基於 Microsoft AirSim 的無人自動駕駛系統

Date : 2022/04/22

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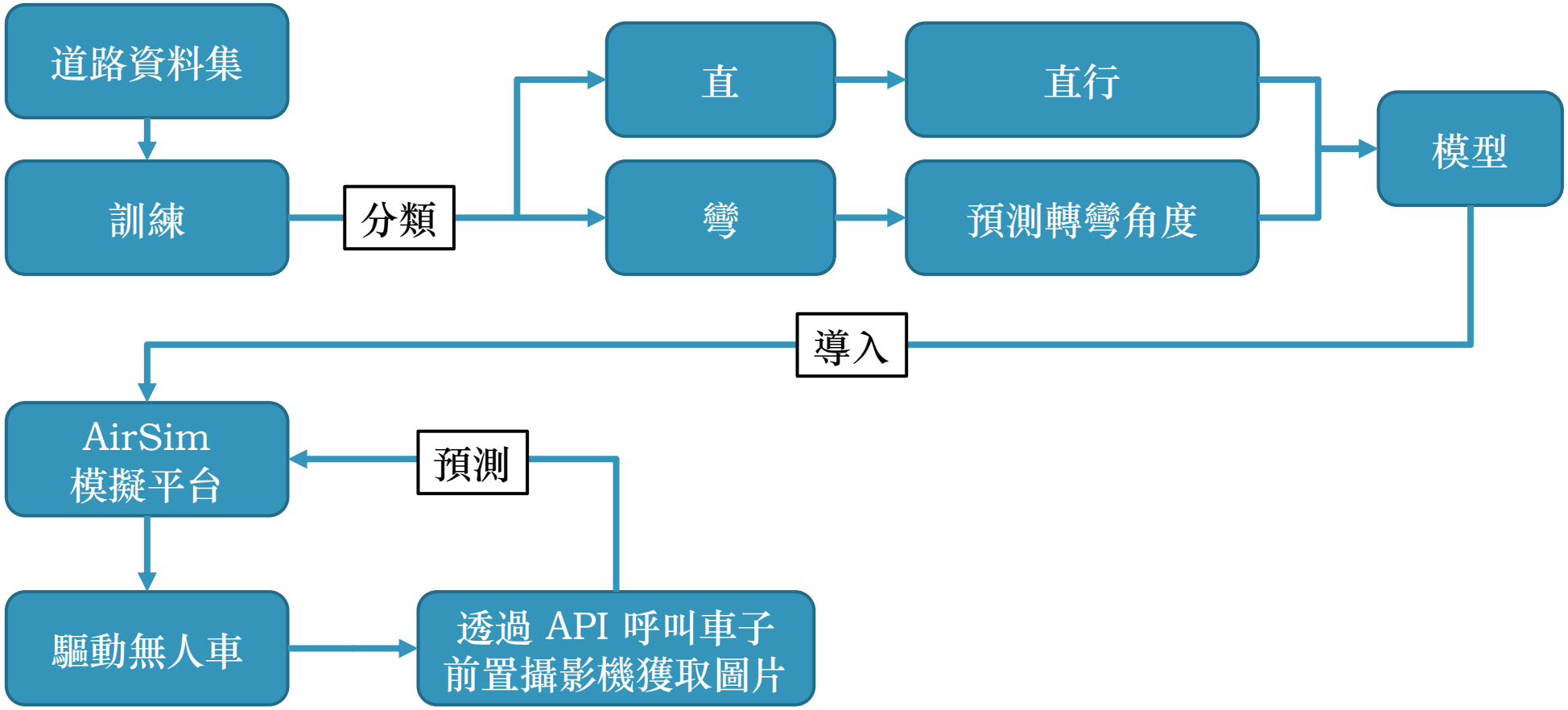
專案架構


