

Constrain-based Deformable Object Simulations

This project aims to build an interactive system that can simulate different types of deformable objects such as strings, clothes, and volumetric bodies. The topic requires a knowledge of physics-based simulations involving partial differential equations and numerical methods. Moreover, good programming skills in C/C++ and ability to utilize open-source libraries are essential.



Objectives

In this project, you will build an interactive system, where users can load 3D object(s), set their material parameters such as stiffness, simulate their spatiotemporal changes following laws of physics, visualize their movements, and then save simulation results. To begin with, you will implement a simple yet efficient solver, Position Based Dynamics (PBD) [1]. This will be the base solver of the system. Once you successfully build the base system, you will replace the PBD solver with more advanced solvers. One popular candidate is the Projective Dynamics (PD) solver [2]. To this end, you will utilize an open-source library for linear algebra, Eigen¹. The two solvers, PBD and PD, can be further improved with the Fast Energy Projection (FEPR) algorithm [3]. You are strongly encouraged to lead this project for the potential extensions.

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References

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- [2] Sofien Bouaziz, Sebastian Martin, Tiantian Liu, Ladislav Kavan, and Mark Pauly. 2014. Projective dynamics: fusing constraint projections for fast simulation. *ACM Trans. Graph.* 33, 4, Article 154 (July 2014), 11 pages. <https://doi.org/10.1145/2601097.2601116>
- [3] Dimitar Dinev, Tiantian Liu, Jing Li, Bernhard Thomaszewski, and Ladislav Kavan. 2018. FEPR: fast energy projection for real-time simulation of deformable objects. *ACM Trans. Graph.* 37, 4, Article 79 (August 2018), 12 pages. <https://doi.org/10.1145/3197517.3201277>

¹ <https://gitlab.com/libeigen/eigen>