Anisotropic Elastoplasticity For Codimensional Frictional Contact

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SUMMARY

UCLA researchers in the Department of Mathematics and Department of Computer Science have developed a novel hybrid Lagrangian/Eulerian approach to simulate frictional contact in thin codimensional elastic objects, such as cloth, hair, and knit. It allows a more smooth and vivid animation of those objects with faster speed and higher robustness.

BACKGROUND

Physically-based animation of elastic surfaces and curves has been an essential aspect of computer graphics. The collision and contact phenomena are essential for the richness and realism provided by physics based simulation. However, the thin nature of materials such as clothing, hair and knit makes collision detection and resolution challenging for modern visual effects.

The typical elastic surface or curve simulation method takes a Lagrangian approach. It is beneficial because it naturally allows for tracking of the codimensional manifold, however collision must then be detected and resolved separately. Eulerian methods are promising alternatives because collision processing is automatic and while this is effective for volumetric objects, advection of a codimensional manifold is too inaccurate in practice.

INNOVATION

UCLA researchers have proposed a novel hybrid Lagrangian/Eulerian approach that preserves the best aspects of both aforementioned views. They have defined their collision response with a novel elastoplastic constitutive model, which separately characterizes the response to manifold strain as well as shearing and compression in the directions orthogonal to the manifold. Collision intensive scenarios with millions of degrees of freedom require only a few minutes per frame and examples with up to one million degrees of freedom run in less than thirty seconds per frame. Since the approach is based on a volumetric continuum assumption that includes the contact/ collision response in the constitutive model, it has many speed and robustness advantages, and doesn't require post process modeling.

APPLICATIONS

- Modeling for contact phenomena in thin codimensional elastic objects (cloth, knit, hair)
- Elastic surface or curve simulation
- Visual effect design and process

ADVANTAGES

- High speed, robust, high accuracy
- Computationally efficient: simple modeling and no complicated iteration or post process

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,145,099	10/12/2021	2017-656

RELATED MATERIALS

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OTHER INFORMATION

KEYWORDS

MPM, elastoplasticity, friction, cloth, knit, hair, simulation, visual effect, codimensional, elastic, collision

CATEGORIZED AS

- **Computer**
  - Software
- **Imaging**
  - Software

RELATED CASES

2017-656-0

► C. Jiang, T. Gast, J. Teran, Anisotropic Elastoplasticity for Cloth, Knit and Hair Frictional Contact, ACM Transactions on Graphics (SIGGRAPH 2017), 36(4), pp. 152:1-152:14, 2017.

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