臺北市立大安高級工業職業學校
電子科 專題報告
自動駕駛車
donkeycar

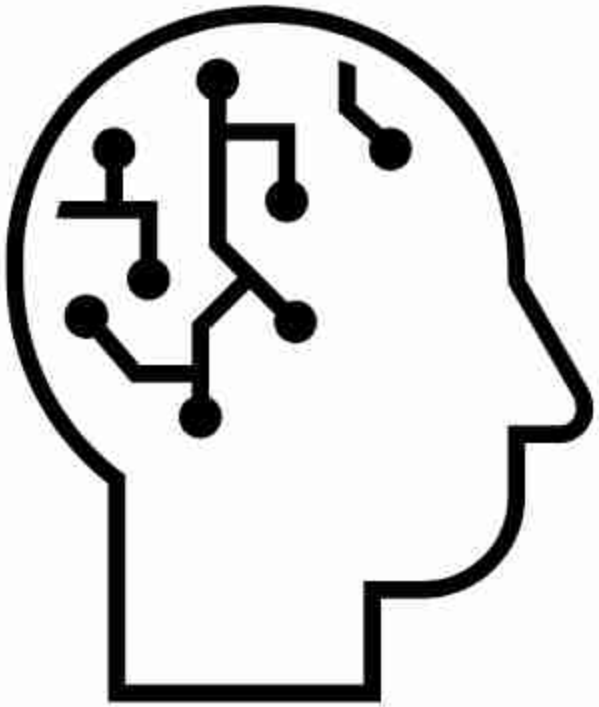
- 組長:陳天寶
- 組員:陳安
- 組員:廖昱安
- 組員:歐哲佑

- 指導老師:張顯盛老師

目錄

製作動機

人工智慧將是未來科技的趨勢，目前生活上的各個方面都在試著加入人工智慧讓生活更加便利而交通也不例外，全自動駕駛車是汽車未來發展的趨勢。



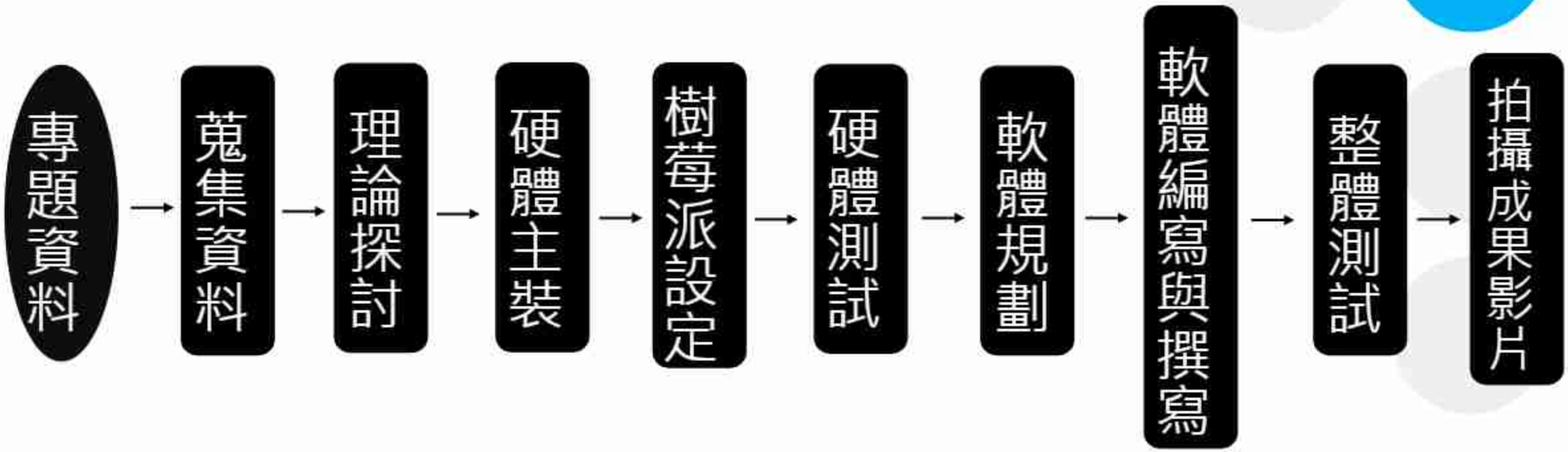
預期成果

操控自走車跑完一段路程並會自動拍攝路過的道路

自走車會分析拍攝的照片來分辨可行走的道路與障礙物

學習完的自走車在相同的路程上自動前進並躲避障礙物

流程圖



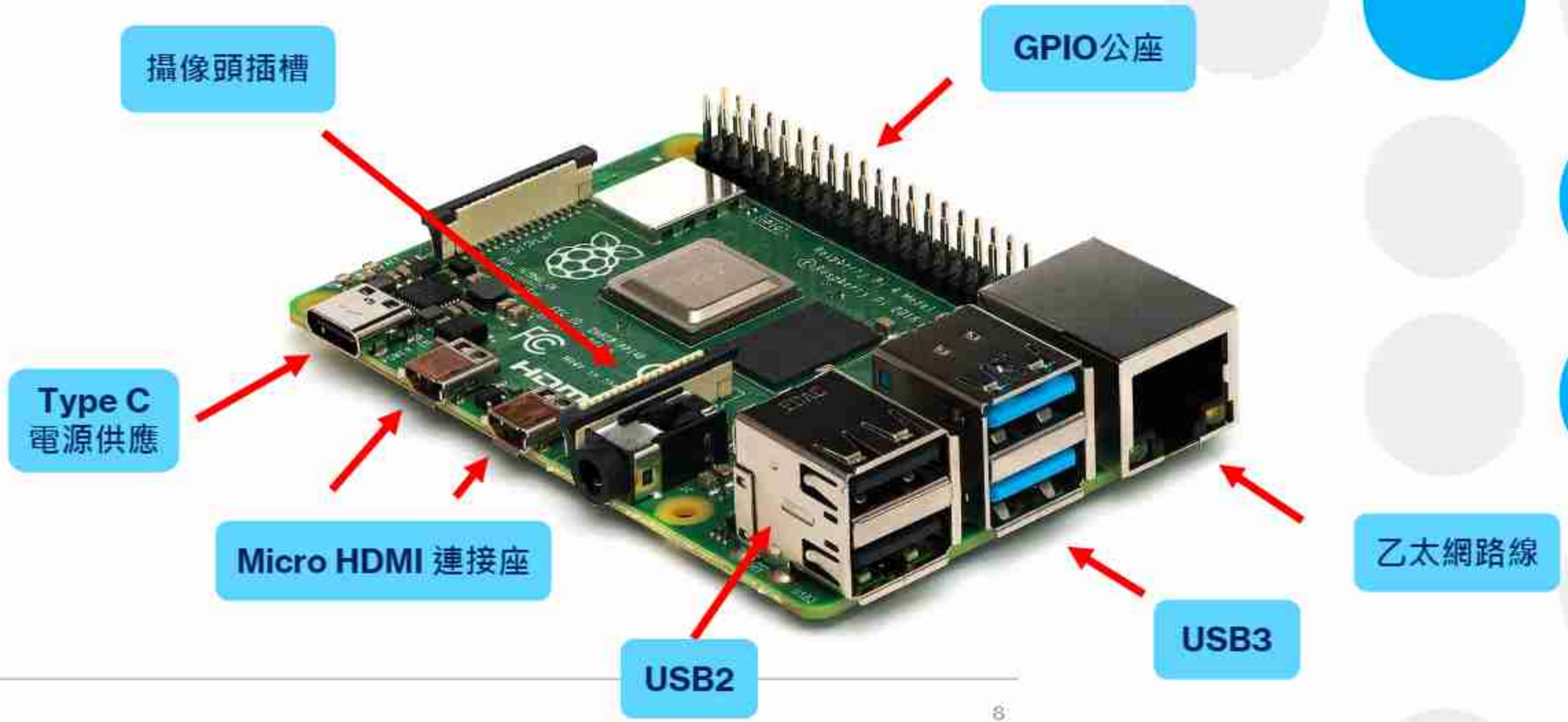
硬體部分

硬體

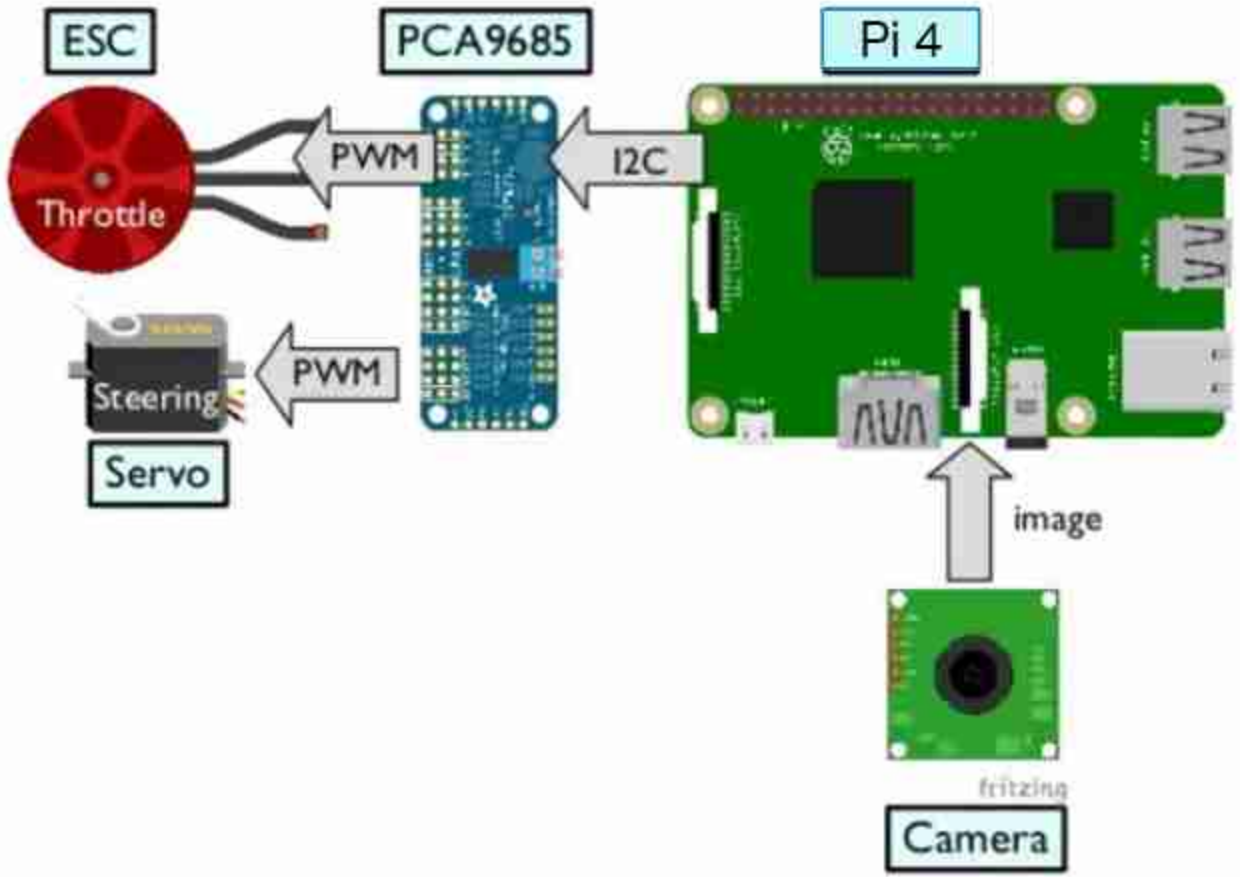
樹莓派(raspberrypi)

英國樹莓派基金會開發的微型單板電腦，目的是以低價硬體及自由軟體促進學校的基本電腦科學教育。
