Fakultät für
Elektrotechnik und
Informationstechnik

Lehrstuhl für
Regelungssystemtechnik

Master Thesis:
Deep Learning for Mobile Robot Navigation
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This thesis investigates deep learning [1] for the acquisition of an obstacle avoidance from planned trajectories. The robot learn a navigation behavior from a dataset of sensor input and motor commands recorded by means of a global navigation architecture (ROS navigation stack). The obstacle avoidance behavior relies either on laser range data or a local cost map of obstacles in conjunction with a goal pose. Since training deep networks depends on huge dataset augmentation of the recorded data has to be considered to achieve satisfactory generalization. A major challenge is to represent the perceptual raw data in a manner that is adequate for prediction of control actions. The thesis is supposed to investigate the utilization of auto-encoder networks for dimensionality reduction. A conventional recursive neural network (time-delay network) is trained to predict the steering direction.
The thesis should investigate convolutional neural networks (CNN) to learn the policy [2]. The laser range data unfolded in time provides the input the CNN which is processed through several convolution layers. The final fully connected layer maps the learned features to a set of discrete motor commands (classifier). An optional part of the thesis is to investigate deep recurrent networks for the policy learning. The thesis should provide a comparative analysis among deep and shallow neural networks w.r.t. ability to mimic the planner based navigation behavior. The thesis is supposed to analyze differences between range sensor perceptual data and local cost-map information.

Literature:

[1] Deep Learning, MIT Press, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016
[2] Deep Active Learning for Autonomous Navigation, Ahmed Hussein, Mohamed Medhat Gaber, Eyad Elyan, 2016

Proposed approach:

1. Literature survey and relation to state of the art
2. Collection of extensive training data in simulation (Stage) and experiment in the IRF environment with ROS navigation stack and TEB local planner.
3. Conception and implementation of data augmentation of laser range data
4. Deep learning of an autoencoder network for feature extraction of raw laser and map data
5. Implementation and evaluation of convolutional neural network for policy learning
6. Implementation and evaluation of deep recurrent networks for policy learning
7. Comparative analysis of network architectures and experimental validation on a Turtlebot.
8. Documentation and presentation of results

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