Assignment 5: Animation with Cloth Simulation

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1 INTRODUCTION

In this assignment, the following features have been achieved.

- Force simulation on a cloth.
- Simulate the behavior of wind.
- Collision with a sphere.
- Drag a mesh point to move the cloth with mouse in real-time.

Declaration: To trim the size of the paper, not everything is mentioned. Only main ideas and key codes are introduced.

2 IMPLEMENTATION DETAILS

2.1 Force simulation on a cloth

For a mechanical system like cloth, the most dominant type of force is the Hooke force. Moreover, imagine that this piece of cloth is composed of many masses and small, massless spring between each pair of masses. As shown in Fig.1

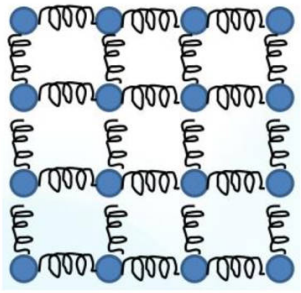

Fig. 1. cloth mass system

Furthermore, the Mass Spring Model[Xavier Provot 1995] shows how masses are connected, as shown in Fig.2

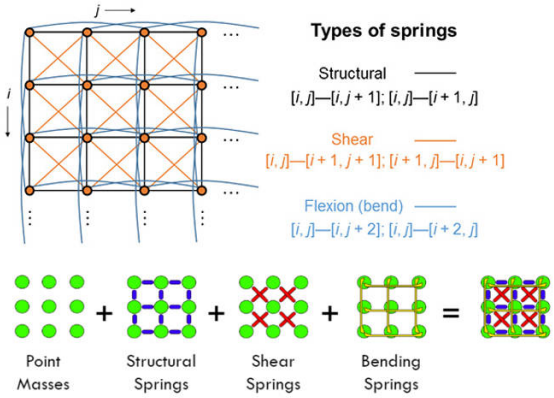

Fig. 2. spring system

Recall the Hooke's law,$F = kx$. Now we substitute the x with the actual distance between two masses.

$$F = k(L_0 - \|p - q\|) \cdot \frac{p - q}{\|p - q\|}$$

So far, the force of every mass in the mechanical system of cloth can be calculated accurately. However, in order to simulate the effect of cloth motion, it is still necessary to use the knowledge of kinematics to convert the forces acting on the masses into displacements.
The core principles of Newtonian mechanics and Galilean kinematics is

$$\dot{v}(t) = a(t) = \frac{f(t)}{m} \tag{1}$$

$$\dot{x}(t) = v(t) \tag{2}$$

Unfortunately, Computers are very bad at **symbolic computation** , and the efficiency of using CPUs for solving **ordinary differential**

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equations would be catastrophic. Thus, the differential equations must be solved using approximate methods. One of the more common engineering approaches is to use the forward Euler algorithm.

$$c\dot{v}^t = v^t + \frac{f(t)}{m}\Delta t \tag{3}$$

$$x^{t+1} = x^t + v^t \Delta t \tag{4}$$

Specially, in this problem, we define the initial state as

$$v^0 = 0 \tag{5}$$

$$x^0 = \text{where the object locates} \tag{6}$$

At last, We already have all the mechanics and kinematics theory needed to simulate this physical system.

3 RESULTS

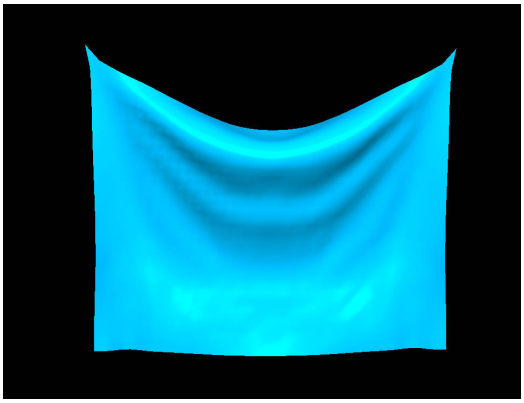

Fig. 3. Cloth Force Simulation with gravity

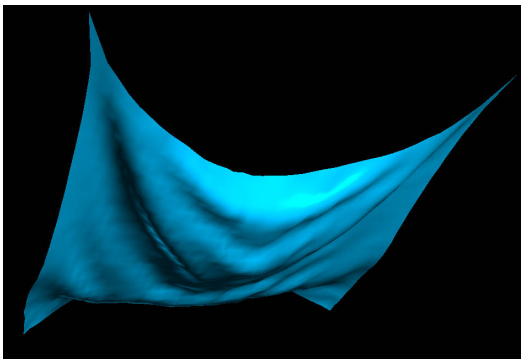

Fig. 4. Wind Simulation

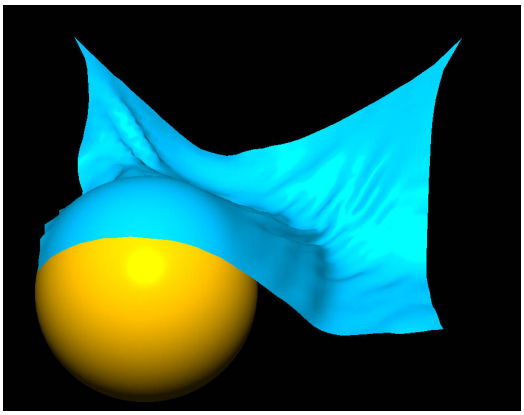

Fig. 5. Sphere Collision Simulation

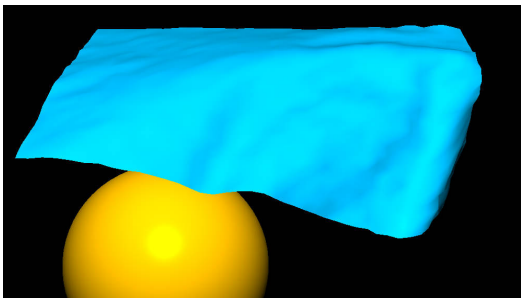

Fig. 6. Darg And Play