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Simulation-Based Planning and Design for Robotic Systems with Intermittent Contact

(Jeff Trinkle)

Abstract

One of the main weaknesses of intelligent robotic systems today is their inability to reason generally about contact. This prevents them from planning and performing grasping and dexterous manipulation in unstructured environments such as homes. In manufacturing settings, robotic workcells are typically highly structured with tight tolerances, so much so, that these "flexible" workcells have little flexibility and high implementation costs. These two issues alone present significant drags on the growth of the personal robotics market and penetration of robotic systems in the manufacturing of personalized and low-volume products.

Results in time-stepping methods for multibody systems, optimization techniques, and supporting software have presented roboticists (and their robots) with some of the technical components needed to support simulation-based planning and design tasks involving intermittent contact. In this talk, I will present a basic underlying multibody model and discuss its use in solving a range of problems from planning dexterous manipulation to the design of plate motions for vibratory manipulation. As will be seen, the power of simulation-based approaches are that they can yield solutions when human intuition completely fails and they can provide better solutions by considering possibilities outside of the designer's "comfort zone."

Bio

Jeff Trinkle received bachelor's degrees in Physics (1979) and Engineering Science and Mechanics (1979) from Ursinus College and Georgia Institute of Technology, respectively. In 1987, he received his PhD from the Department of Systems Engineering at the University of Pennsylvania, where he was a research assistant in the GRASP Laboratory. Since 1987, he has held faculty positions in the Department of Systems and Industrial Engineering at the University of Arizona and the Department of Computer Science at Texas A&M University. From 1998 to 2003 he was a visiting research scientist at Sandia National Laboratories in Albuquerque, New Mexico. He moved to Rensselear Polytechnic Institute in Troy, New York, in 2003, where he served as Chair of the Computer Science Department until 2009. He is now Professor of Computer Science and Director of the CS Robotics Lab.

Trinkle's primary research interests lie in the areas of robotic manipulation, multibody dynamics, and automated manufacturing. With continuous support from the National Science Foundation since 1988. One of his technical results (with David Stewart) was the first to

develop a popular method for simulating multibody systems. Variants of this method are key components of several physics engines for computer game development, for example, NVIDIA PhysX and the Bullet Physics Library. For his work in the area of robotic grasping and dexterous manipulation, Trinkle was elected Fellow of the IEEE in 2010. He will spend most of 2010 as a Humboldt Fellow at the Institute for Mechatronics and Robotics at the German Aerospace Center and the Institute for Applied Mechanics at Technical University of Munich.