LOCALLY NON-CONVEX CONTACT MODELS AND SOLUTION METHODS FOR ACCURATE PHYSICAL SIMULATION IN ROBOTICS.

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An Abstract of a Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major Subject: COMPUTER SCIENCE

The original of the complete thesis is on file
in the Rensselaer Polytechnic Institute Library

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Troy, New York

June 2011
(For Graduation August 2011)

ABSTRACT

In recent years, physical simulation has been becoming increasingly popular. In robotics, new designs of robots, new autonomous multi-robots motion planning, as well as new grasping strategies can be easily tested on computer thanks to physical simulation. In entertainment industry, physical simulation plays a significant role in the success of many computer games, block buster movies. Despite such achievements, in general, simulating multi-rigid bodies with friction is far from a solved problem. In fact, most current physical simulation libraries typically focus on only one type of application by making certain modeling choices. Such decisions affect the accuracy as well as performance of the simulations. I start the thesis by the discussions of physical, mathematical and computational backgrounds of physical simulation. Each of them represents a level of abstraction that involves a certain set of modeling choices. One main question I try to answer in this thesis is, what are the effects of different decisions on contact and friction approximation models and solution methods to the simulation's performance and accuracy. To answer this question, I present my studies on the modeling choices of existing simulation methods and the effects on the outcomes. The second focus of the thesis is to develop new models and solution methods that are faster and more accurate than current state-of-the-art methods. The new methods' development was inspired by the understandings of the advantages and disadvantages of existing methods. Generally, most computational tasks of the new methods proposed in this thesis are designed to run in parallel to be aligned with current multi-core evolution of computer hardware.