Geometric Computing Laboratory

Contacts in Elastic Sheets

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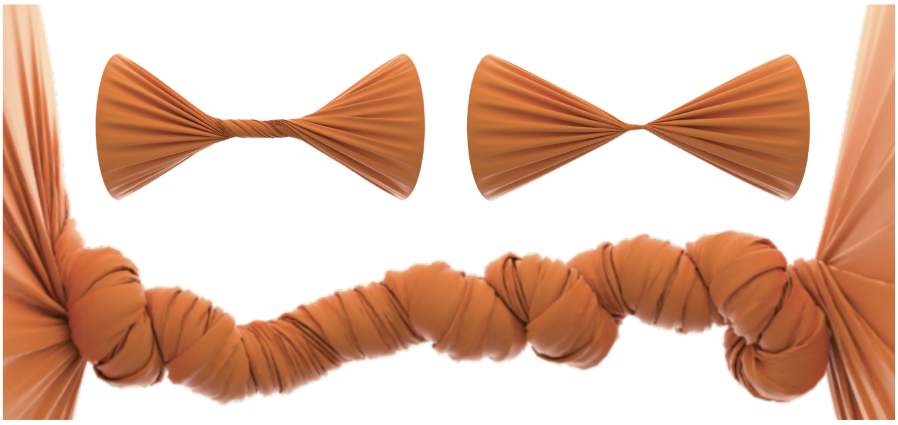

Figure 1: An elastic sheet undergoing extreme deformation. The deformation generates self-contacts, which need to be properly modeled to avoid simulating unphysical behavior.

Description

Elastic materials can undergo large deformations if loads and external constraints are applied. These deformations can bring points that are far apart in the material domain close to each other in space. In physical-based simulation, properly handling such cases is key to avoid potential self-intersections in the mesh.

We are interested in simulating contacts between elastic sheets while computing their equilibrium configurations. We currently have code that models elastic sheets as 2D meshes [1]. It is usually convenient to use a 2D mesh to model a thin sheet, but this means that collisions cannot be detected by testing intersections between tetrahedra. Continuous-time collision detection is needed. Following the detection of a contact, repulsive forces are used to preserve a thickness layer and prevent self-penetrations. Incremental Potential Contact (IPC) [2, 3] can be used to model contact forces in a variational formulation framework.

We would like to integrate IPC into an existing elastic sheet simulation framework. The student will start by studying the formulation of the energy minimization problem for elastic sheets, and the variational formulation of IPC. The goal will be to integrate IPC into the current Newton-based optimization algorithm used to compute equilibrium states of elastic sheets.

The project is designed for master students. Good knowledge of C++ and linear algebra is required.

References

[1] Grinspun, E., Y. Gingold, J. Reisman, and D. Zorin (2006). Computing discrete shape operators on general meshes. *Computer Graphics Forum 25*(3), 547–556.

[2] Li, M., Z. Ferguson, T. Schneider, T. Langlois, D. Zorin, D. Panozzo, C. Jiang, and D. M. Kaufman (2020, July). Incremental potential contact: Intersection-and inversion-free, large-deformation dynamics. *ACM Transactions on Graphics 39*(4).

[3] Li, M., D. M. Kaufman, and C. Jiang (2021, August). Codimensional incremental potential contact. *ACM Transactions on Graphics 40*(4), 1–24.