Motion Planning for Industrial and Service Robots

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PROJECT DESCRIPTION:

Motivation & Objectives

The technology of producing robot manipulators as well as the advancement of motion planning algorithms enables many industries to be automated. This particularly leads to increased global productivity. However, there are still rooms for improvement in order to fully automate some complex tasks such as manipulation tasks. As time of task execution is a determining factor in industrial productivity, the planned motions need to be fast and dynamically feasible. Researchers aim to tackle the problem of complex manipulation tasks such as fine assembly, by taking dynamics constraints into consideration.

Methodology

Researchers propose to develop a novel planning algorithm which is capable of planning unimanual (one-arm) and bimanual (two-arm) manipulation motions for industrial manipulators while taking into account both kinematic and kinodynamic constraints.

Progress

- In this study of planning with kinodynamic constraints, researchers have developed an algorithm called AVP-BiRRT. This is an integration of a bidirectional RRT, which plans geometric paths and AVP algorithm, which verifies feasibility of geometrical paths based on given constraints. The superiority and efficiency of AVP-BiRRT was illustrated through computer simulations and a hardware experiment. Researchers have successfully planned a kinodynamically feasible "waiter motion" for an industrial manipulation, equipped with a tray at its end-effector, transporting a bottle through a small opening. The main difficulty lies in planning for kinodynamically feasible motions in such a scenario such that no quasi-statically stable motion exists. The video of the robot executing the motion can be found at https://youtu.be/LdZSjNwpJs0.
- Researchers have developed a pick-and-place manipulation planning algorithm for a single-arm manipulator which makes use of the proposed Grasp-Placement Table. The algorithm does not require heavy pre-processing, which is necessary for many existing manipulation planning algorithms, and is therefore suitable for solving single-query manipulation planning problems. The construction and use of Grasp-Placement Table helps improve both running time and quality of solutions compared to existing technologies. Apart from simulations, researchers also conducted an experiment on the hardward system to illustrate the potential of their planner. A video of the robot performing a pick-and-place manipulation task can be found at https://youtu.be/tLouwj0wITQ.

GRANT:

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PUBLICATIONS:

Refereed Journal (Published/In Press):

Q.-C. Pham, S. Caron, P. Lertkultanon, Y. Nakamura. Admissible Velocity Propagation: beyond quasi-static path planning for high-dimensional robots (under review).

Refereed Conference (Published/In Press):

P. Lertkultanon and Q.-C. Pham, A Single-Query Manipulation Planner. Submitted to ICRA 2016 (available online at http://arxiv.org/abs/1509.00600).

P. Lertkultanon and Q.-C. Pham, Dynamic non-prehensile object transportation. *Control Automation Robotics & Vision (ICARCV), 2014 13th International Conference on*, 2014.