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Guest Editors' Foreword

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In recent years there has been an upsurge of interest in a more algorithmic approach to solving critical problems in robotics. This is evidenced by the emergence of the Workshop on Algorithmic Foundations of Robotics (WAFR) as a forum that focuses on the foundational and algorithmic aspects of robotics.

A few years ago, this journal had a special issue on "Computational Robotics: Manipulation, Planning, and Control" [1] containing (by now classic) papers with a strong algorithmic flavor. The current special issue may be thought of as another checkpoint in this development in the field of robotics. The papers in this special issue all consider fundamental problems in robotics and attempt to lay some algorithmic foundations toward solving them; not surprisingly, most of these papers were presented initially in the 1996 Workshop on Algorithmic Foundations of Robotics [2]. In selecting these papers, we have attempted to capture both the breadth and the depth of this important field. We may characterize the set of papers presented here as being geared toward either *Motion Planning* or *Grasping and Manipulation*, arguably the two subfields of robotics with the strongest emphasis on algorithmic research.

The reader may find it useful and interesting to refer to the previous special issue [1], both for background information and to obtain a sense of the impressive progress in this discipline.

Motion Planning. The problem of planning sensor control strategies entails finding motions to move a sensor to an observation point as well as setting control parameters. Briggs and Donald give algorithms for computing visibility maps and use these to solve versions of the sensor control problem, such as determining the set of sensor placements from which a sensor has an unobstructed view of a polygonal target.

Brown and Donald consider the problem of localization, or determining a robot's location in the environment based on a map and sensor readings. They give precise algorithms for mobile robot localization using a point-and-shoot range sensor. They also describe a rasterized version of the algorithm.

LaValle begins by reminding us that path planning is just one step in the general setting of planning a strategy for motion. In analogy with configuration spaces as a mathematically tractable formulation of path planning, he develops a game-theoretic setting for general motion strategy planning.

Assembly planning involves determining a sequence of motions that take an initially separated collection of parts and produces an assembled product. Halperin, Latombe, and

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Wilson provide a general framework for studying this problem based on the concept of motion space which generalizes the notion of configuration space to assembly planning. They describe a representation of the constraints on the motion in terms of the so-called directional blocking graph. Some algorithmic techniques are also presented for reasoning within this framework.

Grasping and Manipulation. Teichmann and Mishra consider the issue of selecting a strong grasp of an object with n points where fingers can be placed. The goal is to minimize c, the number of fingers used for the grasp, while optimizing several measures of goodness. They present good approximation algorithms based on a reduction to convex set covering problems.

Akella, Huang, Lynch, and Mason tackle the problem of feeding parts onto a moving conveyor using a single-jointed arm. They describe planners and implementation results for such systems, including the case when there is no sensing required.

Sensorless manipulation of parts is the main focus of the paper by Böhringer, Bhatt, Donald, and Goldberg. Specifically, they explore the use of controlled vibrations of a surface to position and orient parts systematically without any force closure or sensory feedback.

The paper by Marigo, Ceccarelli, Piccinochi, and Bicchi considers the problem of rolling a polyhedral part resting on a plane, from a starting position to a final position. They describe a polynomial-time algorithm that approximately solves this problem: the algorithm reaches a final position that is close to the specified final position.

Sudsang, Ponce, and Srinivasa study grasping and manipulating parts that are gripped between two parallel plates, one of which is flat and the other contains rectangular pins that can be positioned in discrete steps. They describe the mechanics of this problem, an algorithm for solving it, and implementation studies.

Another sensorless model is consider by van der Stappen, Goldberg, and Overmars. They consider the number of push and push-squeeze gripper actions required for orienting a planar parts. They relate the manipulation complexity to a notion of eccentricity of the planar part, and show that the complexity can be bounded purely in terms of eccentricity and without reference to the part complexity.

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