樹莓派系列電腦每一代均使用博通（Broadcom）出產的ARM架構處理器，如今生產的機型（樹莓派4B）記憶體在2GB和8GB之間，主要TF卡作爲系統儲存媒體（初代使用SD卡），配備USB介面和HDMI的視訊輸出（支援聲音輸出），內建Ethernet/WLAN/Bluetooth網路鏈結的方式（依據型號決定），並且可使用多種操作系統

Raspberry Pi 4B硬體裝置用途

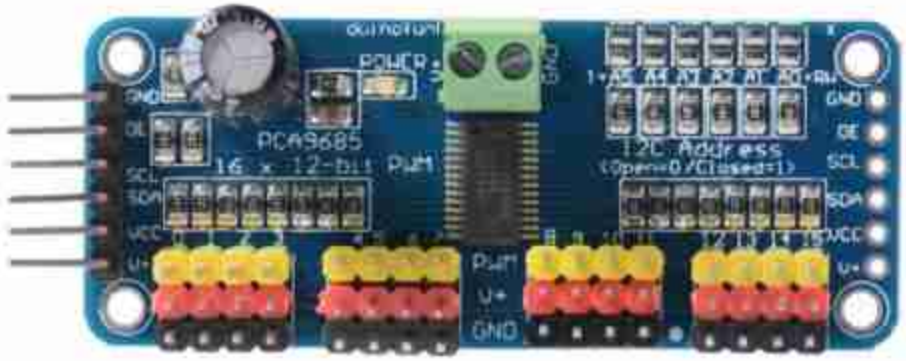


硬體架構

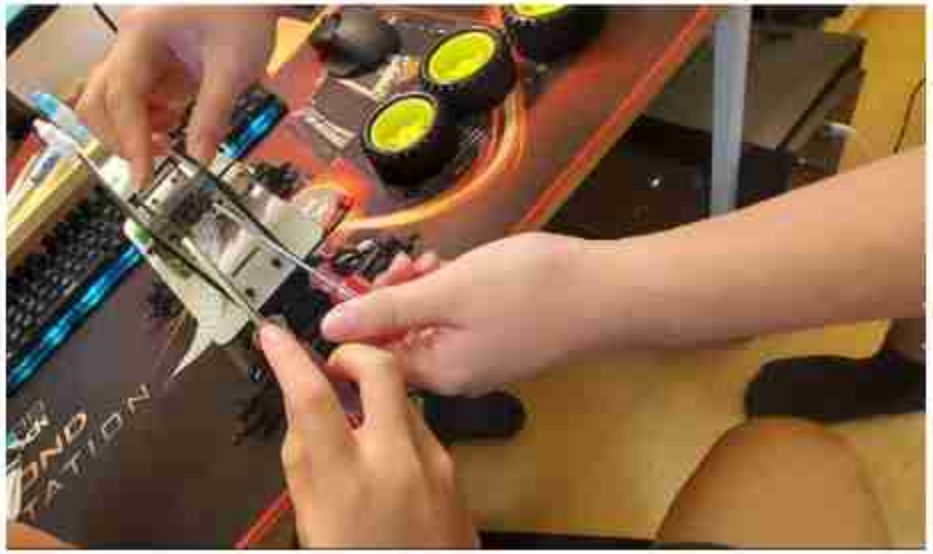

ESC
PCA9685
Pi 4
PWM
I2C
Throttle
PWM
Steering
Servo
image
fritzing
Camera

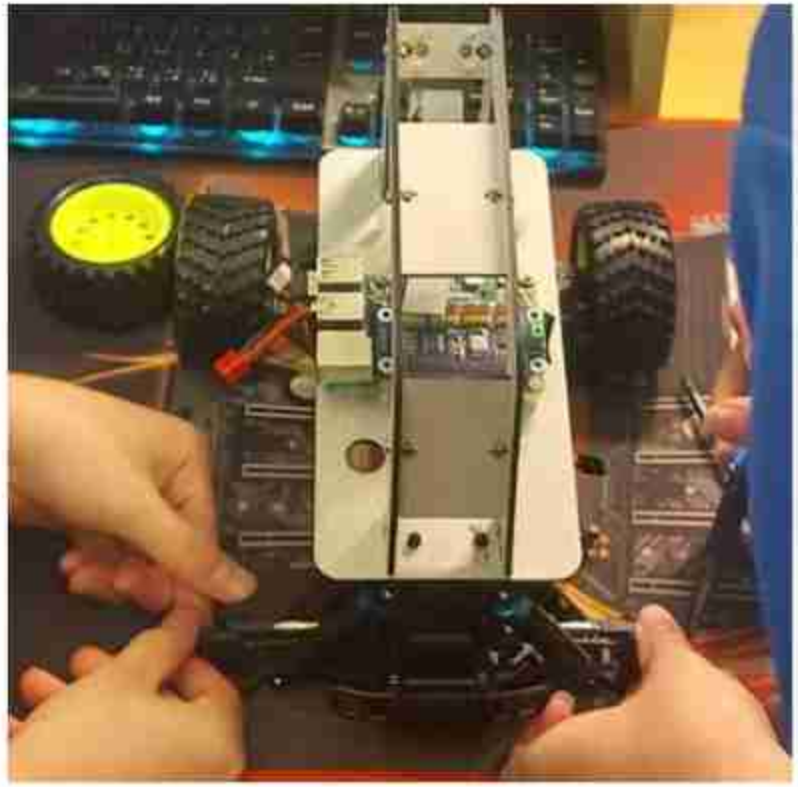
PCA9685

PCA9685 伺服控制器可以控制多達 16 個 PWM 設備，例如伺服、電機控制器、LED 或幾乎任何使用 PWM 信號的設備。它通過 I2C 引腳連接到 RaspberryPi 40 引腳 GPIO 總線。