道路資料集
訓練
分類
直
彎
直行
預測轉彎角度
模型
導入
AirSim
模擬平台
預測
驅動無人車
透過 API 呼叫車子
前置攝影機獲取圖片

DataSet

PyTorch

Loss
Acc

AirSim

Demo

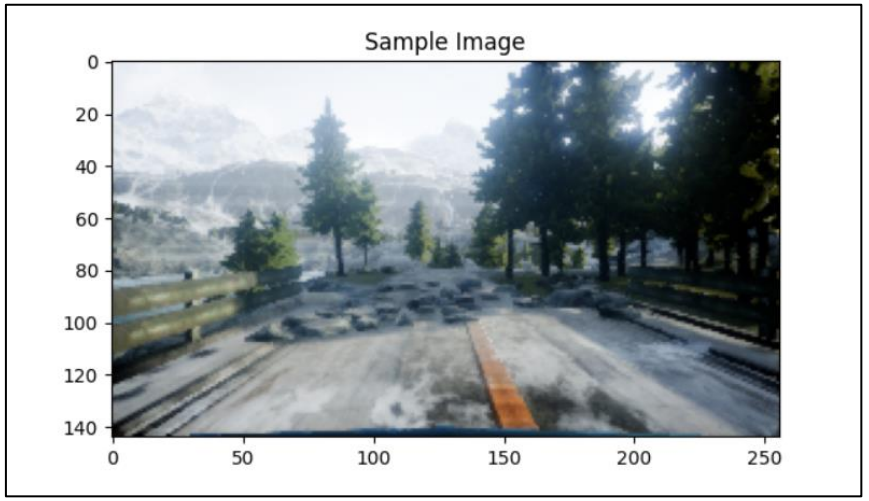
訓練檔案參數說明					
Timestamp	Speed (km/h)	Throttle	Steering	Gear	Image Name
時間戳	速度	加速度	轉彎角度	換擋	圖片名稱

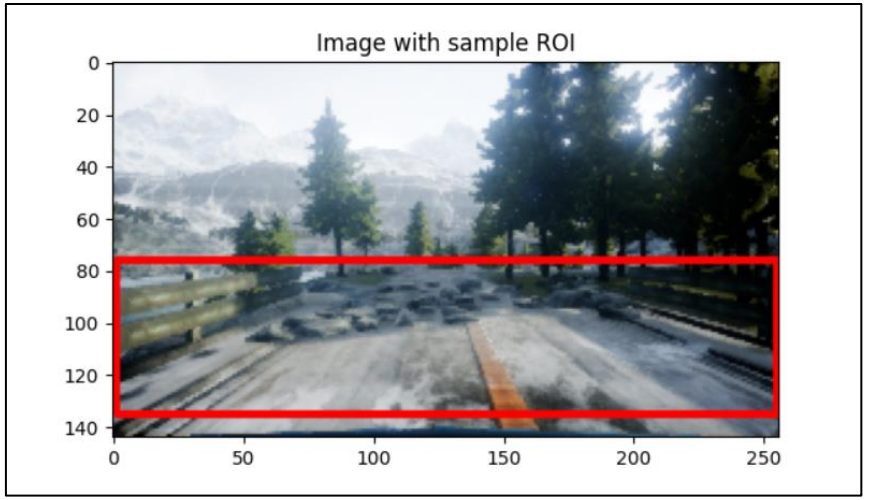
```
train_test_split = [0.9, 0.1]
full_path_raw_folders = [os.path.join(RAW_DATA_DIR, f) for f in DATA_F
def data_split(folders, output_directory, train_test_split):
    output_files = [os.path.join(output_directory, f) for f in ['train
    if (any([os.path.isfile(f) for f in output_files])):
        print("Preprocessed data already exists at: {0}. Skipping preprocessing.".format(output_directory))
```

