Assignment 5 : Cloth Simulation with the Mass Spring System

HONG YU 2021533148 HONGYU@SHANGHAITECH.EDU.CN

1 INTRODUCTION

In this assignment, we have implemented the basic framework for cloth simulation, including the establishment of a particle system and its solution. In the bonus section, we have incorporated wind force simulation and collision detection for both the cloth and spheres.

2 IMPLEMENTATION DETAILS

2.1 Mass Spring System

First, we established the particle system. In the particle system, we defined the properties of particles, including mass, velocity, force, and acceleration.
For springs, we defined properties such as stiffness, rest length, and damping coefficient.
During the initialization of particles, we assigned values for the mass, velocity, force, and acceleration of each particle. When initializing springs, we connected springs in the horizontal, vertical, and diagonal directions, along with their respective orientations.

2.2 Simulation

In the basic simulation, we considered gravitational force, air resistance, and spring forces. We first calculated the forces acting on each particle. For the calculation of spring forces, we initially computed the forces originating from each particle and then determined the forces directed towards each particle.
Formula for calculating gravitational force:

$$G = mg$$

Formula for calculating air resistance:

$$F_{airresistance} = -a * v$$

We applied Hooke's Law to calculate spring forces. The formula is as follows:

$$F_{hooke} = -k * (x_{current} - x_{rest})$$

2.3 Constraints

To impose constraints on the cloth simulation, we fixed the particles at the top-left and top-right corners. The implementation involved skipping the calculation of velocity and position for these fixed points at each iteration and, finally, assigning them their initial positions.

2.4 Wind force

In the bonus section, we introduced wind force. We calculated the wind force as a constant vector. The formula is as follows:

$$F_{wind} = a * vector$$

2.5 Sphere collision

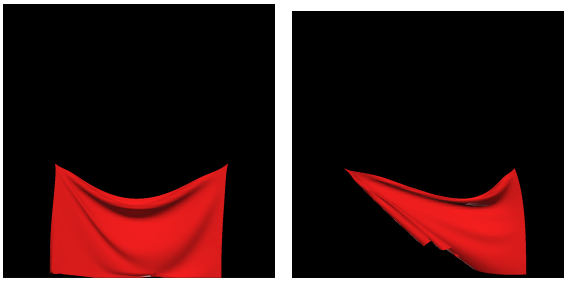
In the bonus section, we implemented collision detection between the cloth and a sphere.
Firstly, we defined a virtual sphere using its center and radius to represent a sphere in space. For each particle, if its distance to the sphere's center is less than or equal to the radius, and the dot product of the particle's velocity and the vector pointing from the particle to the sphere's center is positive (indicating that the particle has a component of velocity towards the sphere's center), we consider a collision is imminent.
We simulated the collision by updating the velocity. First, we calculated the distance between the particle and the sphere's center. Then, we computed the component of the particle's velocity in the direction of the vector pointing to the sphere's center. Subtracting this component from the velocity simulates the collision.
Additionally, we visualized the sphere by creating a Sphere class. We used latitude and longitude to generate the sphere's vertices and connected these vertices with triangles to represent the sphere's surface.
We then applied the provided shader in the code to render the sphere. The specific rendering approach can be referred to our first assignment.

3 RESULTS

We presented some results, showcasing simulations of the cloth in the must-have part, wind force simulation, and three states during collision detection between the sphere and the cloth.

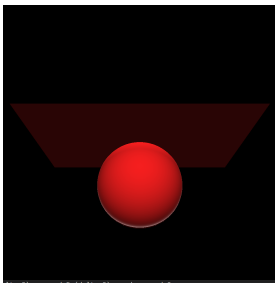
First, we demonstrated the simulation of the cloth in the must-have part.

Next, we showcased the simulation of wind force. Finally, we displayed three states during collision detection between the sphere and the cloth.

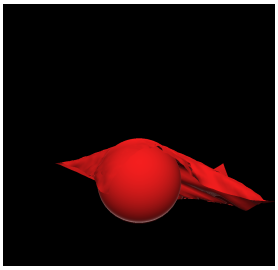


(a) Must

(b) Wind Force



(c) Sphere Collision



(d) Sphere Collision

(e) Sphere Collision

Fig. 1. Results

4 CONCLUSION

In this cloth simulation, we transformed the simulation of the cloth into a simulation of a particle and spring system. We successfully implemented the must-have part of the cloth simulation, as well as the bonus sections involving wind force simulation and collision detection between a sphere and the cloth.