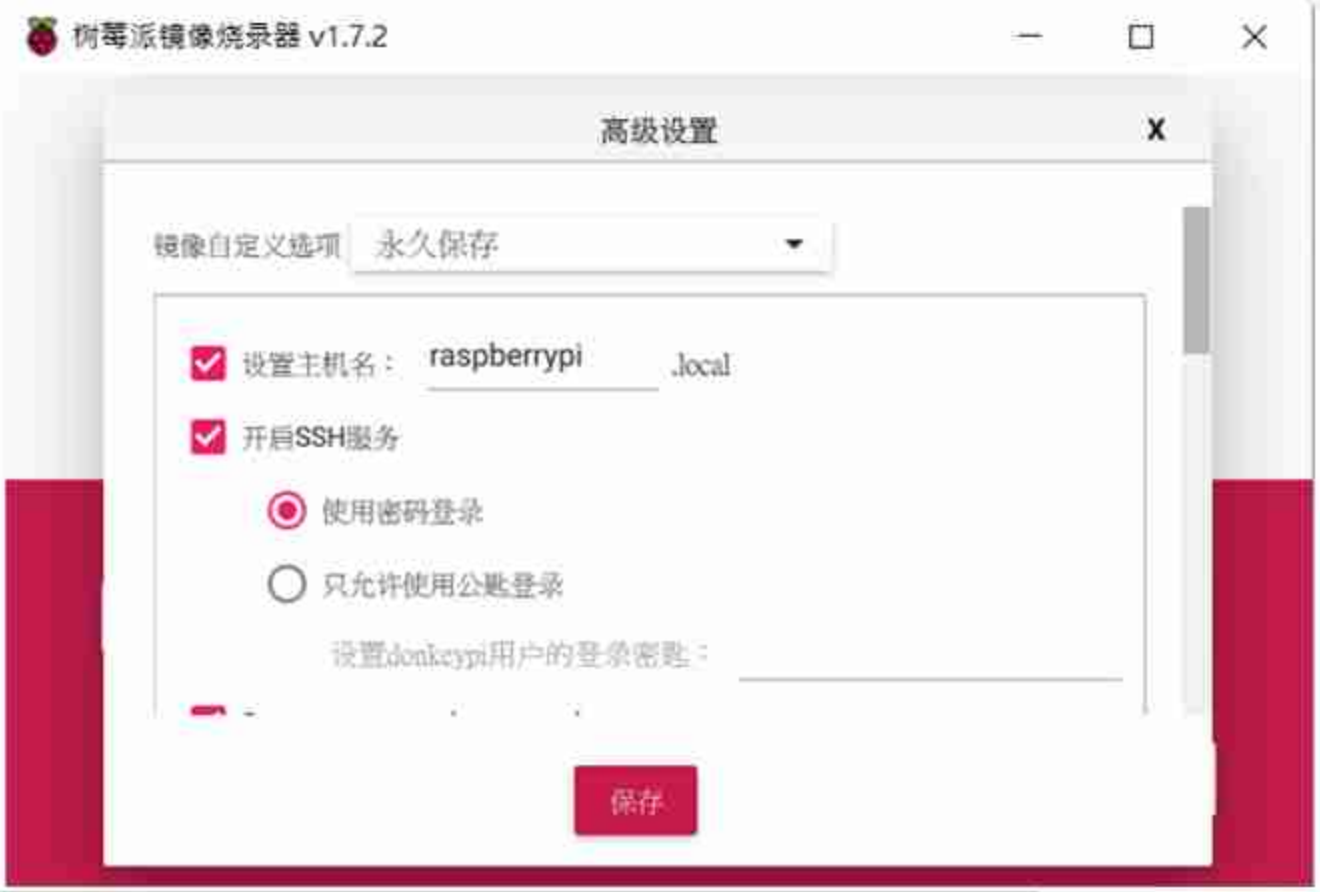


組裝相機與輪胎





啟動SSH


树莓派镜像烧录器 v1.7.2
高级设置
X
镜像自定义选项
永久保存
设置主机名：
raspberrypi
.local
开启SSH服务
使用密码登录
只允许使用公匙登录
设置donkeypi用户的登录密匙：
保存

設置 WiFi 以進行首次啟動

設置Pi的主機名


树莓派镜像烧录器 v1.7.2
高级设置
使用密码登录
只允许使用公匙登录
设置donkeypi用户的登录密匙：
Set username and password
Username: donkeypi
密码：
配置WiFi
保存

連接到 Pi

```
C:\Users\ian>ping raspberrypi.local -4

Ping raspberrypi.local [192.168.46.39] (使用 32 位元組的資料):
回覆自 192.168.46.39: 位元組=32 時間=6ms TTL=64
回覆自 192.168.46.39: 位元組=32 時間=26ms TTL=64
回覆自 192.168.46.39: 位元組=32 時間=7ms TTL=64
回覆自 192.168.46.39: 位元組=32 時間=7ms TTL=64

192.168.46.39 的 Ping 統計資料:
    封包: 已傳送 = 4，已收到 = 4，已遺失 = 0 (0% 遺失)，
大約的來回時間 (毫秒):
    最小值 = 6ms，最大值 = 26ms，平均 = 11ms
```

登入樹莓派

```
C:\Users\ian>ssh -l donkeypi 192.168.46.39
donkeypi@192.168.46.39's password:
Linux raspberrypi 5.15.61-v7l+ #1579 SMP Fri Aug 26 11:13:03 BST 2022 armv7l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Oct 26 17:21:04 2022 from 192.168.46.14
Linux raspberrypi 5.15.61-v7l+ #1579 SMP Fri Aug 26 11:13:03 BST 2022 armv7l

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Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Oct 26 17:21:04 2022 from 192.168.46.14
(env) donkeypi@raspberrypi:~ $
```

軟體部分

- 樹莓派(raspberry pi 4B)
- 深度學習(deep learning)

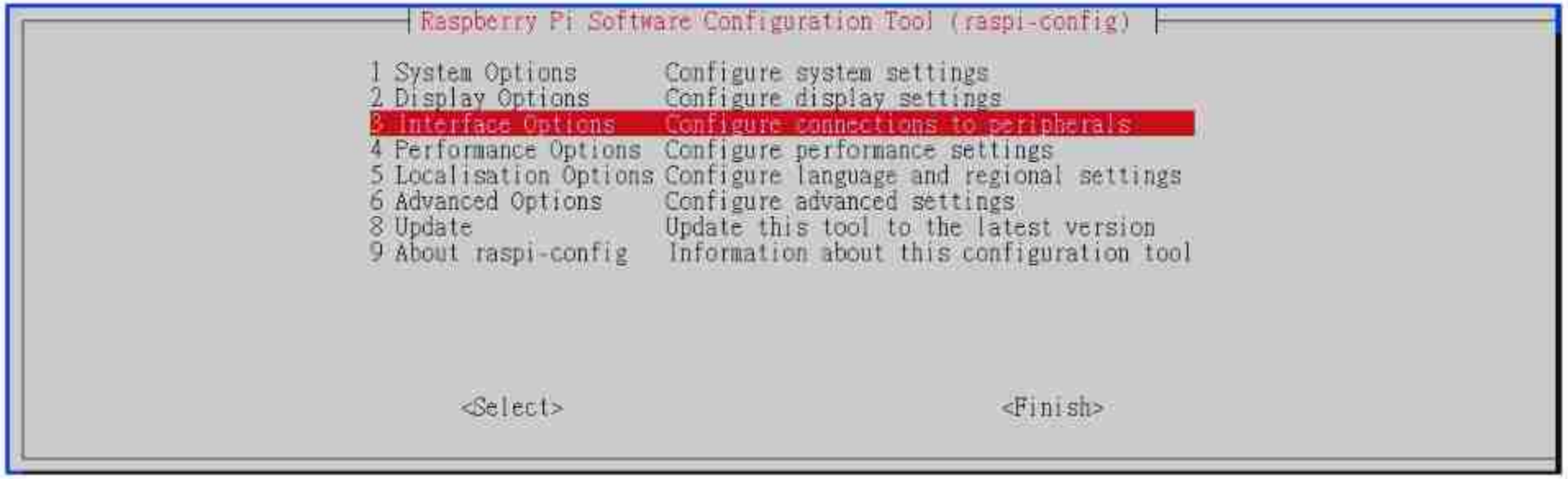
更新和升級

```
donkeypi@raspberrypi:~ $ sudo apt-get update --allow-releaseinfo-change
```

```
donkeypi@raspberrypi:~ $ sudo apt-get upgrade
```

