Reconstructing Trees Using L-Systems by Shape Analysis/Indexing

Multimedia data representation has changed the way we get and use the information these days. As we go on, 3D data is becoming more and more popular and available. Being able to see a natural scene in 3D is one of the areas that is becoming more and more ubiquitous. While previous research question was how to achieve 3D data, now the question is how do we process/model/store 3D data. In this work we are specifically looking through modeling trees. Modeling trees and plants has been looked through in several different points of view. Here we briefly go over the methods used in this research. The problem of simulating trees using 3D LIDAR Point Cloud Data has two main phases. First we produce the global/main shape of the point data and second we have to refine the skeleton/simulated shape to a natural looking tree.

There are several approaches for model the 3D shape in a point cloud. One approach is to cut the point cloud into 2D slices and then do 2D template matching for the slices. After fitting to the cut region, we cut the cloud into perpendicular slices and refine the shape in that orthogonal view [1,2]. Although this way one will loose a lot of detail information but it's a very fast approach to find the overall shape. Another approach is finding the visual hull of the point cloud and then finding the medial axis information hulls to produce the main shape of the tree, then using L-systems (described in the next paragraph) for producing the leaves and small branches [4].

A widely used method for reproducing foliage and small branches was first introduced by Lindenmayer called L-System (short name for Lindenmayer-System). An L-system or system is a parallel rewriting system, namely a variant of a formal grammar (a set of rules and symbols), used to model the growth processes of plant development [3]. In each step of the simulation, rewriting rules replace all modules in the predecessor string by successor modules. The resulting string can be visualized, for example, by interpreting the modules as commands to a LOGO-style turtle. Even very simple L-systems are able to produce plant-like structures [4].

Our Suggested Approach:

Having a color-less 3D point cloud data as the input, in the first phase of this project my main focus will be estimating the shape of a 3D point cloud of the tree. The result will then be used to constrain the growth of an L-system responsible for adding details. The shape structure is represented by calculating the major medial axes of the shape. Since medial axis can be computed very efficiently in 2D, we project the point data onto a set of planes whose axes are along the principal axis of the point cloud. For example, with 90 degree sampling angle, one obtains two planes and hence for projection of the point cloud onto 2D. Next the point set on each plane are clustered to different blobs and the convex hull of each cluster is computed. Since the number of clusters in not known a priori, we can use Agglomorative Clustering which stops at a certain threshold [6]. Now we have a set of 2D boundaries for which medial axis [5] can be effectively computed (e.g. Using morphological operations in image processing or using the a Voronoi-Diagram that is pruned until it doesn't have any biconnection). Now the the planes are aggregated again in 3D to build a 3D skeleton of the original shape. This 3D skeleton can then constrain the growth of the L-system accordingly.

References:

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