資料集分割
訓練：測試 = 9：1

擷取所需以減少訓練成本

```
23  sample_tsv_path = os.path.join(RAW_DATA_DIR, 'normal/airsim_rec.txt')
24  sample_tsv = pd.read_csv(sample_tsv_path, sep='\t')
25  sample_tsv.head()
26
27  sample_image_path = os.path.join(RAW_DATA_DIR, 'normal/images/img_0.png')
28  sample_image = Image.open(sample_image_path)
29  plt.title('Sample Image')
30  plt.imshow(sample_image)
31  plt.show()
32
33  sample_image_roi = sample_image.copy()
34
35  fillcolor=(255,0,0)
36  draw = ImageDraw.Draw(sample_image_roi)
37  points = [(1,76), (1,135), (255,135), (255,76)]
38  for i in range(0, len(points), 1):
39      draw.line([points[i], points[(i+1)%len(points)]], fill=fillcolor, width=3)
40  del draw
41
42  plt.title('Image with sample ROI')
43  plt.imshow(sample_image_roi)
44  plt.show()
```





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```python
# GPU/CPU
device = torch.device('cpu')

train_transform = transforms.Compose(
    [transforms.Resize((224, 224)), transforms.ToTensor(), transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))]
)
```

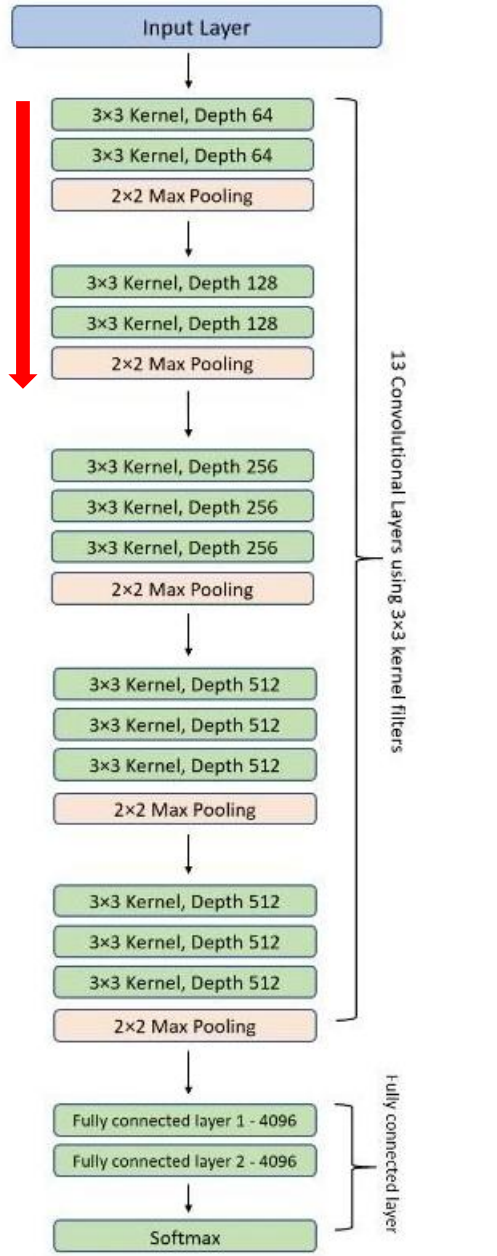
轉化成 224×224 的輸入特徵圖