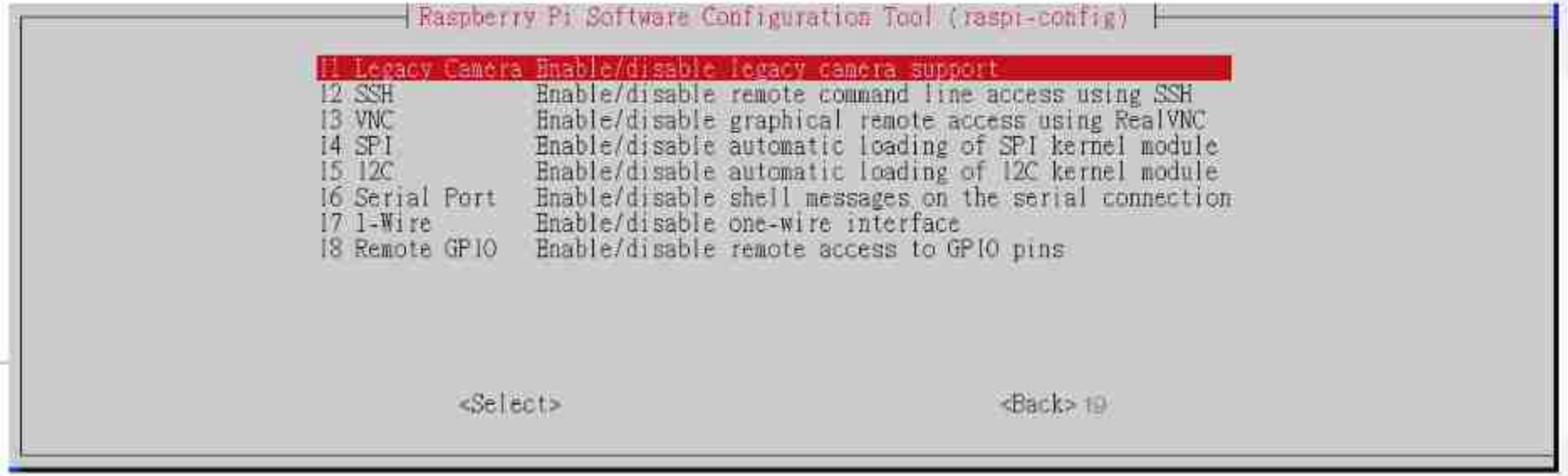
樹莓派配置

```
donkeypi@raspberrypi:~ $ sudo raspi-config
```



樹莓派配置


Raspberry Pi Software Configuration Tool (raspi-config)
I1 Legacy Camera Enable/disable legacy camera support
I2 SSH Enable/disable remote command line access using SSH
I3 VNC Enable/disable graphical remote access using RealVNC
I4 SPI Enable/disable automatic loading of SPI kernel module
I5 I2C Enable/disable automatic loading of I2C kernel module
I6 Serial Port Enable/disable shell messages on the serial connection
I7 1-Wire Enable/disable one-wire interface
I8 Remote GPIO Enable/disable remote access to GPIO pins
<Select>
<Back>


Raspberry Pi Software Configuration Tool (raspi-config)
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I6 Serial Port Enable/disable shell messages on the serial connection
I7 1-Wire Enable/disable one-wire interface
I8 Remote GPIO Enable/disable remote access to GPIO pins
<Select>
<Back>

設置虛擬環境

```
donkeypi@raspberrypi:~ $ python3 -m virtualenv -p python3 env --system-site-packages
```

```
donkeypi@raspberrypi:~ $ echo "source ~/env/bin/activate" >> ~/.bashrc
```

```
donkeypi@raspberrypi:~ $ source ~/.bashrc
```

安裝依賴項

```
(env) donkeypi@raspberrypi:~ $ sudo apt-get install build-essential python3 python3-dev python3-pip python3-
virtualenv python3-numpy python3-picamera python3-pandas python3-rpi.gpio i2c-tools avahi-utils joystick lib
openjp2-7-dev libtiff5-dev gfortran libatlas-base-dev libopenblas-dev libhdf5-serial-dev libgeos-dev git ntp
```

安裝donkeycar python 代碼

```
(env) donkeypi@raspberrypi:~ $ mkdir projects
```

```
(env) donkeypi@raspberrypi:~ $ cd projects
```

```
(env) donkeypi@raspberrypi:~ $ git clone https://github.com/autorope/donkeycar
```

```
(env) donkeypi@raspberrypi:~ $ cd donkeycar
```

```
(env) donkeypi@raspberrypi:~ $ git checkout main
```

```
(env) donkeypi@raspberrypi:~ $ pip install -e .[pi]
```

```
(env) donkeypi@raspberrypi:~ $ pip install https://github.com/lhelontra/tensorflow
-on-arm/releases/download/v2.2.0/tensorflow-2.2.0-cp37-none-linux_armv7l.whl
```

創建donkeycar專屬資料夾

```
(env) donkeypi@raspberrypi:~ $ donkey createcar --path ~/mycar
```

查看創建目錄中 myconfig.py

```
(env) donkeypi@raspberrypi:~ $ cd ~/mycar
(env) donkeypi@raspberrypi:~/mycar $ nano myconfig.py
```

配置I2C PCA9685

```
(env) donkeypi@raspberrypi:~/mycar $ sudo i2cdetect -y 1
```

```
(env) donkeypi@raspberrypi:~/mycar $ sudo apt-get install -y i2c-tools
```

```
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:          -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: 40 -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: 70 -- -- -- -- -- -- --
```

正確位址網格

操縱桿設置(PS4)

```
bluetoothctl
<response> Agent registered
<response> [bluetooth]#
scan on
<response>
[CHG] Controller BB:22:EE:77:BB:CC Discovering: yes
[NEW] Device 10:20:30:40:50:60 10-20-30-40-50-60
[NEW] Device 10:20:30:40:50:70 10-20-30-40-50-70
[NEW] Device 10:20:30:40:50:80 10-20-30-40-50-80
[NEW] Device 10:20:30:40:50:90 10-20-30-40-50-90
[NEW] Device 20:AA:88:44:BB:10 WHSCL1
```

```
<response>
[NEW] Device 1C:AA:BB:99:DD:AA Wireless Controller
```

操縱桿設定(PS4)

```
(env) donkeypi@raspberrypi:~/mycar $ bluetoothctl
Agent registered
[  CHG  ] Controller DC:A6:32:AC:2D:9B Pairable: yes
[  CHG  ] Device 70:20:84:70:C8:9A Connected: yes
[Wireless Controller]# devices
Device 70:20:84:70:C8:9A Wireless Controller
[  CHG  ] Device 70:20:84:70:C8:9A Connected: no
[  CHG  ] Device 70:20:84:70:C8:9A Connected: yes
[Wireless Controller]#
```

設置完成

```
#JOYSTICK
USE_JOYSTICK_AS_DEFAULT = True
JOYSTICK_MAX_THROTTLE = 0.5
 full speed available.
JOYSTICK_STEERING_SCALE = 1.0
AUTO_RECORD_ON_THROTTLE = True
ystick.
CONTROLLER_TYPE = 'ps4'
USE_NETWORKED_JS = False
NETWORK_JS_SERVER_IP = None
JOYSTICK_DEADZONE = 0.01
JOYSTICK_THROTTLE_DIR = -1.0
USE_FPV = False
JOYSTICK_DEVICE_FILE = "/dev/input
```

校準汽車(轉向)

```
(env) donkeypi@raspberrypi:~/mycar $ donkey calibrate --channel 1 --bus=1

using donkey v4.3.22 ...
sombrero enabled
sombrero disabled
init PCA9685 on channel 1 address 0x40 bus 1
Using PWM freq: 60
/home/donkeypi/projects/donkeycar/donkeycar/management/base.py:250: DeprecationWarning: Call to deprecated class PCA9685
 (Deprecated in favor or PulseController.  This will be removed in a future release).
  c = PCA9685(channel, address=address, busnum=busnum, frequency=freq)

Enter a PWM setting to test ('q' for quit) (0-1500): 400
Enter a PWM setting to test ('q' for quit) (0-1500): 320
Enter a PWM setting to test ('q' for quit) (0-1500): 470
Enter a PWM setting to test ('q' for quit) (0-1500): q
(env) donkeypi@raspberrypi:~/mycar $
```

校準汽車(油門)

