Two-dimensional circulation-preserving fluid simulation with discrete exterior calculus

Bachelor-Thesis by Sascha Räsch, Department of Mathematics
November 13, 2015
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Bachelor Thesis

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Abstract

Collision handling has been an active research topic in the area of the physically-based simulation of rigid and deformable bodies for many years. A common approach in interactive environments are discrete penalty forces, computing a repulsion forced based on the penetration at one moment in the time step. They provide low computational costs and good scalability, though they suffer from jitter and instability. Tang et al. [3] improved the approach of discrete penalty forces and introduced 2012 the continuous penalty forces (continuous penalty forces), continuously accumulating penalty forces along the penetration trajectory over the whole time step. Thereby, the jitter and instability issues are reduced. Although, the continuous penalty forces show artifacts especially for enduring contacts, precluding the simulation of sliding contacts.

In this thesis, we present a unified system to handle collisions between rigid and deformable bodies with friction. We modify the integration scheme by Bridson et al. [1] to handle rigid and deformable bodies, apply a CCD [2] and handle the detected collisions with continuous penalty forces [3]. We discuss the artifacts arising from the continuous penalty forces algorithm, examine methods to tackle them and apply the new methods to the continuous penalty forces algorithm. Finally, we analyze the results of the continuous penalty forces algorithm in comparison to discrete penalty forces, evaluate our new algorithm to handle the continuous penalty forces artifacts and inspect further improvements.

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Bibliography

[1] R. Bridson, R. Fedkiw, and J. Anderson. Robust treatment of collisions, contact and friction for cloth animation. In *Proceedings of the 29th annual conference on Computer graphics and interactive techniques*, SIGGRAPH '02, pages 594–603, New York, NY, USA, 2002. ACM. ISBN 1-58113-521-1. doi: 10.1145/566570.566623. URL http://doi.acm.org/10.1145/566570.566623.

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