

Proposal: CUDA-Accelerated Cloth Simulation with Vulkan Rendering

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1. Overview

This project aims to implement a real-time cloth simulation system based on mass-spring model using CUDA for physics computation and Vulkan for rendering.

The goal is to demonstrate efficient GPU-based physical simulation and visualization.

2. Expecting Result

The project is expected to produce a real-time cloth simulation running entirely on the GPU, with smooth animation and interactive control.

A key demonstration will be the **Hanging Cloth** scenario, where a piece of fabric is suspended from its upper edge and reacts dynamically to external forces.

The cloth should sway naturally under gravity and respond accurately to spring-based internal forces computed by the CUDA solver.

Users can click and drag on the cloth to apply localized forces, allowing them to pull or disturb specific regions of the fabric in real time.

A wind field can be activated, applying directional forces that make the cloth flutter and wave like a flag in the breeze.

The Vulkan renderer will display the simulation at interactive frame rates (target \geq 60 FPS), with optional lighting, shading, and parameter controls.

Overall, the expected outcome is a visually engaging and physically realistic interactive cloth simulation, highlighting the advantages of GPU computing for dynamic systems.

3. Potential Extensions

Possible extensions of this project include several directions that enhance realism, interactivity, or computational sophistication.

The simulation could be expanded to support more complex collision geometries such as balls or cubes which can interact with the fabric.

If time permits, different shading techniques could be incorporated to compare lighting quality and performance. In addition, the cloth surface can be rendered with different material properties, including silk-like reflective fabrics or rough cotton textures, by adjusting parameters such as specular intensity, roughness, and subsurface scattering.