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Skeleton extraction for tree models

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ABSTRACT

The curve skeleton extraction for a given laser-scanned tree model plays an important role in many virtual agricultural applications, such as modelling, animation and growth simulation. To extract the curve skeletons of various tree models, which can capture the essential topology structures, a simple and robust algorithm based on point cloud contraction using constrained Laplacian smoothing is proposed. The adaptive sampling and post-processing steps designed for complex tree-like models can effectively reduce the computation time and reconstruct the correct curve skeleton from a contracted point cloud. The experimental results show that the curve skeletons extracted by this algorithm are faithful and smooth, and they can be well utilized in many fields.

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1. Introduction

With the great development of computer graphics techniques, three-dimensional (3D) related applications are becoming more and more popular in computer generated virtual worlds. A lot of large and complex objects can be scanned conveniently due to the increasing availability and power of range scanners. The curve skeleton extraction for 3D models, such as laser-scanned point clouds, is an important problem in computer graphics. A skeleton is a concise 1D representation that is helpful for describing the shape and essential topology of a 3D object. Many applications, such as in animation [1,2], model retrieval [3,4] and deformation [5], regard the curve skeleton as a simple and accurate representation of the given point cloud.

Trees are very common but vital objects in the natural environment. Research on tree models is beneficial to other fields, such as forestry and ecosystems [6,7]. Unlike other vegetation models, a tree model, which often consists of a trunk and many densely intricate branches, is very difficult to handle. Besides the complexity of tree models, another troublesome fact is that different kinds of trees have different characteristics. Therefore, computing the curve skeletons of various tree models is a challenge in digital agricultural research. Although many methods for skeleton extraction have been studied over the past decades [8–11], there are few papers on this special problem. To sum up, there are two difficulties in extracting curve skeletons of tree models. One is that obtaining a point cloud by laser scanning is not always easy to implement. Because of the complex branches and leaves, scanned data are always noisy or incomplete, which is intractable for algorithms. The other is that the algorithm should be robust enough to cope with the diversity of 3D tree models and the differences in applications, such as modelling and animation.

In this paper, we present a novel algorithm for extracting the curve skeletons of tree models. Without reconstructing the surface, the proposed algorithm is implemented directly on the point cloud. First, the model is iteratively contracted

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