Mapless Navigation: A reinforcement learning approach

Graduate

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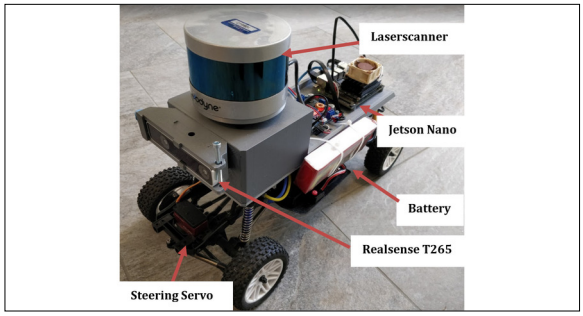
Introduction: Autonomous navigation from A to B in indoor environments is a widely researched field. Many known approaches are based on a mapping of the entire environment to calculate a path through the space in advance. This Master thesis proposes a new approach based on reinforcement learning (RL). It shows that a system can navigate by only using sensor data and system pose relative to a target—the method is based on the Robot Operating System (ROS) and Gazebo for simulation and training. To test the algorithms, a vehicle with Ackermann steering was realized and used.

Approach: In contrast to traditional machine learning, RL tries to maximize a reward claimed by an environment rather than finding a hidden structure in labelled data. In RL, an Agent gathers experiences by taking actions in the environment, which yields certain rewards and uses these experiences to form a policy for the most rewarding behaviour in its environment. Here, the Agent was trained to get as close to the target as possible.
To investigate the capabilities of the created RL navigation approach, experiments in simulation and real-world were conducted.

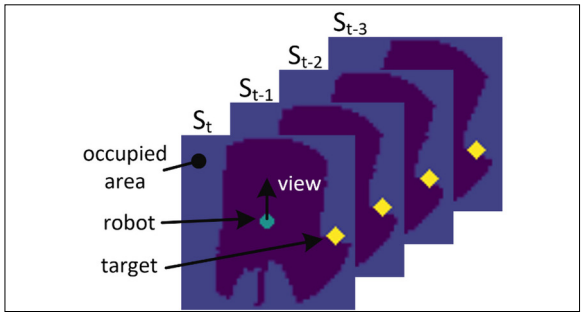
Result: The evaluation showed that it is possible to train an Agent in simulation and to deploy it to a real-world test vehicle without retraining or adapting any parameters.
However, the success rate of actually reaching the target with the defined tolerance (0.5 m radius) is rather low (20% in forwarding resp. 7% success rate in backward direction) compared to the approach with the state of the art TEB local planner (100% success rate). Nevertheless, the proposed method has potential because it neglects the need for complete maps, and less expensive variants of sensors do not affect the system performance, such as accuracy or reliability.

https://github.com/dschori/Ackerbot

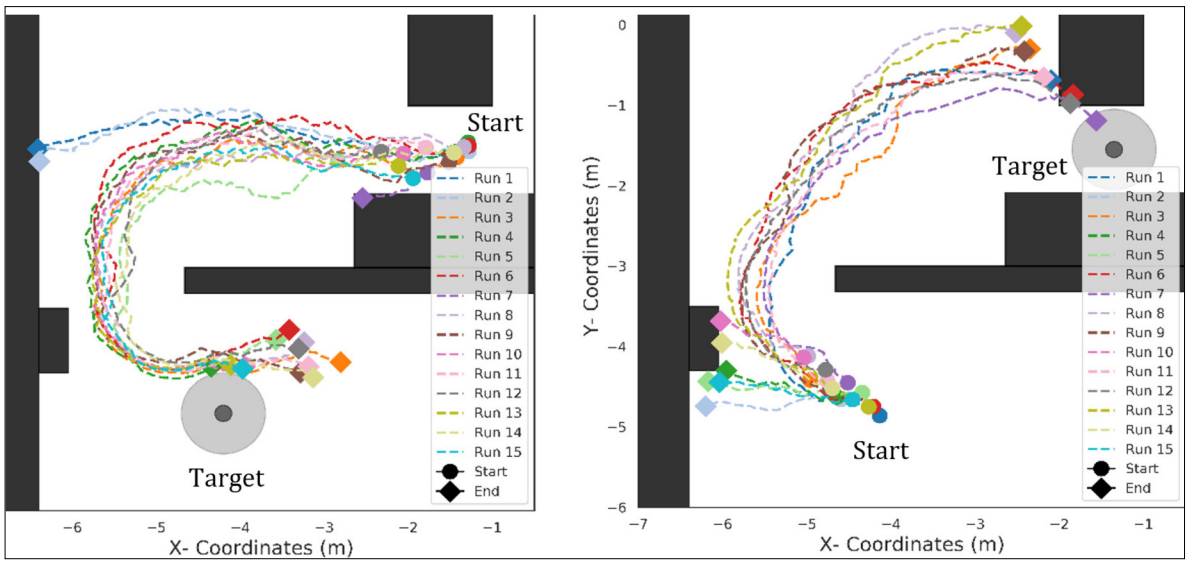
Test vehicle with Ackermann steering based chassis, the necessary sensors and Nvidia Jetson device for computing
Own presentment



State represented as an image which is seen by the reinforcement learning Agent with four time channels.
Own presentment



Trajectories of the vehicle using the reinforcement learning approach given only local map information
Own presentment



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