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Darko Ojdanić

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Abstract

This thesis introduces novel motion planning algorithms, capable of dealing with manipulators with many degrees of freedom in complex environments. The focus lies on using Cartesian space information for the planning, which stands in contrast to contemporary motion planning approaches usually based on the configuration space. With the concepts presented in this work the planners achieve good computationally efficiency, which makes them suitable for realistic applications.

The developed algorithms could be separated in three conceptual parts. Firstly, the goal-seeking planner is introduced. This method guides the end effector of the manipulator throughout the workspace toward the goal. The planning is done stepwise, whereas in each step several directions are offered for the motion, where the obstacles, joint velocities and other robot-specific objectives are taken into account. The planner has good computational and path performances, but it can be blocked with in a "dead-end" obstacle constellation. The second part introduces a planner that is capable of solving also those kind of complex situations. It combines cell-decomposition with the graph search in Cartesian space, but in a manner that the overall kinematical structure of the manipulator is considered for the obstacle avoidance. Moreover, the particular joint limits are also taken into account. Its efficient usage of the workspace information results in a skilful planner with the calculation time suitable for the practical applications. Finally, a technique for improving the quality of planned paths is described. It combines the best characteristics of the Cartesian and configuration space, in order to efficiently increase the clearance and reduce the path length. Moreover, the method is independent from the applied motion planner.

The evaluation of developed methods is done twofold in this work: a comparison with the state-of-the-art planners was performed, and the implementation on a robotic system is achieved. The probabilistic roadmap method and the rapidly exploring random trees approach were implemented for the comparison, with more emphasis on latter one. The Cartesian planner developed here could show better performances for the calculation time as well as for the resulting path quality. Furthermore, the planners are realised and successfully run on a service robotic system containing a manipulator with seven degrees of freedom. The practical value of the developed methods is proved on several real scenarios.