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Abstract

STUDY OF PROGRESSIVE LOD TECHNIQUES ON STATIC AND DYNAMIC MODELS IN DIGITAL GEOMETRY PROCESSING

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Nowadays, more and more high-resolution 3D models, static or dynamic, are widely used in numerous applications. A technique called Level of Detail (LOD) for the model processing has been applied in many years for managing the complexity of highly detailed models, in which multiple representations of the base model are created, with varying amounts of detail, to meet the needs of various applications. Methods for generating different LOD models were widely investigated in the last decade. However, most of these methods are designed merely for simplifying static meshes. Very little work has been proposed to deal with the problem of dynamic model approximation. The main goal of this thesis is to develop methods to generate optimal progressive LOD models for both static and dynamic models.

We first propose a static mesh simplification method based on feature preservation and triangle optimization. The basic idea is to classify the edges and vertices on the original models into several types, and then treat each type separately based on its geometric importance. The method defines a set of edge contraction rules as well as several contraction weights to obtain optimal contraction sequence for a given 3D model. In addition, a mesh smoothing algorithm is finally applied to the approximation model to further adjust the triangle shapes. The method proves to be efficient, and can be used to produce good quality approximations with better sharp features preserved at the desired level of detail.

Next we propose a shape feature based simplification method for deforming meshes. By the method, a shape feature based quadric error metric is applied to compute the edge collapse cost, for efficiently preserving the surface local features. An additional deformation degree weight is appended to the aggregated quadric errors, thus features in areas with large deformation can be preserved. Finally, for each frame the edge contraction order is slightly adjusted to further reduce the geometric distortion. The experimental results show that this method can be used to successfully preserve both the local and motion features in the animation sequence, and good quality dynamic approximations with well-preserved fine details can be generated at each frame.

Finally, a progressive method for generating multi-resolution animated models is proposed. The idea in the method is to create and compute a coarse version for the first frame model as a reference, and then update the edge contraction order for the second frame model according to the deformation information. The third frame model takes the contraction order in the second frame as the reference, and so on. Thus, the coarse versions can be generated progressively from the first frame till the last one. In addition, a mesh optimization algorithm is finally applied to the animation sequence to improve the temporal coherence. We demonstrate that the scheme provides a good means for generating optimal multi-resolution animated models.

For these model simplification algorithms, we have made comparison with previous work in visual and quantitative experiments. Although the methods are slightly more expensive in computation, much more accurate results and pleasant effect can be achieved in terms of both user perception and geometric error statistics.

Keywords: Progressive mesh, level of detail, deforming meshes, mesh simplification, mesh optimization, computer animation.