Physically-Based Simulation in Computer Graphics
Project : Position-Based Dynamics and other applications

Thomas Poyet, Lucas Teissier, Davide Corigliano

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1 Category

Our project will be about soft bodies simulation, using position-based dynamics and oriented particles.

2 Introduction and method

We chose to work on the paper "Solid Simulation with Oriented Particles" [1], which describes how to handle the simulation of solids with ellipsoidal particles. This article is based on the technique described in "Position-Based Dynamics" [2], which explains how to simulate particles using their positions and a set of constraints.
Therefore, we are planning to implement position-based dynamics first, and then move to the implementation of oriented-particle dynamics. Our aim is to focus on a efficient simulation of soft bodies, which is suitable for real-time applications like gaming.

3 Minimal target

First, we would like to implement 3D position-based dynamics and obtain a reliable and robust implementation. To do this, we will start with a 2D implementation for fluids from Taichi and adapt it to both particles and 3D applications.

4 Desired target

Then, we aim to update the solver to handle ellipsoid particles and collisions between them. Doing so, we will be able to lay a strong foundation for the following simulation of collisions between complex meshes (which will be composed of a graph of ellipsoidal particles). Hence, the desired target is to implement the method presented in the "Solid Simulation with Oriented Particles" article. Through this method, we will be able to produce a reliable collision simulation system for soft bodies.
An implementation of "Solid Simulation with Oriented Particles" can be organized in 3 steps. Given a visual mesh, a graph of ellipsoids is inferred from it. Then, collisions are simulated using the particles-based solver implemented in the minimal target. Finally, once the particles are simulated, the position and rotation of each particle are used to skin the visual mesh, and determine deformations. The skinning part will be done with Blender.

5 Timeline

1. A working 3D particles-based dynamics solver (Minimal Target)
2. Updating the solver to handle ellipsoid particles (collisions and shape matching)
3. Generating graphs of oriented particles from visual meshes
4. Skinning of soft bodies to get the deformed mesh back from the graph (done with Blender)

6 References

(1) M. Müller, N. Chentanez, Solid Simulation with Oriented Particles, ACM Transactions on Graphics (SIGGRAPH 2011)

(2) M. Müller, B. Heidelberger, M. Hennix, J. Ratcliff, Position Based Dynamics, Virtual Reality Interactions and Physical Simulations (VRIPhys) 2006