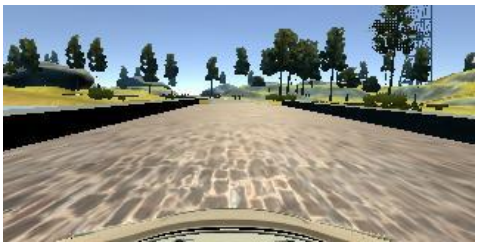
Behavioral Cloning

The steps of this project are the following:

1. Collecting data by driving the car in the simulator:

   I drove the track with recording on to get the training data. I drove the track two times, I tried to drive in the center of the road, and recovering back from left/right to the center of the road.




2. In model.py, I build my model on multiple stages:

   a. Preprocessing Data:

      I considered the three camera images, and adjust the measurement accordingly(steering), so finally I have 3 images for every instant and three measurements. I added a correction factor 0.2 so if the image is taken from the left camera, I added the correction factor, and I subtracted it in case of right image.

   b. Data Augmentation:

      I flipped the images and the steering measurements in order to have more images to train the network.

   c. Building a convolution neural network:

      I used NVIDIA architecture, I added a cropping layer to remove pixels from the up and the bottom of the image that are not helpful. I faced also an overfitting problem where the training loss error was good while the validation loss was increasing so I removed one convolution layer at the end.

Here is the model layers:

Layer (type)	Output Shape	Param #
lambda_1 (Lambda)	(None, 160, 320, 3)	0
cropping2d_1 (Cropping2D)	(None, 65, 320, 3)	0
conv2d_1 (Conv2D)	(None, 31, 158, 24)	1824
conv2d_2 (Conv2D)	(None, 14, 77, 36)	21636
conv2d_3 (Conv2D)	(None, 5, 37, 48)	43248
conv2d_4 (Conv2D)	(None, 3, 35, 64)	27712
flatten_1 (Flatten)	(None, 6720)	0
dense_1 (Dense)	(None, 100)	672100
dense_2 (Dense)	(None, 50)	5050
dense_3 (Dense)	(None, 10)	510
dense_4 (Dense)	(None, 1)	11

d. Compiling the model, I used adam optimizer, so I don't have to change the learning rate manually.
e. I trained the model on training and validation set and observe the mean squared error to determine the overfitting and underfitting.

3. Drive the car autonomously using the model created (model.h5), the car drives the track without leaving the road.