Learning for Self-Driving Cars and Intelligent Systems

Project 2

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Task Description:

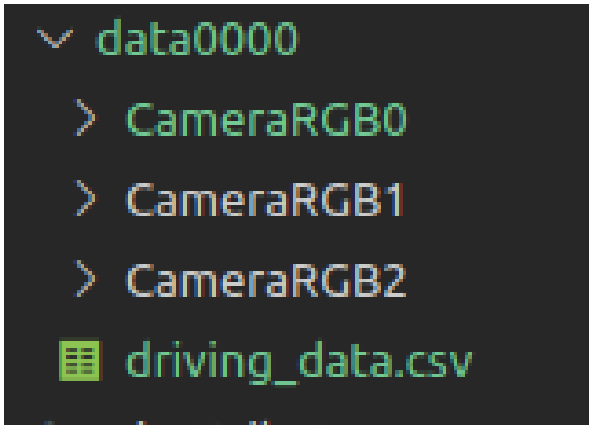
To implement a neural network for predicting the steering angle of a vehicle, using the dataset gained by CARLA simulator, by 3 cameras on the vehicle.

Dataset Preparation:

RGB images was captured using CARLA simulator in autopilot mode, without other cars, with 3 cameras on it, the RGB0 represents the one in the middle, the RGB1 is the one on the left by 0.5 meter, and the RGB2 means the right one with 0.5 meter distance. All driving data was saved in a csv. file, includes steering, position etc., only steering value would be used in this task.

One data should contain 3 corresponding images from 3 cameras, and a steering value.

In order to combine 3 image and their position value, I introduced a fourth channel for each image, which is their position away from the middle camera. In the end I combine 3 four-channel images together, becoming a 12 channel tensor.



Model Structure:

As introduced before, a tensor of shape (batch size, 12, 512, 512) would be the model input. Here I choose an ALEXnet like structure, since this task is a little complicated for a model, to predict steering angle based on 3 images. There are totally 5 convolutional layers, between them there are max pooling layers and

activation layers. In the end, 3 linear layers (dense) were used to handle the output, which is a 1 element tensor, representing the predicted steering angle.

Training:

Here I used Mean square Loss, since this is a regression task in the end. Optimizer was chosen of Adam, with weigt decay. 1 epochs of training was performed with a significant loss decrease. The calculation and time consumption was not huge and batch size =12 could be accepted. But the training was not stable, since there are too many pictures representing the straight moving, which has a little valu of steering angle, this leads to the difficulties of training.

```
Epoch 0 Counter 1 Current loss 421.5646057128906
Epoch 0 Counter 2 Current loss 0.2263036072254181
Epoch 0 Counter 3 Current loss 0.1004977822303772
Epoch 0 Counter 4 Current loss 2.5637001991271973
Epoch 0 Counter 5 Current loss 6.252585411071777
Epoch 0 Counter 6 Current loss 10.587952613830566
Epoch 0 Counter 7 Current loss 2.686375379562378
Epoch 0 Counter 8 Current loss 0.020107939839363098
Epoch 0 Counter 9 Current loss 0.16682755947113037
Epoch 0 Counter 10 Current loss 0.049661606550216675
Epoch 0 Counter 11 Current loss 0.02784722112119198
Epoch 0 Counter 12 Current loss 0.004642525687813759
Epoch 0 Counter 13 Current loss 0.009485680609941483
Epoch 0 Counter 14 Current loss 0.028431396931409836
Epoch 0 Counter 15 Current loss 0.00024485046742483974
Epoch 0 Counter 16 Current loss 0.00029996383818797767
Epoch 0 Counter 17 Current loss 0.000355550175299868
Epoch 0 Counter 18 Current loss 0.0001960706722456962
Epoch 0 Counter 19 Current loss 0.0001037522015394643
```

Prediction:

Testing result from a random frame:

During inference a new data containing 12 channels from 3 images was chosen as input. After loading the checkpoint we could see the result. The first line in the picture was the prediction of steering angel from the model. The second line in the picture is the true value from the simulator.

Further Works:

1. The result of this task is not satisfying, because in the dataset there are too many straight moving. So, in the future, a specific training should be implemented on the turning area.
2. Difficulty with Carla simulator, it doesn't perform well on my setting, which leads to the difficulty of capturing raw data with high quality.