```python
import torch
import torch.nn as nn
import torch.nn.functional as F

class VGG16(nn.Module):
    def __init__(self):
        super(VGG16, self).__init__()
        self.conv1_1 = nn.Conv2d(3, 64, 3) # 64 * 224 * 224
        self.conv1_2 = nn.Conv2d(64, 64, 3, padding=(1, 1)) # 64 *
        self.maxpool1 = nn.MaxPool2d((2, 2), padding=(1, 1)) # pooli
        self.conv2_1 = nn.Conv2d(64, 128, 3) # 128 * 110 * 110
        self.conv2_2 = nn.Conv2d(128, 128, 3, padding=(1, 1)) # 128
        self.maxpool2 = nn.MaxPool2d((2, 2), padding=(1, 1)) # pooli
        self.conv3_1 = nn.Conv2d(128, 256, 3) # 256 * 54 * 54
        self.conv3_2 = nn.Conv2d(256, 256, 3, padding=(1, 1)) # 256
        self.conv3_3 = nn.Conv2d(256, 256, 3, padding=(1, 1)) # 256
        self.maxpool3 = nn.MaxPool2d((2, 2), padding=(1, 1)) # pooli
        self.conv4_1 = nn.Conv2d(256, 512, 3) # 512 * 26 * 26
        self.conv4_2 = nn.Conv2d(512, 512, 3, padding=(1, 1)) # 512
        self.conv4_3 = nn.Conv2d(512, 512, 3, padding=(1, 1)) # 512
        self.maxpool4 = nn.MaxPool2d((2, 2), padding=(1, 1)) # pooli
        self.conv5_1 = nn.Conv2d(512, 512, 3) # 512 * 12 * 12
        self.conv5_2 = nn.Conv2d(512, 512, 3, padding=(1, 1)) # 512
        self.conv5_3 = nn.Conv2d(512, 512, 3, padding=(1, 1)) # 512
        self.maxpool5 = nn.MaxPool2d((2, 2), padding=(1, 1)) # pooli
        self.fc1 = nn.Linear(512 * 7 * 7, 4096)
        self.fc2 = nn.Linear(4096, 4096)
        self.fc3 = nn.Linear(4096, 1000)
        # softmax 1 * 1 * 1000
```

建立 VGG16

```python
def forward(self, x):
    x = self.conv1_1(x) # 224
    x = F.relu(x)
    x = self.conv1_2(x)
    x = F.relu(x)
    x = self.maxpool1(x) # 112
    x = self.conv2_1(x)
    x = F.relu(x)
    x = self.conv2_2(x)
    x = F.relu(x)
    x = self.maxpool2(x) # 56
    x = self.conv3_1(x)
    x = F.relu(x)
    x = self.conv3_2(x)
    x = F.relu(x)
    x = self.conv3_3(x)
    x = F.relu(x)
    x = self.maxpool3(x) # 28
    x = self.conv4_1(x)
    x = F.relu(x)
    x = self.conv4_2(x)
    x = F.relu(x)
    x = self.conv4_3(x)
    x = F.relu(x)
    x = self.maxpool4(x) # 14
    x = self.conv5_1(x)
    x = F.relu(x)
    x = self.conv5_2(x)
    x = F.relu(x)
    x = self.conv5_3(x)
    x = F.relu(x)
    x = self.maxpool5(x) # 7
    x = x.view(x.size(0), -1)
    x = self.fc1(x)
    x = F.relu(x)
    x = self.fc2(x)
    x = F.relu(x)
    x = self.fc3(x)
    x = F.log_softmax(x, dim=1)
    return x
```



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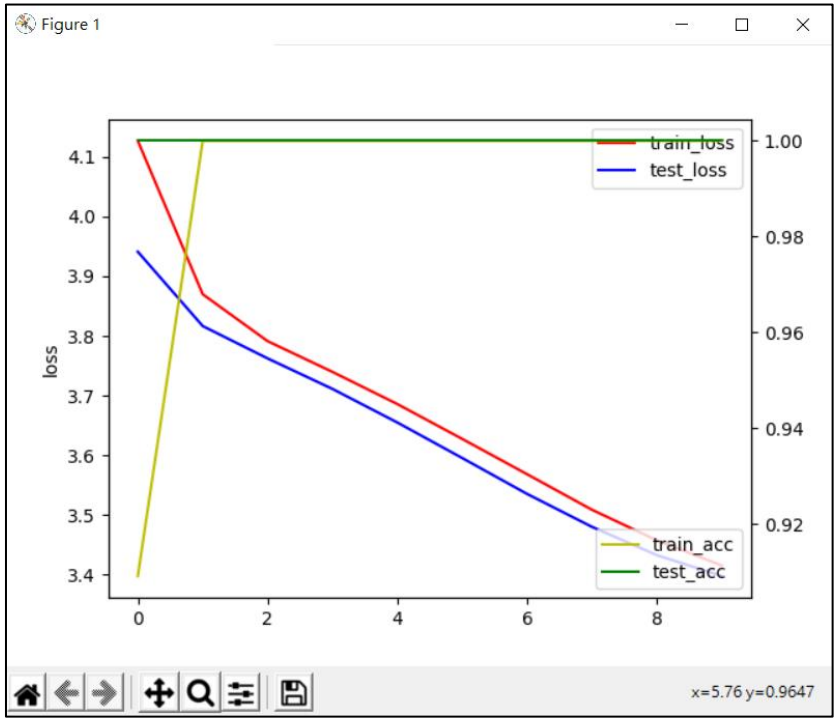


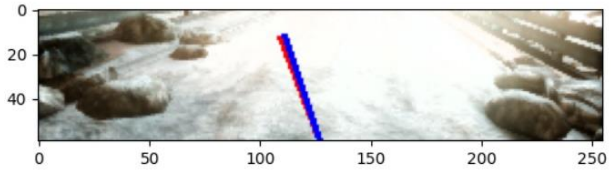
Best Loss : 3.397599
Best Acc : 1.0

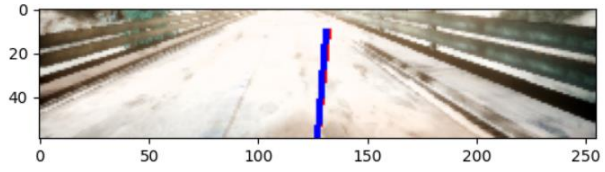
Epoch	Train Loss	Test Loss
0	4.126955	3.941048
1	3.869843	3.816520
2	3.791219	3.762283
3	3.739658	3.711134
4	3.685726	3.654823
5	3.627308	3.595281
6	3.568144	3.535111
7	3.508555	3.479923
8	3.457371	3.432542
9	3.415804	3.397599