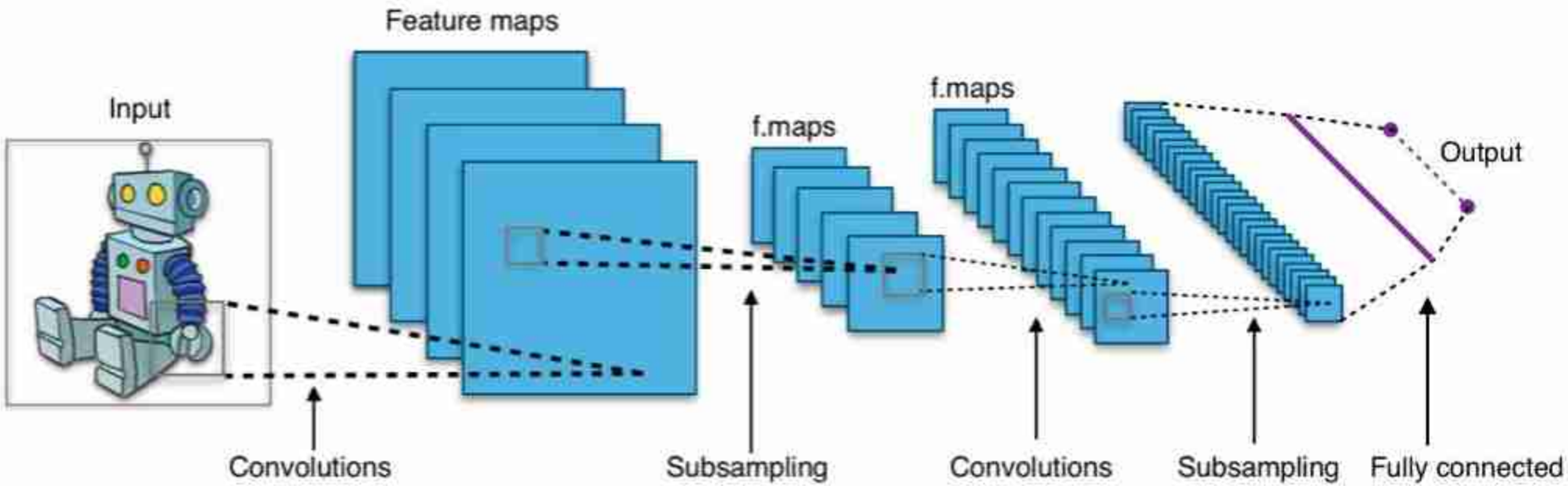
```
(env) donkeypi@raspberrypi:~/mycar $ donkey calibrate --channel 0 --bus=1

using donkey v4.3.22 ...
sombrero enabled
sombrero disabled
init PCA9685 on channel 0 address 0x40 bus 1
Using PWM freq: 60
/home/donkeypi/projects/donkeycar/donkeycar/management/base.py:250: DeprecationWarning: Call to deprecated class PCA9685
 (Deprecated in favor or PulseController.  This will be removed in a future release).
  c = PCA9685(channel, address=address, busnum=busnum, frequency=freq)

Enter a PWM setting to test ('q' for quit) (0-1500): 370
Enter a PWM setting to test ('q' for quit) (0-1500): 330
Enter a PWM setting to test ('q' for quit) (0-1500): 400
Enter a PWM setting to test ('q' for quit) (0-1500): 370
Enter a PWM setting to test ('q' for quit) (0-1500): q
```

校準完成

```
# I2C_SERVO (deprecated in favor of PWM_STEERING_THROTTLE)
#
STEERING_CHANNEL = 1            #(deprecated) channel on the 9685 pwm board 0-15
STEERING_LEFT_PWM = 470         #pwm value for full left steering
STEERING_RIGHT_PWM = 320        #pwm value for full right steering
THROTTLE_CHANNEL = 0            #(deprecated) channel on the 9685 pwm board 0-15
THROTTLE_FORWARD_PWM = 400      #pwm value for max forward throttle
THROTTLE_STOPPED_PWM = 370      #pwm value for no movement
THROTTLE_REVERSE_PWM = 330      #pwm value for max reverse throttle
```

啟動汽車

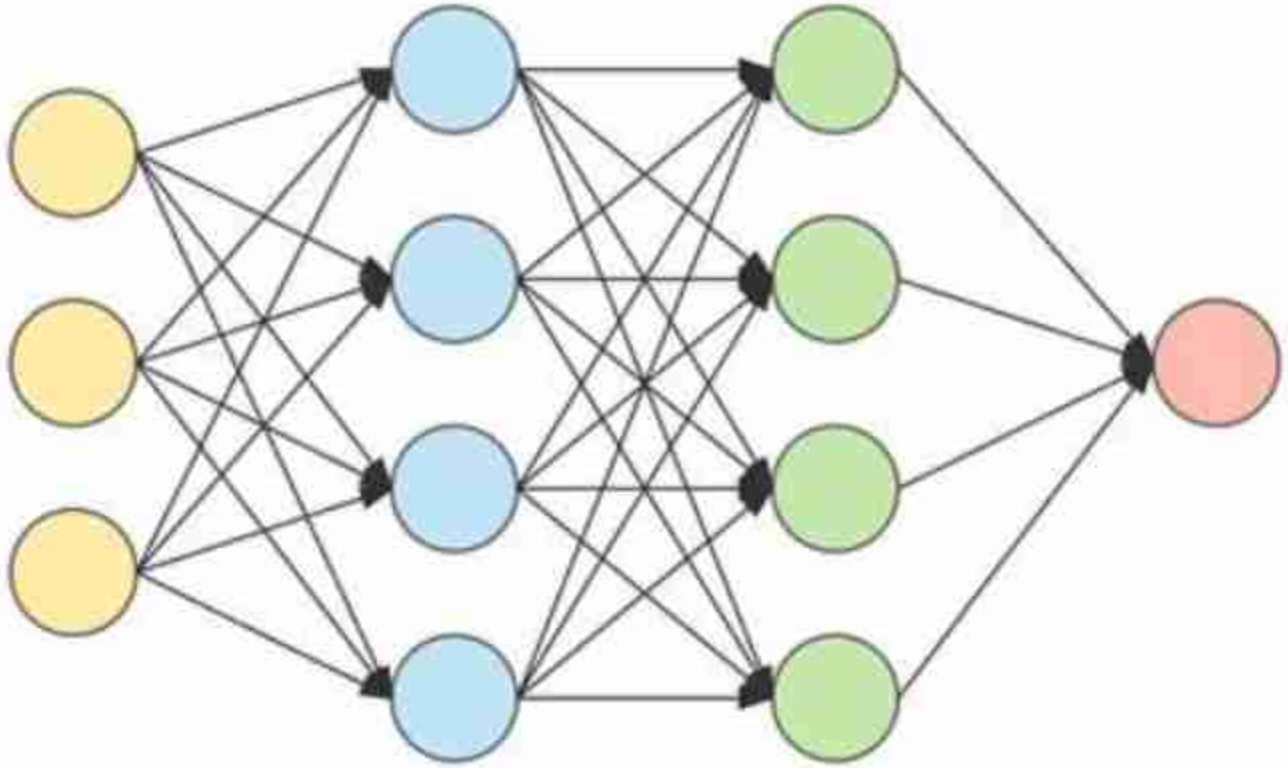
```
(env) donkeypi@raspberrypi:~/mycar $ python manage.py drive
```



卷積神經網路 (CNN)

- 神經網路
- 卷積層
- 池化層
- 平坦層

神經網路



神經網路

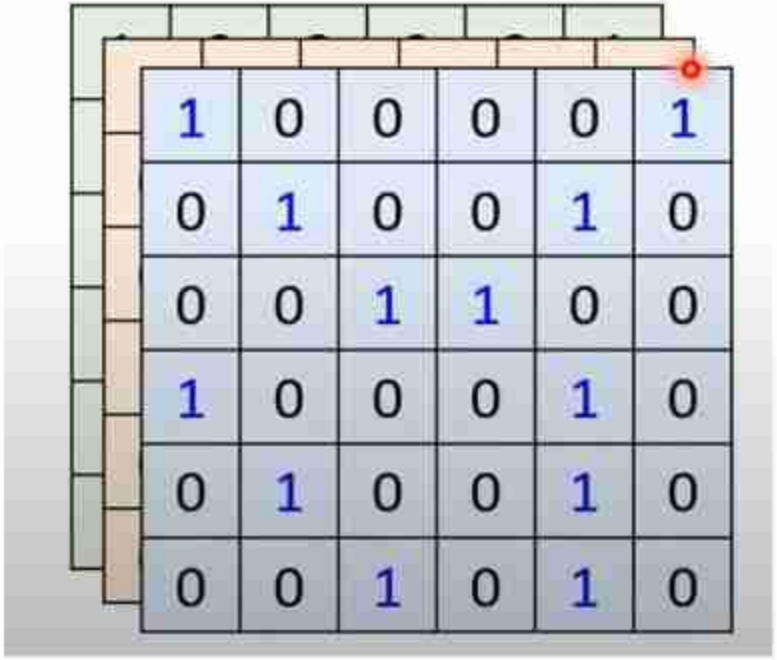
優點：1.使用無限制，神經網路在使用是不需要任何前提的
2.效率極高，神經網路運算速度極快

