STEM_2

自 學 教 材

樣 本

專案 1 人流計數器

目錄

固定在一片硬卡紙或者簿木板之上。螺絲、海棉雙面膠紙、熱熔膠、寶貼萬用膠等，都可以用作發射器和感應器的固定用途。

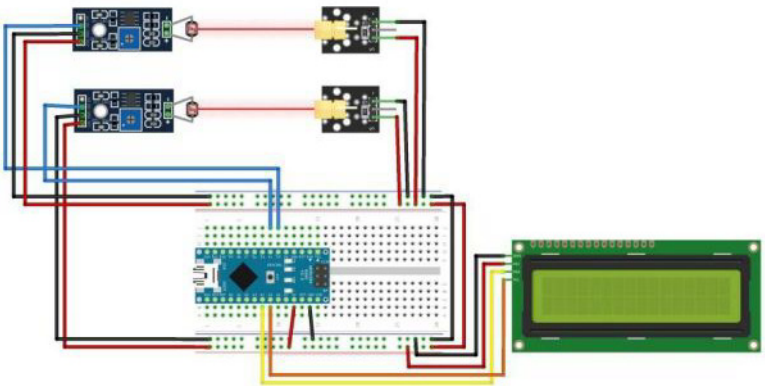
[資源檔案: Single-Light-Beam-Counter.sb2]

6. 作業 1

1. 我們的光敏電阻感應器模組，在激光照射時會輸出一個「低電位」的信號。假如我們換成另一個感應器模組，它的輸出是相反的，在激光照射時會輸出一個「高電位」的信號，那在上一節的程式中，我們要作出甚麼修改呢？
2. 在第 5 節的程式中，每當激光光束斷開時，計數器便會加一。嘗試修改程式，令到人流計數器在激光光束重新連接時才加一。

7. 兩組光束

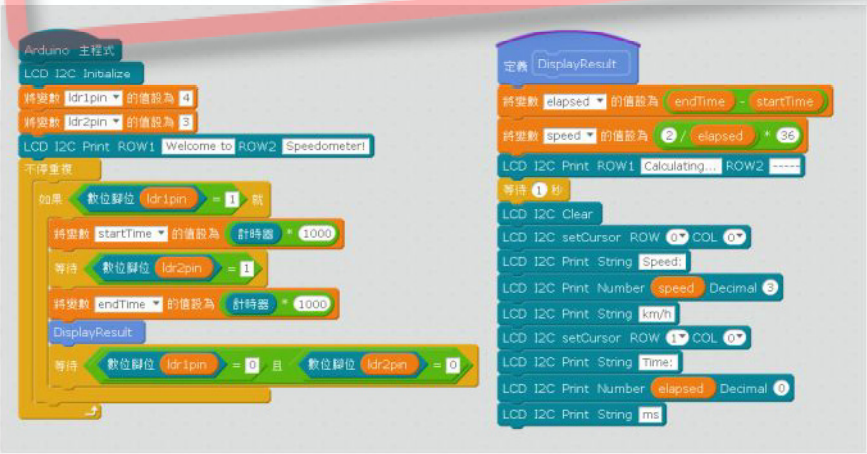
當只有一束激光，我們是不可能知悉行人行走的方向的。所以，單一光束的人流計數器，只有在限制人流方向的地方才有用。例如超級市場的出入口，又或者巴士上落的車門。



在大部的的其他地方，可能根本沒有兩個出入口，又或者限制人流方向會引起太大的不便。在此種程況，使用兩個感應器在同一個出入口來同時偵測人流的方向，便會是不錯的選擇。

讓我們在之前的系統的基礎上，再添加一對發射器和感應器。發射器和感應器的連接基本上是一樣的，除了我們另外多了一個光敏電阻感應器模組的數位輸出。這第二個數位輸出，我們把它接到 Arduino NANO 主板的數位輸入針腳 3。一個光束發射器，再配合一個光的感應器，這樣的組合一般會叫作「光電感應器」（photoelectric sensor）。光電感應器廣泛應用於工業生產，它們並不只適用於人流感應器。光電感應器還會用於偵測距離、監測空氣質量、通訊等方面。

