END TO END LEARNING FOR VISUAL NAVIGATION

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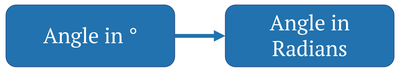
Abstract

An important component in autonomous vehicles is visual navigation. We used an ordered sequence of frames recorded at the front of the car to obtain the steering angle using an end to end approach. Based on these images, we also computed the optical flow over adjacent frames to get additional motion information as input to our network and added an LSTM cell after the convolutional layers.
Our approach is based on the network proposed in Bojarski et al.[1] consisting of five convolutional and three fully connected layers using the human steering angle as training signal. As this model did not fully exploit the temporal information of image sequences, we extended this architecture by training an additional convolutional network with optical flow calculated from the original images as input and optimizing the combined loss. As this approach yielded good results, we trained a second network consisting of a *Long-Short term memory* (LSTM) cell instead of the fully connected layers.

Data Preprocessing

Images

Labels



Training

Original Model

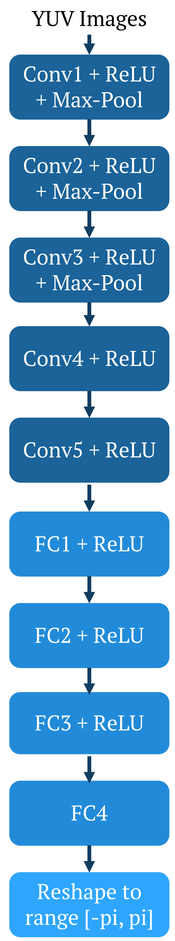
Optical Flow Model

Optical Flow + LSTM Model

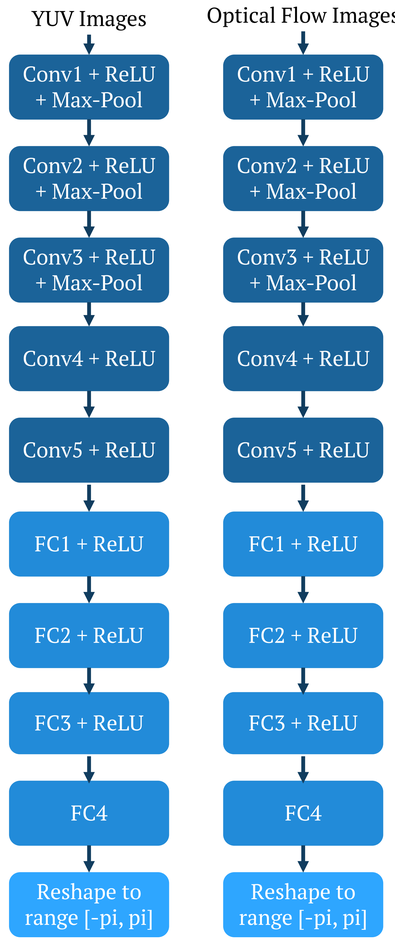
Results

Architectures

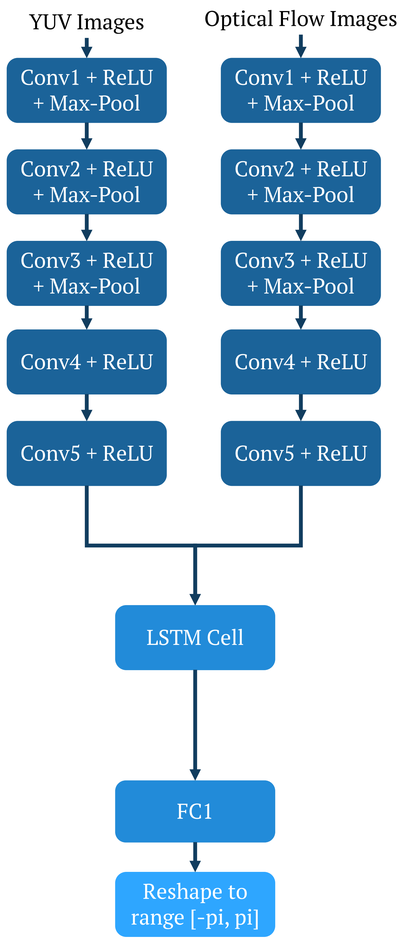
Original Model



Optical Flow Model



Optical Flow + LSTM Model



Loss Functions

Original Model

$$loss = \sum (y - labels)^2$$

Optical Flow Model

$$loss = \sum (y_{orig} - labels)^2 + \sum (y_{opt} - labels)^2$$

Optical Flow + LSTM Model

$$loss = \sum (y - labels)^2$$

Optimizer

We used Adam for all three models.

References

[1] M. Bojarski, D. D. Testa, D. Dworakowski, B. Firner, B. Flepp, P. Goyal, L. D. Jackel, M. Monfort, U. Muller, J. Zhang, X. Zhang, J. Zhao, and K. Zieba. End to end learn- ing for self-driving cars. *CoRR*, abs/1604.07316, 2016. 1, 2