CS 448B: Topics in Modeling

Critique of De Rose et. al. "Subdivision Surfaces in Character Animation," SIGGRAPH '98, pp. 85-94, Orlando, FL, 1998.

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Synopsis:

This paper aims to reassure graphics artists that subdivision surfaces can be used in a "high-end" CG production environment. The impact of their usability was demonstrated in the production of the short film Geri's Game, where subdivision surfaces were used to model Geri's head, hands and clothing.

Summary:

1. What they did:
   - Added a variant of Catmull-Clark subdivision surfaces to Pixar's rendering and animation systems.

     a. Modified the method of Hoppe et. al.[1] so that sharp creases can be modeled without effecting the continuity of the limit surface

     They did this by implementing a hybrid scheme, where sharp rules are used for a number of iterations (corresponding to the sharpness index, s) and then smooth rules (normal Catmull-Clark) are used to obtain the limit surface. The resulting smoothness only depends on the second set of rules.

     b. Introduced energy functionals in the mass-spring simulations that model the behavior of edges and diagonals and described energy functional for virtual threads that run throughout the simulated fabric

This was accomplished by putting constraints in the mesh that enforce stiffness properties at given locations and in given directions. The stiffness parameters are modulated to reach the desired effect.

c. Described an intuitive method of obtaining a hierarchy for collision detection

First they start with leaf nodes in the hierarchy corresponding to a face the subdivision control mesh. They then create the l-th level in the hierarchy by marking all non-boundary edges in the l-th level as candidates for removal. Two faces are merged into one super-face by removing the joining edge. This edge is then removed from the candidate list so that he super-face does not go through merging again for the l-th level. This is all done in a preprocessing step since mesh is not changing.

d. Identified that the texture coordinates assigned to the control vertices, an instance of a scalar field function that varies over the surface, can be subdivided using the same rules as geometric subdivision

Again combinations of texturing/shading schemes were used for different surfaces to reach the desired effect.

2. Why they did it:
  • Trimmed NURBS are plagued by discontinuity at the seams requiring manual effort to hide these artifacts
  • Because Catmull-Clark subdivision is more general than the Loop scheme previously modified to admit sharp features
  • To bring subdivision surfaces into commonly used rendering packages

Comments:

All of the above mentioned techniques were used to model Geri. Along with the other figures in the text, I'd say the results are rather convincing. However, I found the paper to be sparsely written as compared to others on this topic[1]. The author assumes a lot of knowledge about NURBS, subdivision and clothing simulation and often presents rather important features of these fields in a hasty way. I

found it most helpful to refer to the other papers mentioned in the text in order to follow the author's train of thought.

I found the clothing simulation in the short film to be fascinating, but I was disappointed that the description in the text was so brief. The author acknowledges that a detailed description of clothing simulation would require an entire paper of its own, but that his goal was to "highlight the issues related to the use of subdivision surfaces to model both kinematic and dynamic objects." Aside from the collision hierarchy, which closely resembled a NURBS quadtree, I was not convinced that the energy functional descriptions were special to subdivision surfaces. I found the methods used to create such dramatic results to be vague. In the first paragraph on the 6th page, the author seems to be contradicting himself stating that "weak diagonal springs allow the mesh to skew excessively" and then "we sometimes use weak springs along the diagonal to keep the material from wrinkling too much." In what cases does the excessive skew not matter?

This was a short paper, perhaps meant to be informational to other modelers in the field.

References:

[1] H. Hoppe, T. DeRose, T. Duchamp, M. Halstead, H. Jin, J. McDonald, J. Schweitzer, and W. Stuetzle. Piecewise smooth surface reconstruction. Computer Graphics, 28(3): 295-302, July 1994.