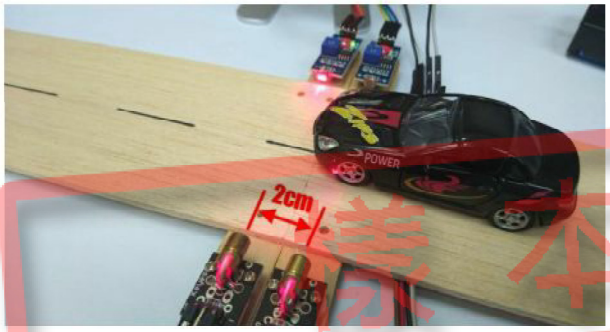
以下是一個簡單的程式，可以將上面那個兩組光束電路，化身成為一個測速儀。同時在程式中，我們也會使用幾個 LCD 模組的新積木。



當程式開始時，我們要初始化一次 LCD 模組，以及建立兩個變數來儲存兩個數位輸入針腳號碼。如果兩組光束都沒有被觸動，那兩個數位輸入針腳都傳回 0，這時程式是不會觸發任何動作的。

當第一組光束被觸動時，第一個數位輸入針腳就會傳回 1，這時程式就會把當下的時間儲存到 startTime 變數。然後我們用了一個「等待」積木，令程式等待，直到第二組光束被觸動。這時，程式會再一次儲存時間，但這一次的時間會被儲存到 endTime 變數。

當我們有齊了開始時間和結束時間，我們便可以用自定義積木「DisplayResult」來計算及顯示所偵測到的速度。然後，程式會再次等待，直至兩組光束都回復到正常狀態，那時程式會再次回復到等待第一個光被觸動。



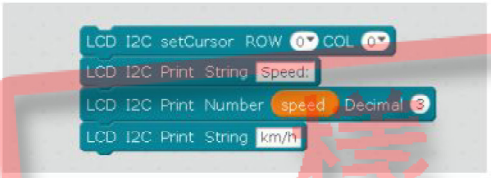
在自定義積木「**DisplayResult**」裡面，我們先用結束時間減去開始時間，得出總共過去了多少時間，然後再用這個時間去計算速度。至於距離，那就是兩組光束之間的距離，我的光束相距是 2cm，所以在例子中的算式是使用了 2。同學們要根據自己的光束距離來修改程式。在上例中，速度的單位由 cm/ms 換算成為 km/h，這樣可以令我們更容易理解。

然後，我們特別顯示了「Calculating...」的訊息和讓程式等待了 1 秒。這純粹是為了增加戲劇性的效果，並沒有任何實際用途。即使刪除了這兩塊積木，程式亦不會有任何影響。

然後，我們應用了幾個新的積木來顯示速度的測量結果。

「**LCD I2C Clear**」積木，是用是清除所有顯示的文字的。

「**LCD I2C setCursor ROW x COL x**」積木是用來設定遊標的位置的。在 1602 LCD 模組上，有上下兩行可以顯示資料（0 和 1），兩每一行可以顯示 16 位字符（0 - 15）。



「**LCD I2C Print Sting**」積木和「**LCD I2C Print Number**」積木，都會在遊標當下的位置開始顯示訊息，而每列印了一個字符，遊標都會自動前進一位。

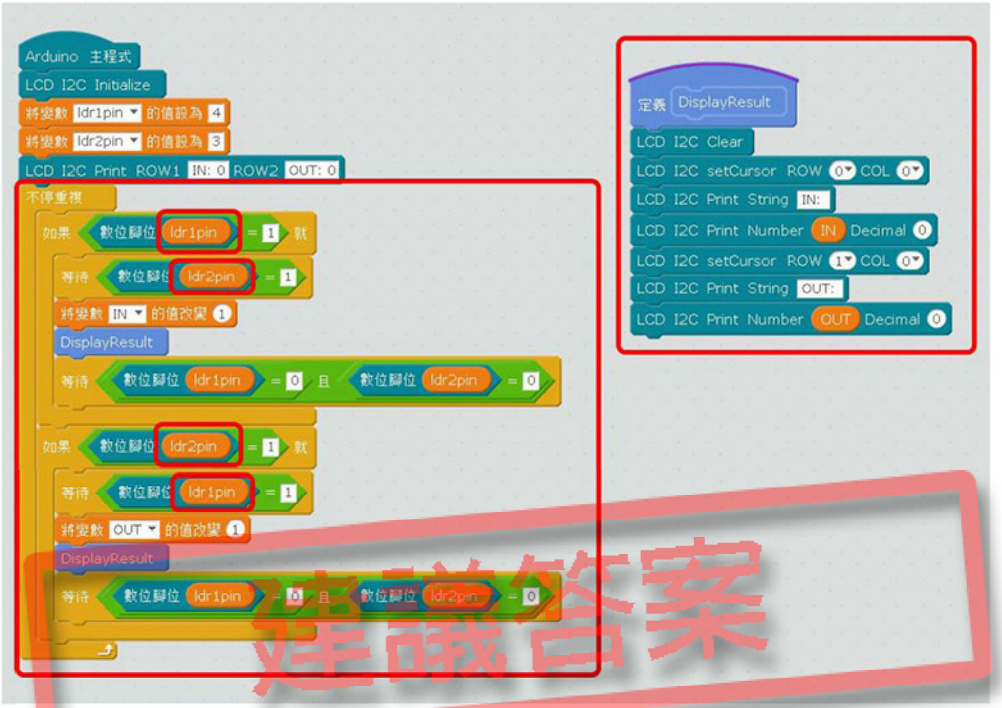
在上例中，程式會先把遊標移動到 0 行 0 位，然後順次序打印第一行的訊息。然後程式把遊標移動到 1 行 0 位，再接著列印第二行的訊息。