```python
# predict steering angles
def draw_image_with_label(img, label, prediction=None):
    theta = label * 0.69  # Steering range for the car is +- 40 degrees -> 0.69 radians
    line_length = 50
    line_thickness = 3
    label_line_color = (255, 0, 0)
    prediction_line_color = (0, 0, 255)
    pil_image = image.array_to_img(img, k.image_data_format(), scale=True)
    print('Actual Steering Angle = {0}'.format(label))
    draw_image = pil_image.copy()
    image_draw = ImageDraw.Draw(draw_image)
    first_point = (int(img.shape[1]/2), img.shape[0])
    second_point = (int((img.shape[1]/2) + (line_length * math.sin(theta))),
    int(img.shape[0] - (line_length * math.cos(theta))))
    image_draw.line([first_point, second_point], fill=label_line_color, width=line_thickness)

    if prediction is not None:
        print('Predicted Steering Angle = {0}'.format(prediction))
        # print('L1 Error: {0}'.format(abs(prediction-label)))
        theta = prediction * 0.69
        second_point = (int((img.shape[1]/2) + (line_length * math.sin(theta))),
        int(img.shape[0] - (line_length *math.cos(theta))))
        image_draw.line([first_point, second_point], fill=prediction_line_color, width=line_thickness)

    del image_draw
    plt.imshow(draw_image)
    plt.show()
```

Epoch	Train Angle	Predicted Angle
0	-0.0685	-0.0615
1	-0.0039	0.0016
2	0.0622	0.0616
3	-0.3571	-0.3303
4	0.1060	0.1070
5	0.5652	0.4624
6	-0.1371	-0.1108
7	-0.0295	-0.3038
8	0.0058	0.0138
9	-0.2430	-0.2344

Train Steering Angle
Predicted Steering Angle





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AirSim 環境建置過程示意

```
選取 Developer Command Prompt for VS 2019 - build.cmd
**********************************************************************
** Visual Studio 2019 Developer Command Prompt v16.11.11