缺點：黑盒子，隱藏層數寫愈多層最後將會很難解釋整體模型

卷積層

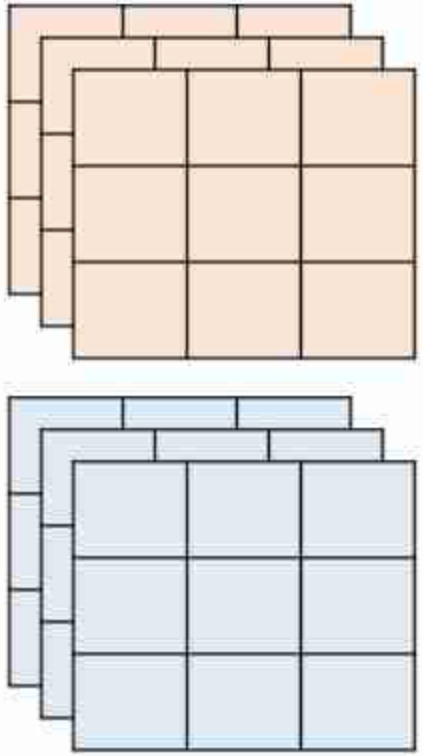
人類眼中的照片

圖像在電腦的樣子



卷積層

主要工作：提取圖像中的局部特徵



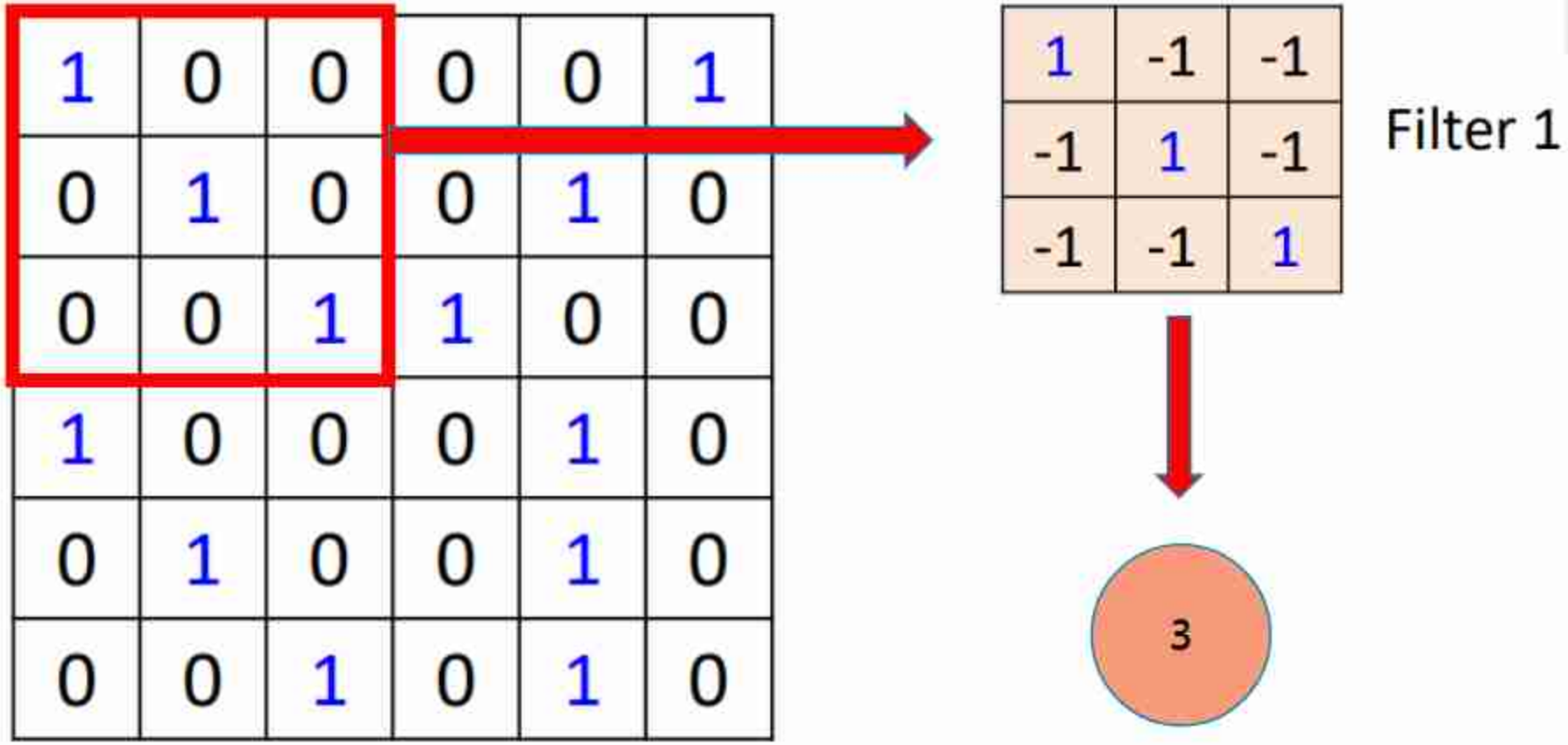
Filter 1

Filter 2

卷積核

(3*3*channal)

卷積層

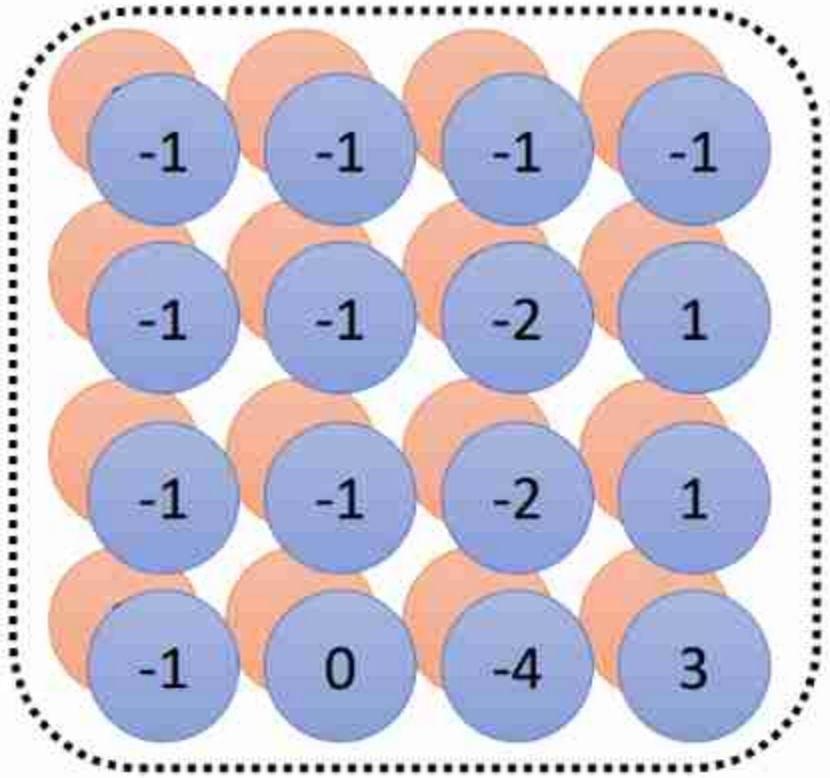

1 0 0 0 0 1
0 1 0 0 1 0
0 0 1 1 0 0
1 0 0 0 1 0
0 1 0 0 1 0
0 0 1 0 1 0
1 -1 -1
-1 1 -1
-1 -1 1
Filter 1
3

卷積層

1	0	0	0	0	1
0	1	0	0	1	0
0	0	1	1	0	0
1	0	0	0	1	0
0	1	0	0	1	0
0	0	1	0	1	0

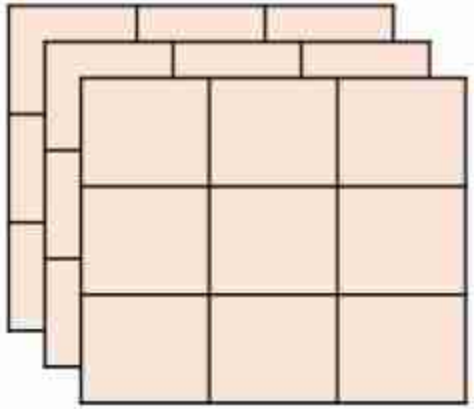
-1	-1	-1	-1
-1	-1	-2	1
-1	-1	-2	1
-1	0	-4	3