[資源檔案:　Two-Light-Beams.sb2]

8. 作業 2

1. 在第 7 節的測速儀程式中，程式只能夠偵測到單一方向的速度（從光速 1 走到光束 2）。試修改該程式，令到程式可以偵測到兩個方向的速度。
2. 試修改題目 1 的答案，令到程式成為一個雙向人流計數器。我們把其中一個方向定義為 IN，另一個方向定義為 OUT。並把 LCD 模組所顯示的資訊修改到如下圖的格式。

問題 2 ：



在「不停重複」積木裡面，有兩個「如果...就」積木。每一個「如果...就」積木會計算一個方向的人流。兩個「如果...就」積木的分別就只是「ldr1pin」和「ldr2pin」調換了。

在自定義積木「DisplayResult」裡面，我們把 IN 的結果列印到第一行，然後把 OUT 的結果列印到第二行。

[project-1-assignment-2-answer-2.sb2]

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Self-learning Guide

PROJECT 2 PLANT WATERING SYSTEM

Table of Contents

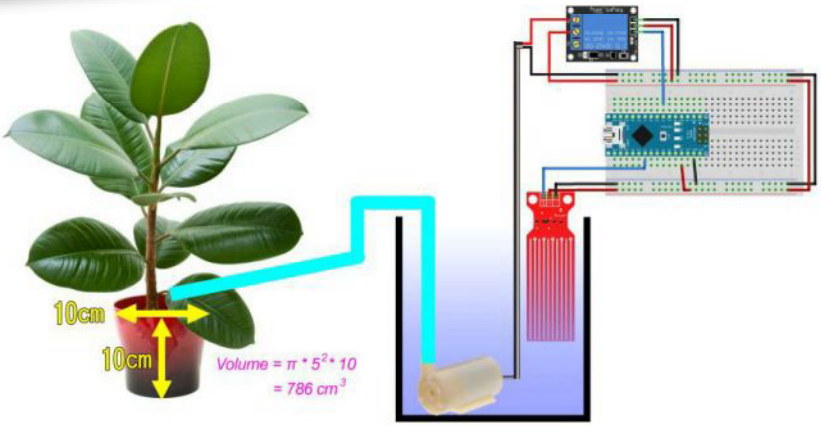
The “L” on-board led connected to pin 13 is used for something else too. It is used to indicate the water level. If the water level above **normal** (>610), the “L” led would be turned OFF. If the water level is below **critical** level (<500), the led would be turned ON. If the water level is in between, the led would be blinking.

The analog values used in this program to determine the water level is from experiment of the previous section. Do forget to change those values in your program to fit your configuration.

[Resources file: Protect-the-submersible-pump.sb2]

7. A timed watering system

We now know how to operate the most crucial part of a plant watering system, the water pump. We also learn to protect the pump by adding a water level sensor in the reservoir. It is time for us to build our first plant watering system.



