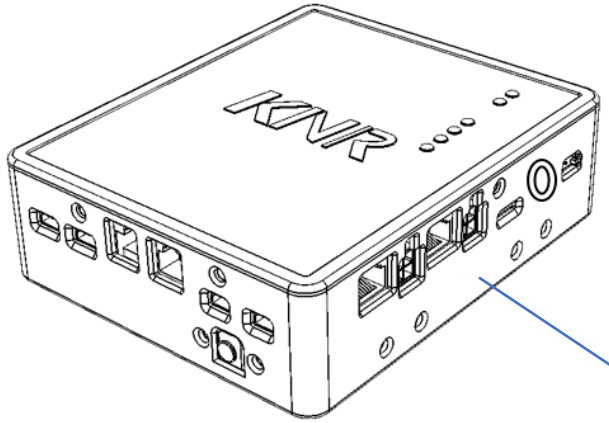
Connect to PC
(電腦連接插孔)

KNRm | front view





KNRm | right view



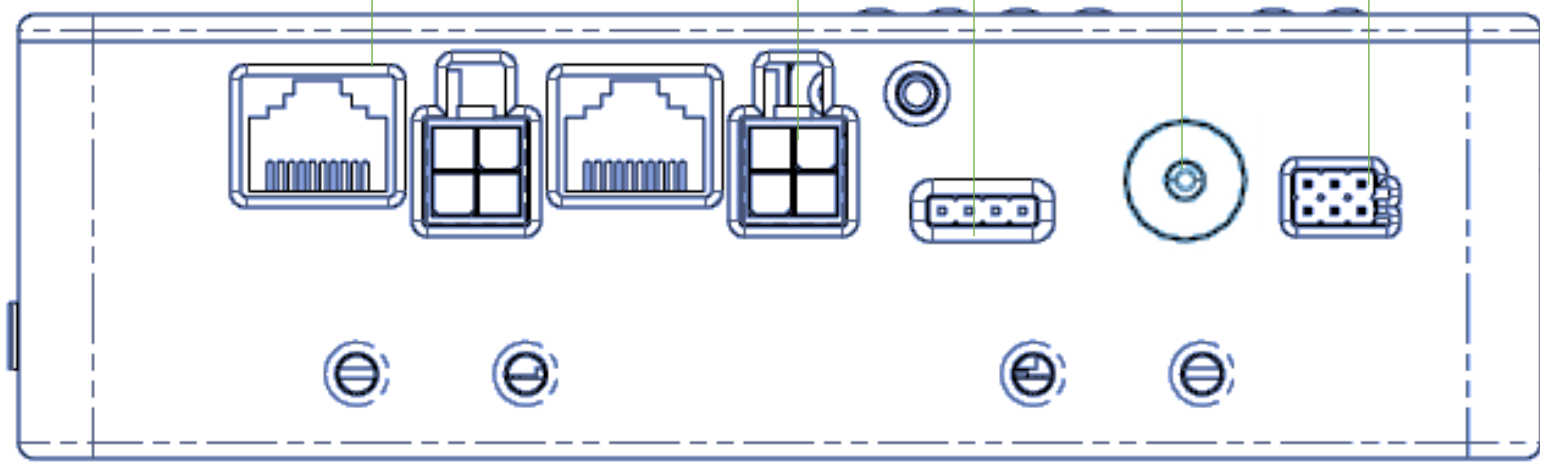
10P RJ45 (DC馬達輸出)

4P ATX Mod. Power
(馬達電源供應端子)

UART (紅外線測距模組)

Power (Battery) In
(總電源輸入端)

RC Servo Motor
(RC 伺服馬達 輸出端子)

