UNIVERSITY OF SOUTHERN DENMARK

Abstract

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Ph.d. thesis

Spatio-Temporal Vision for Human-Robot Interaction using Deep Learning

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Industrial mobile robots have for years been part of the production flow in factories all over the world. However, they are lacking capabilities required to move from the constrained environments of factory halls to unconstrained environments at, e.g., hospitals or nursing homes. Service robots are another class of mobile robots, which aim to operate in these unconstrained environments using better capabilities for human-robot interaction, etc. Operating in such environments requires constant semantic information of the surroundings, including the pose of people and objects.

As mobile processing units have seen en exponential increase in processing power and large amounts of training data have been released to the public, deep learning neural networks have begun to outperform all other algorithms in image recognition tasks. Neural networks can be used to estimate the state of surrounding people and objects, including their pose, size, and velocity, which gives the robot a lot of information to base its behaviors on. This thesis presents a so-called "SPA-map": a system for detecting semantics, predicting future states, and estimating affordances.

One of the behaviors which the SPA-map facilitates is social navigation. By combining semantic information about surrounding people with social space theory, a behaviour is created which predicts future collision points between people and the robot, which makes it able to preemptively avoid those paths.

The SPA-map is tested on the SMOOTH and Health-CAT robots, two service robots which were designed and built during the duration of this thesis. The SMOOTH-robot used the SPA-map to solve three distinct use cases: picking up and transporting laundry, guiding elderly people, and serving beverages. The Health-CAT robot was used to collect test data at a hospital.