Cloth Simulation: Detailed Explanation

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1 Introduction

Intro here. It's just a lousy cloth. Get over it.

2 Cloth Simulation Overview

The simulation represents a piece of cloth as a network of particles linked by springs. This is not scaleable at all without optimizations.

2.1 Components

- **Particles**: These are points arranged in a grid. Each particle can move and is influenced by the forces applied to it through connected springs. Pretty simple
- **Springs**: Springs connect adjacent particles both horizontally and vertically. They simulate the elastic properties of the cloth, resisting changes in length when stretched or compressed. They get compressed when the point(s) they are attached to move.

3 Physics and Math

Simple math from honors physics in MS.

3.1 Spring Force Calculation

Hooke's Law.

$$F = k \cdot (d - L) \tag{1}$$

where:

- F is the force exerted by the spring.
- k is the spring constant, which determines the stiffness of the spring.

- d is the current distance between the two particles connected by the spring.
- L is the rest length of the spring.

To compute the distance between two particles, distance formula:

$$distance = \sqrt{(dx)^2 + (dy)^2} \tag{2}$$

where dx and dy are the differences in the x and y coordinates of the particles.
Decompose this stuff:

$$force_x = F \cdot \cos(angle) \tag{3}$$

$$force_y = F \cdot \sin(angle) \tag{4}$$

where the angle is determined by:

$$angle = atan2(dy, dx) \tag{5}$$

3.2 Particle Movement

Particles update their positions based on forces applied and their velocities:

- **Velocity Update**: When a force is applied to a particle, its velocity is updated as follows:

$$vx = vx + force_x \tag{6}$$

$$vy = vy + force_y \tag{7}$$

- **Friction and Drag**: These factors simulate resistance and energy loss:

$$vx = vx \cdot FRICTION \tag{8}$$

$$vy = vy \cdot FRICTION \tag{9}$$

$$vx = vx - vx \cdot DRAG \tag{10}$$

$$vy = vy - vy \cdot DRAG \tag{11}$$

- **Position Update**: The new position of a particle is calculated by:

$$x = x + vx \tag{12}$$

$$y = y + vy \tag{13}$$

3.3 Boundary Conditions

Particles at the edges of the grid are fixed to simulate the cloth being anchored or constrained along its edges. These fixed particles do not move, otherwise it'll just fold lmao.

4 Interaction and Visualization

4.1 Rendering

- **Springs**: Rendered as lines connecting particles. This visually represents the connections and tensions between particles.
- **Particles**: Displayed as circles. The color of each particle reflects its speed, with faster particles shown in red and slower ones in blue.