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Guest Editorial
State-of-the-art in Underactuated Grasping

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We are pleased to present a special issue on the theme of underactuated grasping, which relates to the notion of having fewer actuators than degrees of freedom in a mechanism, in this case a grasper. The application of underactuation requires a mind shift to let go of the conventional full motion control paradigm. The idea is that the object shape determines the phalanx positions. Consequently, one gains a grasper that conforms itself to the objects due to its mechanics. In addition, the costs, weight and control effort of such graspers are reduced, because of the reduction of actuators. The challenge is to get a grip on the mechanics of underactuated graspers, such that their performance to grasp a wide variety of objects is exploited. By virtue of its potential simplicity and self-adaptability, underactuation in grasping has quietly progressed from an anecdotic topic and is currently perhaps the most promising source of innovative design in robotic hands.

Emphasis on design

This special issue is inspired by the First International Workshop on Underactuated Grasping that was organized at École Polytechnique de Montréal, Quebec, Canada, 19 August 2010. The goals of the workshop were to share and expand our mutual knowledge; to identify avenues for the industrial application of underactuated robotic hands; to identify open issues in the theoretical framework; and to define new collaborative research questions. This issue contains 16 papers from this workshop, covering a wide range of aspects in underactuated grasping. The emphasis is on new concepts and the design of fingers, robotic graspers and prosthetic hands. The emphasis on design can be understood by the fact that the performance of underactuated hands is mainly determined by the mechanical design. To substantiate the design choices, mathematical definitions and models to calculate the performance are needed. Several papers covering these aspects are included as well.

During the interactive sessions and the plenary discussion of the workshop, it became clear that agreement on performance metrics and clear definitions is needed for the research and development of underactuated hands. In addition, the design requirements and feedback from industry and prosthetic users on the use of underactuated hands are desired to direct future research. However, the demonstration of the underactuated hands during the interactive sessions convincingly showed that the state-of-the-art already has a big potential to safely and easily grasp a wide variety of objects.

Interactive workshop

If this is the first time you read about underactuaction in grasping, we welcome you to a flourishing and relatively young new domain of robotics. Most of the workshop participants have been working on this topic for more than a decade now. However, this work was often done in isolation and with almost no contact between them. Seeing the recent growth of activity and the emergence of this topic in the spotlights, this situation was deemed unacceptable and the decision was taken to gather a meeting calling for all researchers interested in this topic to share their experience. Taking advantage of the juxtaposition of the ASME International Design and Engineering Conferences in Montréal, the idea of a workshop rose. In this workshop, the papers were presented in lively interactive sessions (i.e. with poster boards and tables for demonstrators or videos) after one-minute plenary podium presentations. It is our great pleasure to see most of the papers published in this first issue of Mechanical Sciences and make this knowledge available to anyone interested.

We hope you enjoy reading this special issue as much as we enjoyed editing it and are enthusiastic to see what future work will arise from this convergence of ideas.

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