卷積層



Feature Map

再疊一層卷積層

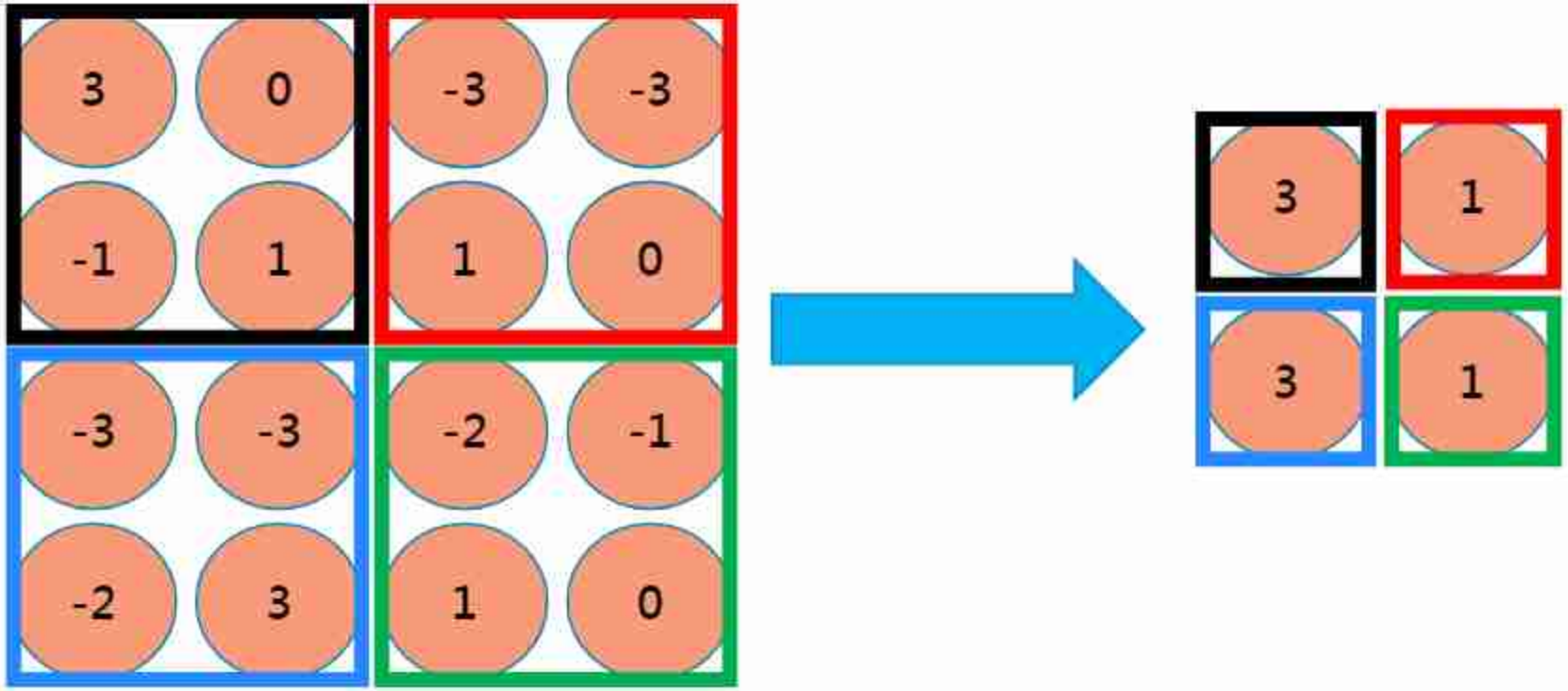


3*3*前層filter數量

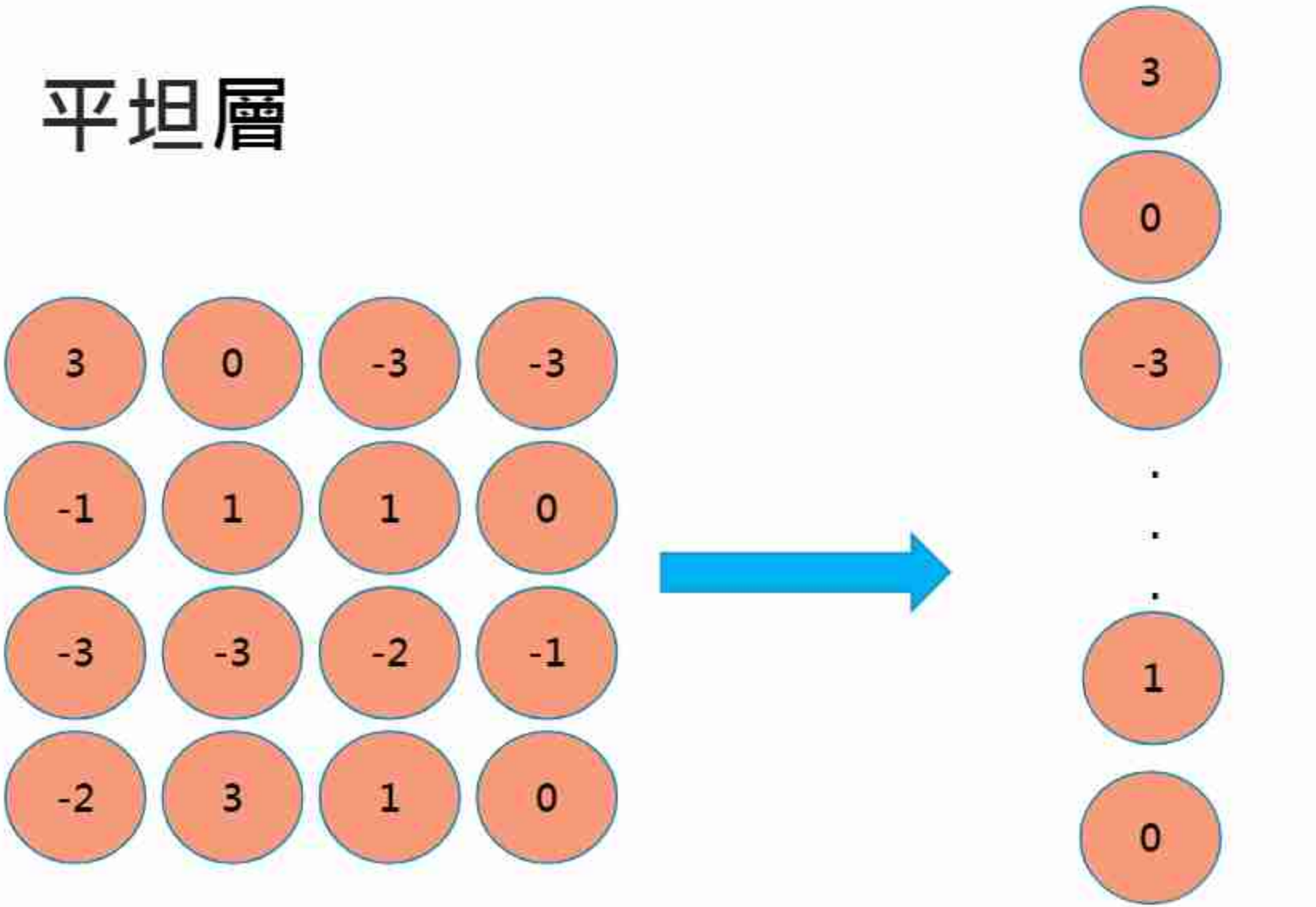
池化層

池化層

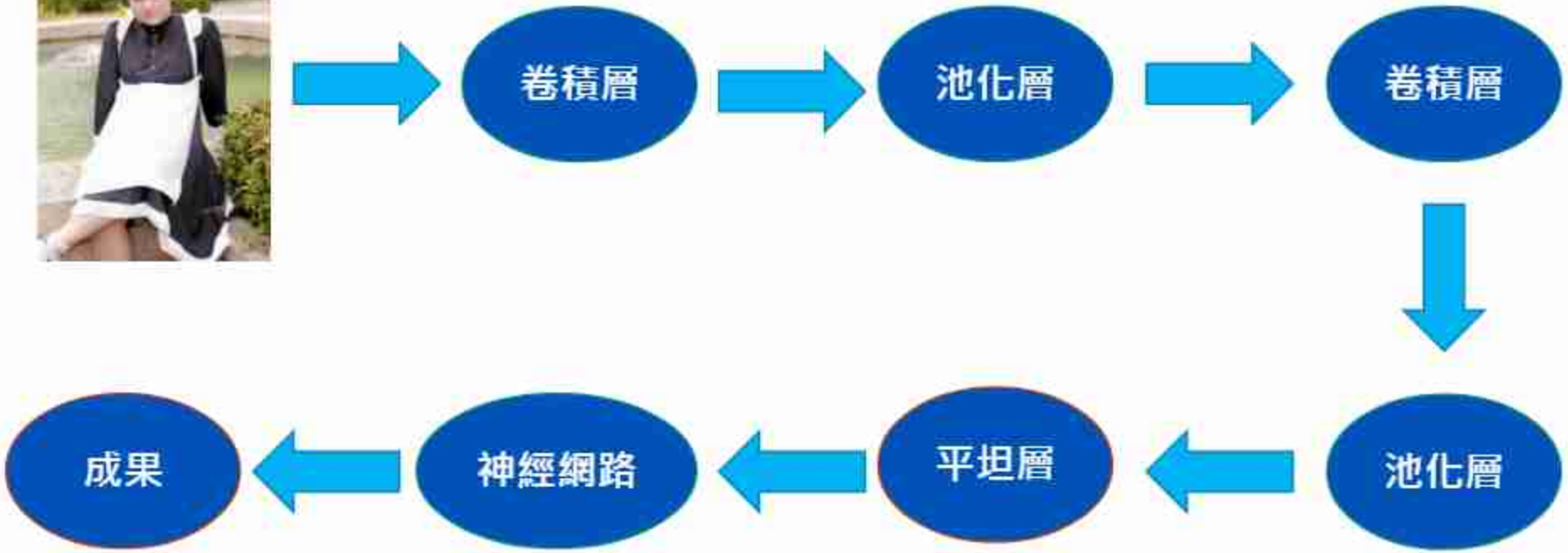
Max Pooling



平坦層



CNN



跑道製作、蒐集資料

軟體

FileZilla

可以一次將多個檔案或資料夾傳輸到遠方主機，且傳輸的速度也比較快。

Anaconda

主要能夠解決Python版本或路徑的不相容問題，並能夠快速安裝所需的Python套件

軟體

Tensorflow

是一個開源軟體庫，用於各種感知和語言理解任務的機器學習。

Python

是一種廣泛使用的直譯式、進階和通用的程式語言。Python支援多種程式設計範式，包括函數式、指令式、反射式、結構化和物件導向程式設計。

深度學習(PC端)

ANACONDA.