Expand-Archive
    正在擴充保存檔案 'D:\AirSimTest\AirSim\external\rpclib.zip'...
            [oooooooooooooooooooooooooooooo
]
D:\>cd AirSimTest

D:\AirSimTest>git clone https://github.com/Microsoft/AirSim.git
Cloning into 'AirSim'...
remote: Enumerating objects: 39718, done.
remote: Counting objects: 100% (12/12), done.
remote: Compressing objects: 100% (12/12), done.
remote: Total 39718 (delta 2), reused 5 (delta 0), pack-reused 39706
Receiving objects: 100% (39718/39718), 359.41 MiB | 7.05 MiB/s, done.
Resolving deltas: 100% (25687/25687), done.
Updating files: 100% (1425/1425), done.

D:\AirSimTest>cd AirSim  進入剛 git 下來的 AirSim

D:\AirSimTest\AirSim>build.cmd  build.cmd 開始編譯
found Powershell
Found cmake version: 3.20.21032501-MSVC_2


**********************************************************************
Downloading rpclib
**********************************************************************
```

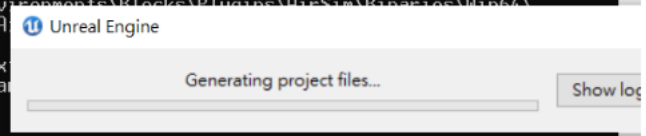
```
C:\Program Files (x86)\Microsoft Visual Studio\2019\Community>D:

D:\>cd Airsim\Unreal\Environments\Blocks  進入 Blocks

D:\AirSim\Unreal\Environments\Blocks>update_from_git.bat 執行指令
Using AirSimPath = ..\..\..
        *EXTRA Dir        -1    D:\AirSim\Unreal\Environments\Blocks\Plugins\AirSim\Binaries\
        *EXTRA Dir        -1    D:\AirSim\Unreal\Environments\Blocks\Plugins\AirSim\Binaries\Win64\
        *EXTRA File              5.9 m        D:\A
es\Win64\UE4Editor-AirSim-Win64-DebugGame.dll
2022/03/22 23:44:16 ERROR 5 (0x00000005) Deleting Ex
AirSim\Binaries\Win64\UE4Editor-AirSim-Win64-DebugGa
Access is denied.

        *EXTRA File            94.9 m        D:\AirSim\Unreal\Environments\Blocks\Plugins\AirSim\Binari
es\Win64\UE4Editor-AirSim-Win64-DebugGame.pdb
2022/03/22 23:44:16 ERROR 5 (0x00000005) Deleting Extra File D:\AirSim\Unreal\Environments\Blocks\Plugins\
AirSim\Binaries\Win64\UE4Editor-AirSim-Win64-DebugGame.pdb
Access is denied.

        *EXTRA File             103        D:\AirSim\Unreal\Environments\Blocks\Plugins\AirSim\Binari
```



完成之後，會在 Airsim\Unreal\Environments\Blocks 生成 Blocks.sln

```
D:\AirSim\Unreal\Environments\Blocks>(
echo Generating files for Blocks.uproject
 "D:\Epic\Epic Games\Launcher\Engine\Binaries\Win64\UnrealVersionSelector.exe" /projectfiles "D:\AirSim\Un
real\Environments\Blocks\Blocks.uproject"
)
Generating files for Blocks.uproject
Press any key to continue . . .
```

1

```python
MODEL_PATH = "model.pt"
print('Using model {0} for testing.'.format(MODEL_PATH))

model = VGG16()
model.load_state_dict(torch.load(MODEL_PATH))
model.eval()
```

導入模型

2

```python
# connect to AirSim server
client = airsim.CarClient()
client.confirmConnection()
client.enableApiControl(True)
car_controls = airsim.CarControls()

print('-----------------------')
print('Connection established!')
print('-----------------------')
```

API 連接

