Tree Model Simplification for Fast Interactive Rendering (sap_0254)

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1 Introduction

Although billboards are often used in representing trees and grass of natural scenes, they are only suitable for distant objects, which are far away from the camera viewpoint. Human visual perception can point out billboards under close examination of such objects. In addition, a moving camera viewpoint around the objects further takes out the realism as some billboards are often programmed to rotate along the camera's viewing direction. In this on-going research, we consider rendering techniques built upon a 3D tree model and focus on geometrical simplification algorithms, which are used to save the rendering effort while keeping the visual quality close to that of a full tree model. Some recent research efforts [Lee et al. 2007] have tried to address this problem under the context of view-dependent rendering. Here, we generalize the framework so that a simplified tree model can be observed from different angles through user interaction.

2 Leaf Prioritization

Lee *et al.* [2007] analyzed the relationship between leaf models on a tree with a fixed camera viewing direction and position. The projectional distance from each leaf object to the camera can be used as a metric for prioritizing leaves under a budget value constraint. Another metric used is the leaf model's normal against the camera viewing direction. The approach is purely object-based. Further extension was done in [Lee and Kuo 2007] by taking the resultant 2D image projection into consideration. That is, visible leaves should be distributed across the screen space as evenly as possible. The framework in [Lee et al. 2007] and [Lee and Kuo 2007] was limited to a fixed viewing position, which is not suitable for applications that allow users to move the camera around at will. In this sketch, we build our algorithm upon their attempt of allocating leaves across the screen space to generate a simplified tree model for multiple viewing angles.

3 Leaf Budget Control and Ordering of Viewing Positions

To support viewing a simplified tree model from multiple camera positions, visible leaves shall be allocated according to their contributions to the final rendered image. Furthermore, for a given budget of the total number of leaf objects (say, 80% of the full tree model), we need to arrange leaf objects uniformly across the screen as well as all possible viewing angles so that the simplied tree model will not degrade the visual quality significantly as compared to the full tree model from any viewing angle. This is called the "leaf budget control" problem. One approach to the leaf budget control problem is to go through a number of iterations in allocating leaves. At each iteration, the viewing angle will move to a different position around the tree to ensure the visual quality from all possible viewing angles is guaranteed to a certain degree. Thus, interesting questions to ask include: 1) the selection and ordering of these multiple viewing positions and 2) the number of leaves to be allocated at a specific viewing position.

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For question 1), a solution is given in Figure 1, which provides a bird's eye view of the tree model. The numbers label the location relative to the tree model at each iteration. The rationale for such an order is to cover the location that is the farthest away from the previous location in terms of distance as well as the rotational angle. For question 2), an intuitive solution is to give more leaf budgets at the first few iterations than latter ones. We have compared two methods: i) the leaf budget is inversely proportional to the iteration number and ii) the leaf budget decays exponentially as a function of the iteration number.

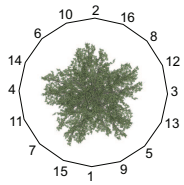

Figure 1: *Relative viewing locations to the tree model at each iteration.*

4 Experimental Results

Subjective visual comparison has shown that a simplified tree model using only 80% of the original number of leaves can provide results close to the full tree. When decreasing to 70%, though not apparent, close examination can point out some missing leaves at certain viewing angles. Using the inversely linear or exponential budget control does not result in that much visual difference at a high percentage. When reduced to a significantly lower percentage (*e.g.* 30%), the exponential budget control seems to perform better at certain viewing angles. Subjective visual comparison in our experiment also indicates that leaf model's normal vector is a better candidate than the projection distance for leaf priority determination.

(a) 100% (b) 80% (c) 70% (d) 30%

Figure 2: *Rendering results at different percentage values.*

References

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