Squishy Ball Simulation

Final Project for Comp 559 - Fundamentals of Animation

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1 INTRO AND RELATED WORK

This project explored several fundamental animation techniques such as procedural mesh generation, smooth subdivision surface, smooth shading, and even served as a nice test for comparing the stability of various numerical integration methods. Once I had achieved a 3D particle spring system, I was inspired by endless ideas: cloth, bouncy objects, evolution simulations [carikh 2015], simulations of chaos such as the double pendulum [Stachowiak and Okada 2006], etc. I settled on a long-time fascination of mine in animation: squishy things. Inspired by a mysterious youtuber who makes all sorts of really squishy simulations [C4D4U 2018], I decided to start with a simple sphere. A lot of research has been done into the generation of an icosphere mesh. Some articles describe fancy indexing methods that increase the speed of the subdivision [Szalay et al. 2005]. For this project I implemented a simple version of the algorithm that is discussed on Wikipedia, in which each triangle is split into 4 triangles [see figure 1]. This can also be visualized as each edge is split into two edges, and a new particle in the middle.

2 METHODS

From experience in the 3D design software Blender, I already knew that the UV sphere is not ideal for complex simulations due to the uneven distribution of surface area between the faces. That's why I wanted to create a more efficient shape: the icosphere. The only way to create an icosphere is to start with the mathematically defined shape: the icosahedron, and subdivide the surface a given number of times to achieve a round-looking sphere. The effect can be sold even further by calculating the normal of each vertex and smooth shading each triangle [figure 2]. The hardest part of this project was creating all the indexing of the triangles, keeping track of particles and springs during subdivisions. In terms of physics simulation, multiple numerical methods which I had implemented in assignment 1 were easily transferable to 3D. It was a great learning experience to see how much more stable the system was with backward Euler rather than forward Euler.

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3 RESULTS

Successfully implemented the icosphere mesh generation with up to 5-6 subdivisions before crashing the program due to lack of heap space. The fun part of this project was implementing the smooth shading, it was difficult to get all the triangles to arrange themselves to be pointing outwards, lots of math and headaches. Overall, it was worth it, I created some nice looking blobs [figure 1 and 2].

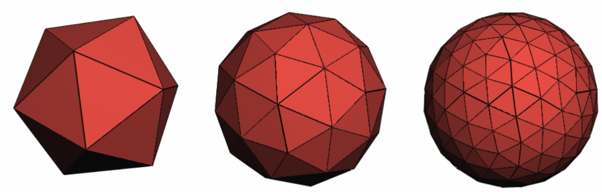

Fig. 1. Icosahedron with 0, 1 and 2 subdivisions as seen in my animation

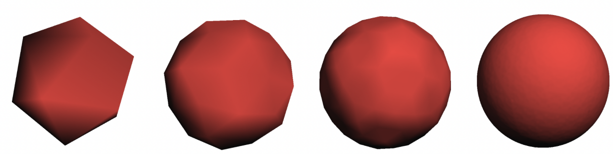

Fig. 2. Smooth shading on an icosphere with subdivisions 0, 2, 4 and 6

4 CONCLUSIONS AND FUTURE WORK

I am quite satisfied with my work although if I had more time I would add some obstacles, some deeper layers to the object, perhaps experiment with different shading and scenes. The work I did in this project has immensely helped my understanding of soft-body dynamics, as well as numerical systems. I may even transfer the code from this project into some modern 3D software so that I can work more flexibly.

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