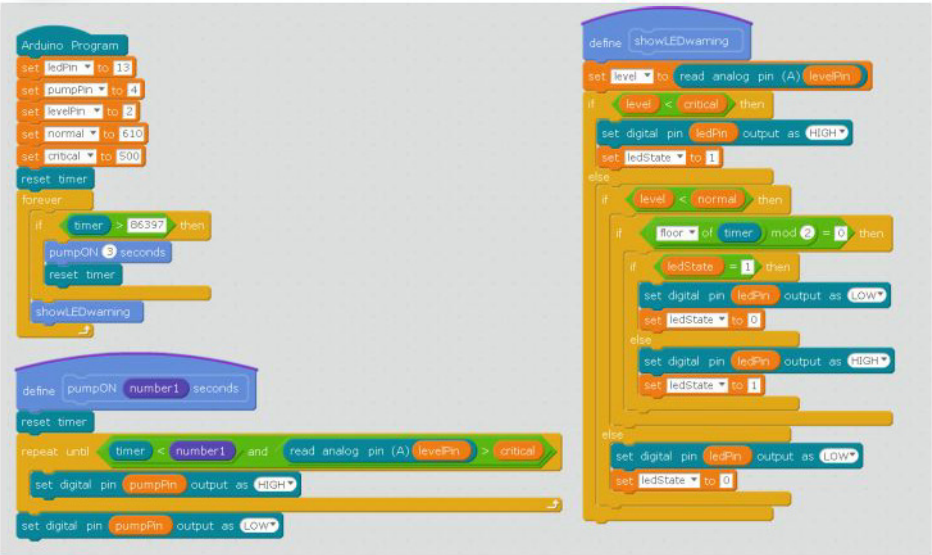
The circuit is the same as section 6. The water pump and relay is connected to digital pin 4. And the water level sensor is connected to analog pin A2.

How much water is needed for each watering? How often do we water the plant? Well, let us run an experiment to find out. We can weight our plant every day to measure how much water was lost during each day.

We should saturate the soil of our potted plant first. Then we wait one hour for the excessive water to drain. We can then measure the weight of the whole plant as the original value. Then we measure the weight again in every 24 hours.

	Original	24 hours	48 hours	72 hours	96 hours
Little Plant (10cm pot)	412.6g	378.1g	349.7g	323.5g	291.5g
Your Plant					

Now we know that our plant would lose around 30ml water in 24 hours. And from assignment 1 we know that our pump can pump 30ml water in approximately 3 seconds. So, let us write a program which can turn on our pump for 3 seconds in every 24 hours.



Actually this is the same program as in section 6, except that we changed the wait time to 24 hours minus 3 seconds and the watering time to 3 seconds. If you do not minus the 3 seconds in the 24 hours, the daily schedule would be pushed later and later every day.

8. Soil Moisture

Soil moisture is the quantity of water contained in the soil. It is expressed as a ratio and can be given on a volumetric or gravimetric basis.

$$\theta = \frac{V_w}{V_{\text{wet}}}$$

The volumetric water content, θ, is equal to the volume of water (V_w) divide by the total volume (V_{wet}) of the wet material.

$$u = \frac{m_w}{m}$$

The gravimetric water content, u, is equal to the mass of water (m_w) divide by the mass (m) of the wet soil.

Water that enters the soil is removed immediately by runoff, drainage, evaporation or transpiration. So the soil moisture is constantly changing.

A flooded field will drain under the influence of gravity until water's adhesive and cohesive forces resist further drainage. It is said to have reached field capacity at this point.

In transpiration, the evaporation of water through the stomata causes water to be

pulled upward through the xylem of the plant. This creates suction at the root to draw water from the soil. The water that plants may draw from the soil is called the available water.

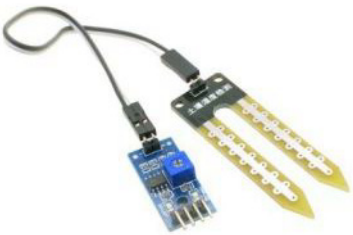
Once the available water is used up the remaining moisture is called unavailable water as the plant cannot produce sufficient suction to draw that water in. This is known to be the wilting point.

The field capacities, available water capacities and wilting points vary greatly for different types of soil. Sandy soil retains very little water, while clay holds the maximum amount.

9. Soil Moisture Sensor Module

Since the direct measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the water content indirectly by some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons.

The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity.



Project 2 Assignment 2 Answers

Repeat the process in section 9 on your own soil. Produce a table with sensor readings similar to the one in section 9.

Suggested Answer:

Items needed:

1. Any kind of soil, around 1000ml in volume.
2. A small flowerpot
3. A measure cup
4. A weight
5. A container to mix the soil

