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Proposal

The project aims to develop a cloth simulation that accurately models the behavior of various fabrics interacting with objects. Given the complexity of cloth dynamics, the primary approach will be based on a particle system method. This method represents cloth as a collection of interconnected particles, each embodying a portion of the fabric's physical properties such as mass, elasticity, and resistance to external forces. The interaction between cloth and objects will be modeled through collision detection algorithms and response mechanisms to simulate the impact of collisions on cloth movement and deformation accurately.

In the simulation, the "objects" that the fabrics will interact with are initially simple geometric shapes, such as spheres and cubes. These basic shapes are chosen due to their straightforward mathematical descriptions, which simplify the collision detection and response algorithms. Simulating cloth interaction with these simple objects allows for focusing on accurately modeling the cloth's physical properties, such as elasticity, weight, and friction, in response to collisions and draping scenarios.

The demo will consist of a series of animations showing simulated interactions between different types of fabrics and objects. Each animation will highlight a specific aspect of the fabric's behavior, such as the drape of silk over a sphere or the response of denim to a fast-moving object. Ideally, I would personally prefer to create a simulation of traditional Chinese clothing, hanfu, interacting with a character model.

Plan B

If the particle system approach proves too challenging, the project will move to a mass-spring system. This alternative plan ensures that the project remains viable while still achieving the goal of simulating fabric behavior.

Related Work

The research in cloth simulation has significantly advanced, demonstrating the importance of accurately estimating simulation parameters for realistic animations. Breen et al. [1] introduced a method crucial for achieving realistic cloth animation by comparing videos of real and simulated cloth using a perception-based metric. This approach allows for the precise adjustment of simulation parameters to achieve highly realistic effects. Additionally, the significance of fast cloth simulation and efficient

collision response has been underscored by Volino and Magnenat Thalmann [2], detailing techniques vital for the development of a real-time operational cloth simulation system.

To further enrich our proposal, we also considered studies that explore the application of particle systems and mass-spring systems in cloth simulation. Li [3] demonstrates the use of a particle system for simulating fabric models, emphasizing the construction of internal and external factors for realistic drape deformation. Similarly, González [4] discusses the use of a discrete mass-spring and particle system, stressing the importance of accurately establishing fabric mechanics models. Huang et al. [5] and Yang & Shang [6] propose improved methods for the mass-spring model, enhancing computational efficiency and system stability.

These foundational studies not only provide theoretical underpinnings and practical guidance but also showcase the potential and effectiveness of particle systems and mass-spring systems in simulating various fabric types and their interactions with objects. Leveraging these studies, our project aims to explore the practical application of these principles in a simplified, accessible manner using Blender, guiding our implementation of particle-based cloth simulation methods and, if necessary, pivoting to mass-spring systems.

Plan

The project will be implemented in Blender, version 2.93 LTS, compatible with various operating systems. Blender is chosen for its robust support for particle systems and physics simulations, necessary for cloth simulation. It is freely accessible, ensuring that the instructor and TAs can easily access and evaluate the project.

The project will require 3D models for objects to interact with the cloth, which can be created within Blender or sourced from free online repositories. No external datasets, textures, or rendering packages are anticipated beyond what is available in Blender.

Gantt Chart

The Gantt chart below [**Table 1**] details the expected time to complete each task.

1. Week 1-2: Research and familiarization with Blender's cloth simulation tools and particle systems.
2. Week 3-5: Development of basic cloth simulation models and initial tests with simple objects.
3. Week 5: Interim Report

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4. Week 5-7: Implementation of collision detection and response mechanisms for different fabric types.
5. Week 7-8: Optimization and evaluation of computational efficiency (FPS vs. particle count).
6. Week 8: Final Report
7. Week 9-10: Preparation of demonstration animations and final system refinement.

Table 1. Gantt Chart

Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
1.										
2.										
3.										
4.										
5.										
6.										
7.										

Foreseen Difficulties

- Learning curve associated with Blender's simulation tools
- Balancing realism with computational efficiency
- Accurately modeling the physical properties of different fabrics

Reference

[1] D. Breen, M. Lin, K. Bhat, C. D. Twigg, J. Hodgins, P. Khosla, Z. Popović, and S. Seitz, *"Estimating Cloth Simulation Parameters from Video Linen Fleece Knit Satin,"* in Eurographics/SIGGRAPH Symposium on Computer Animation, 2003. (accessed February 7, 2024)

[2] P. Volino and N. Magnenat Thalmann, "*Implementing fast cloth simulation with collision response."* (accessed February 7, 2024)

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[3] Q. Li, *"Simulation of the 3D Garment Based on the Dynamic Particle System,"* in International Conference on Industrial Technology and Management Science (ITMS 2015), 2015. (accessed February 7, 2024)

[4] G. González, *"Cloth Simulation with Discrete Mass-Spring and Particle System."* (accessed February 7, 2024)

[5] W. Huang, J. Hu, K. Yu, Y. Wang, and M. Jiang, *"Cloth Simulation Based on Simplified Mass-Spring Model,"* TELKOMNIKA, vol. 12, no. 5, 2014. (accessed February 7, 2024)

[6] J. D. Yang and S. Shang, "*Cloth Modeling Simulation Based on Mass Spring Model,*" Applied Mechanics and Materials, vol. 310, 2013. (accessed February 7, 2024)