建立虛擬環境

```
(base) PS C:\Users\HP> conda create -n donkeycar
```

建立專屬的資料夾並進入

```
(donkeycar) PS C:\Users\ian> cd projects
```

下載**donkey**

https://github.com/autorope/donkeycar

深度學習(PC端)

安裝donkey car程式碼

```
(donkeycar) PS C:\Users\ian\projects\donkeycar-main> pip install -e .[pc]
Obtaining file:///C:/Users/ian/projects/donkeycar-main
  Preparing metadata (setup.py) ... done
Requirement already satisfied: numpy in c:\users\ian\anaconda3\envs\donkeycar\lib\site-packages (from donkeycar==4.3.24) (1.21.5)
Requirement already satisfied: pillow in c:\users\ian\anaconda3\envs\donkeycar\lib\site-packages (from donkeycar==4.3.24) (9.2.0)
Requirement already satisfied: docopt in c:\users\ian\anaconda3\envs\donkeycar\lib\site-packages (from donkeycar==4.3.24) (0.6.2)
Requirement already satisfied: tornado in c:\users\ian\anaconda3\envs\donkeycar\lib\site-packages (from donkeycar==4.3.24) (6.2)
Requirement already satisfied: requests in c:\users\ian\anaconda3\envs\donkeycar\lib\site-packages (from donkeycar==4.3.24) (2.28.1)
Requirement already satisfied: h5py in c:\users\ian\anaconda3\envs\donkeycar\lib\site-packages (from donkeycar==4.3.24) (2.8.0)
Requirement already satisfied: PrettyTable in c:\users\ian\anaconda3\envs\donkeycar\lib\site-packages (from donkeycar==4.3.24) (3.4.1)
Requirement already satisfied: paho-mqtt in c:\users\ian\anaconda3\envs\donkeycar\lib\site-packages (from donkeycar==4.3.24) (1.6.1)
Collecting simple_pid
```

名稱可自己設定

```
(donkeycar) PS C:\Users\ian\projects\donkeycar-main> donkey createcar --path ~/d2
```

深度學習(PC端)

data	2022/11/20 上午 06:54	檔案資料夾	
logs	2022/11/20 上午 06:50	檔案資料夾	
models	2022/11/20 上午 07:20	檔案資料夾	
calibrate	2022/11/20 上午 06:50	Python 來源檔案	5 KB
config	2022/11/20 上午 06:50	Python 來源檔案	33 KB
manage	2022/11/20 上午 06:50	Python 來源檔案	43 KB
myconfig	2022/11/20 上午 06:50	Python 來源檔案	35 KB
train	2022/11/20 上午 06:50	Python 來源檔案	1 KB

深度學習(資料傳輸)

gmail

應用軟體

深度學習(資料訓練)

```
donkeycar) PS C:\Users\ian\d2> donkey train --tub ./data --model ./models/mypilot.h5
```

```
Epoch 29/100
32/32 [==============================] - ETA: 0s - loss: 0.0751 - n_outputs0_loss: 0.0744 - n_outputs1_loss: 7.2268e-04
Epoch 00029: val_loss improved from 0.09377 to 0.09366, saving model to C:\Users\HP\mycar\models\mypilot.h5
32/32 [==============================] - 33s 1s/step - loss: 0.0751 - n_outputs0_loss: 0.0744 - n_outputs1_loss: 7.2268e-04 - val_loss: 0.0937 - val_n_outputs0_loss: 0.0934 - val_n_outputs1
_loss: 2.7808e-04
Epoch 30/100
32/32 [==============================] - ETA: 0s - loss: 0.0834 - n_outputs0_loss: 0.0827 - n_outputs1_loss: 7.0400e-04
Epoch 00030: val_loss did not improve from 0.09366
32/32 [==============================] - 36s 1s/step - loss: 0.0834 - n_outputs0_loss: 0.0827 - n_outputs1_loss: 7.0400e-04 - val_loss: 0.0955 - val_n_outputs0_loss: 0.0952 - val_n_outputs1
_loss: 2.4590e-04
Epoch 31/100
32/32 [==============================] - ETA: 0s - loss: 0.0723 - n_outputs0_loss: 0.0716 - n_outputs1_loss: 6.5364e-04
Epoch 00031: val_loss did not improve from 0.09366
32/32 [==============================] - 43s 1s/step - loss: 0.0723 - n_outputs0_loss: 0.0716 - n_outputs1_loss: 6.5364e-04 - val_loss: 0.0966 - val_n_outputs0_loss: 0.0964 - val_n_outputs1
_loss: 2.1450e-04
Epoch 32/100
32/32 [==============================] - ETA: 0s - loss: 0.0737 - n_outputs0_loss: 0.0731 - n_outputs1_loss: 6.4220e-04
Epoch 00032: val_loss did not improve from 0.09366
32/32 [==============================] - 33s 1s/step - loss: 0.0737 - n_outputs0_loss: 0.0731 - n_outputs1_loss: 6.4220e-04 - val_loss: 0.0945 - val_n_outputs0_loss: 0.0943 - val_n_outputs1
_loss: 2.2672e-04
Epoch 33/100
32/32 [==============================] - ETA: 0s - loss: 0.0751 - n_outputs0_loss: 0.0745 - n_outputs1_loss: 6.6341e-04
Epoch 00033: val_loss improved from 0.09368 to 0.09232, saving model to C:\Users\HP\mycar\models\mypilot.h5
32/32 [==============================] - 39s 1s/step - loss: 0.0751 - n_outputs0_loss: 0.0745 - n_outputs1_loss: 6.6341e-04 - val_loss: 0.0923 - val_n_outputs0_loss: 0.0921 - val_n_outputs1
_loss: 2.5215e-04
Epoch 34/100
32/32 [==============================] - ETA: 0s - loss: 0.0688 - n_outputs0_loss: 0.0682 - n_outputs1_loss: 6.1208e-04
Epoch 00034: val_loss improved from 0.09232 to 0.09079, saving model to C:\Users\HP\mycar\models\mypilot.h5
32/32 [==============================] - 33s 1s/step - loss: 0.0688 - n_outputs0_loss: 0.0682 - n_outputs1_loss: 6.1208e-04 - val_loss: 0.0908 - val_n_outputs0_loss: 0.0906 - val_n_outputs1
_loss: 2.2935e-04
Epoch 35/100
26/32 [=======================>......] - ETA: 6s - loss: 0.0705 - n_outputs0_loss: 0.0699 - n_outputs1_loss: 5.7626e-04
```

深度學習(訓練模組)

database.json	2022/11/17 下午 06:15	JSON 來源檔案	23 KB
mypilot.h5	2022/11/17 下午 06:12	H5 檔案	9,665 KB
mypilot.png	2022/11/17 下午 06:15	PNG 檔案	23 KB
mypilot.tflite	2022/11/17 下午 06:15	TFLITE 檔案	3,197 KB

自駕指令

```
(env) pi@raspberrypi:~/mycar $ python manage.py drive --model ~/mycar/models/mypilot.h5
```

```
using donkey v4.4.0 ...
INFO:donkeycar.config:loading config file: /home/pi/mycar/config.py
INFO:donkeycar.config:loading personal config over-rides from myconfig.py
INFO:__main__:PID: 705
cfg.CAMERA_TYPE PICAM
INFO:__main__:cfg.CAMERA_TYPE PICAM
INFO:donkeycar.parts.camera:PiCamera loaded...
INFO:donkeycar.parts.camera:PiCamera opened...
INFO:donkeycar.parts.camera:...warming camera
```

改變模式

Joystick Controls:

control	action
share	toggle_mode
circle	show_record_count_status
triangle	erase_last_N_records
cross	emergency_stop
L1	increase_max_throttle
R1	decrease_max_throttle
options	toggle_constant_throttle
R2	enable_ai_launch
left_stick_horz	set_steering
right_stick_vert	set_throttle

成果展示

未來展望

- 避障
- 在環境放明顯的物品來指引自駕車
- 依據指令到達相對應的位子(ex:送餐車)

參考文獻

- Donkey car 官方網站
- 【機器學習2021】卷積神經網路 (Convolutional Neural Networks, CNN)
- tf.keras 技術者們必讀！深度學習攻略手冊
- 驢車 (Donkey Car)，一個基於 Raspberry Pi 與機器學習的自走車專案介紹 — PyCon Taiwan 2019

Q&A

謝謝大家