```python
# ----------------------------------  Car APIs ---------
class CarClient(AirSimClientBase, object):
    def __init__(self, ip = ""):
        if (ip == ""):
            ip = "127.0.0.1"
        super(CarClient, self).__init__(ip, 42451)

    def setCarControls(self, controls):
        self.client.call('setCarControls', controls)

    def getCarState(self):
        state_raw = self.client.call('getCarState')
        return CarState.from_msgpack(state_raw)
```

API 設定

3

```python
car_controls.steering = 0
car_controls.throttle = 0
car_controls.brake = 0

image_buf = np.zeros((1, 59, 255, 3))
state_buf = np.zeros((1,4))
```

參數初始化

4

```python
def get_image():
    image_response = client.simGetImages([client.simGetImage(
    image1d = np.fromstring(image_response.image_data_uint8,
    image_rgba = image1d.reshape(image_response.height, image

    return image_rgba[76:135, 0:255, 0:3].astype(float)
```

獲取 img

5

```python
# Control block to run the car
while (True):
    car_state = client.getCarState()

    if (car_state.speed < 5):
        car_controls.throttle = 1.0
    else:
        car_controls.throttle = 0.0

    image_buf[0] = get_image()
    state_buf[0] = np.array([car_controls.steering, car_controls.throttle, car_controls.brake, car_state.speed])
    model_output = model.predict([image_buf, state_buf])
    car_controls.steering = round(0.5 * float(model_output[0][0]), 2)

    print('Sending steering = {0}, throttle = {1}'.format(car_controls.steering, car_controls.throttle))

    client.setCarControls(car_controls)
```

保持 5km/h

預測

控制

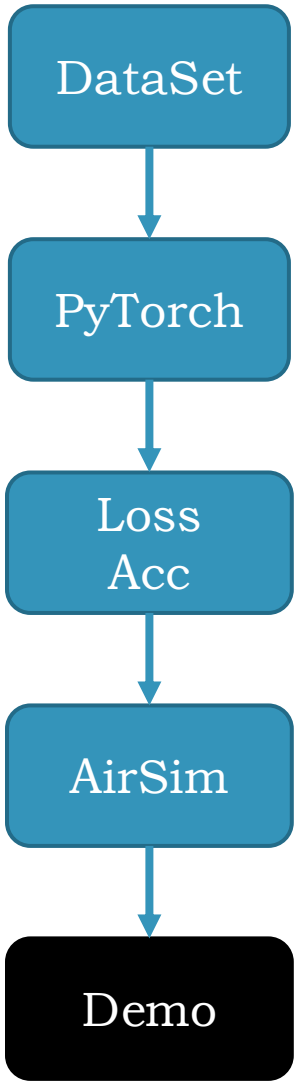
Loaded settings from C:\Users\myg36\Documents\AirSim\settings.json

```
{
    "SimMode": "Car",
    "ClockType": "",
    "ClockSpeed": 1,
    "LocalHostIp": "127.0.0.1",
    "ApiServerPort": 41451,
    "RecordUIVisible": true,
    "LogMessagesVisible": true,
    "ViewMode": "",
    "RpcEnabled": true,
    "EngineSound": true,
    "PhysicsEngineName": "",
    "SpeedUnitFactor": 1.0,
    "SpeedUnitLabel": "m/s",
    "Wind": { "X": 0, "Y": 0, "Z": 0 },
    "CameraDirector": {
      "FollowDistance": -3
    },
    "Recording": {
      "RecordOnMove": false,
      "RecordInterval": 0.05,
      "Folder": "",
      "Enabled": false,
      "Cameras": [
          { "CameraName": "0", "ImageType": 0, "PixelsAsFloat": false,  "VehicleName": "", "Compress": true }
      ]
    },
    "CameraDefaults": {
      "CaptureSettings": [
```

設定檔載入

載入 paper 提供之建模環境

```
Configuring AirSim for scenario landscape...
Creating configuration JSON for scenario landscape...
Attempting to write configuration json to C:\Users\myg36\Documents\AirSim\settings.json...
Configuration json successfully written.
Starting AirSim for scenario landscape...
```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