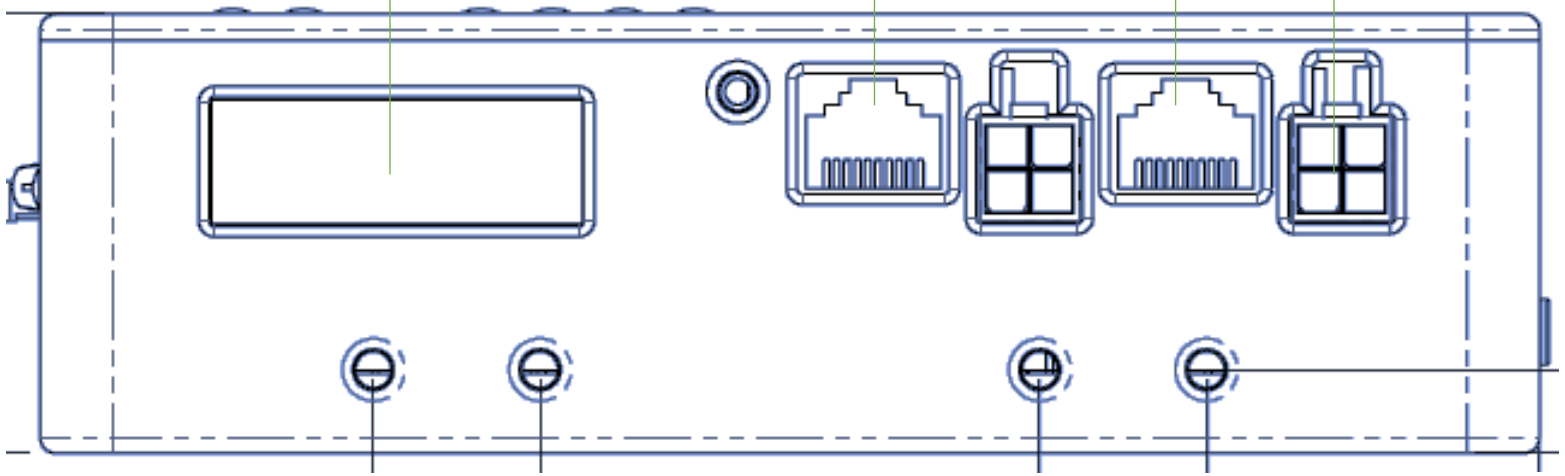


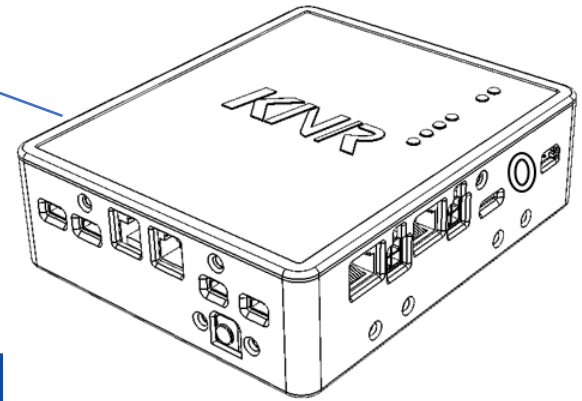
KNRm | left view

14P AUX I/O 4AO 2AI
(類比輸入輸出轉換模組)

10P RJ45 (DC馬達輸出)

4P ATX Mod. Power
(馬達電源供應端子)





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KNRm

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KNR OS 3.1

KNR OS 3.11 Patch

KNR OS for LabVIEW 2018

Matrix Robotics 下載 patch

貝登堡智能

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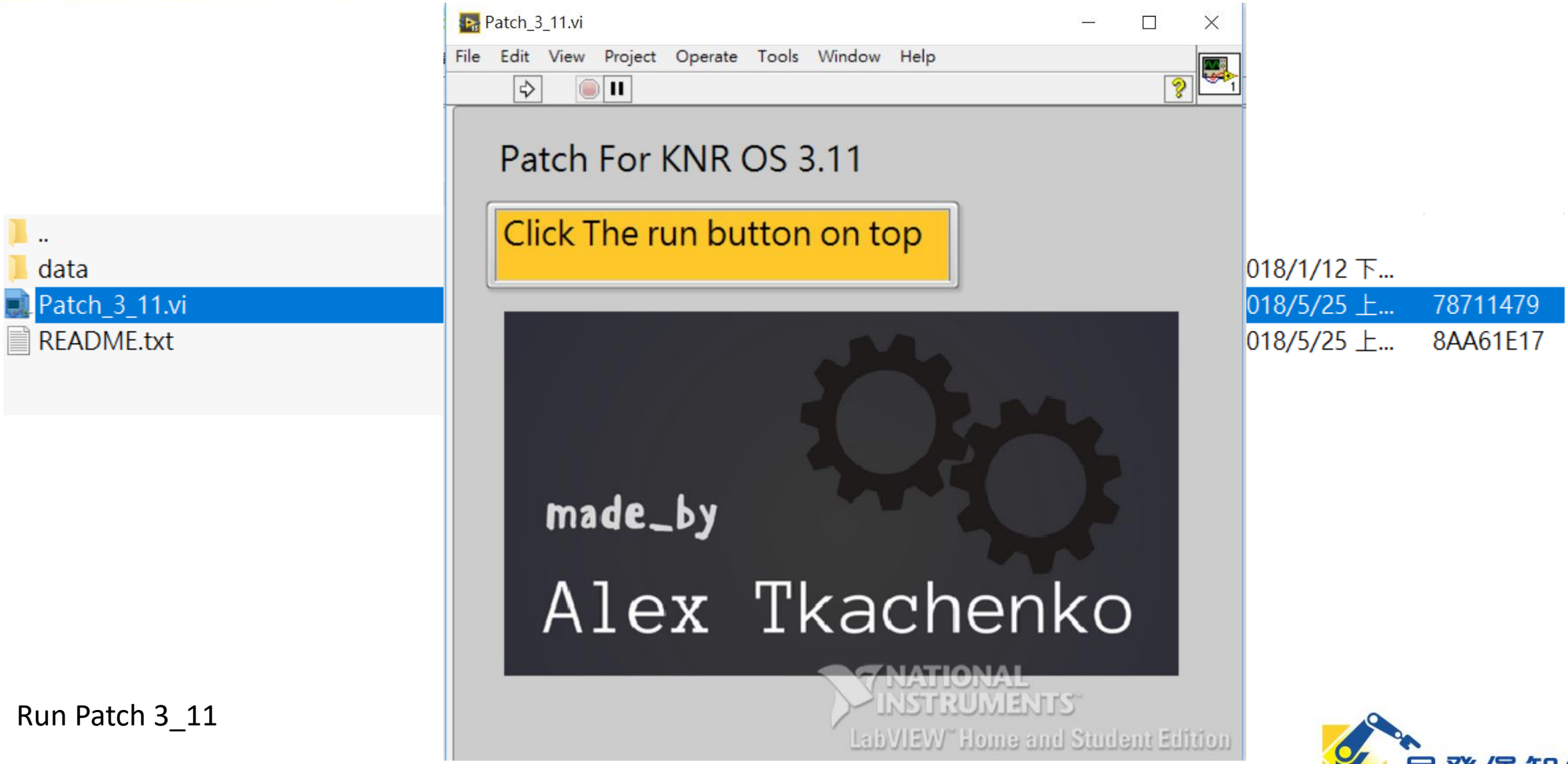

Run Patch 3_11