胡少军,耿楠,张志毅,杨沛,何东健.基于稀疏图像的真实树交互式建模方法[J].农业工程学报,2014,30(9):168-175

基于稀疏图像的真实树交互式建模方法

Interactive modeling method of outdoor trees based on sparse images

投稿时间： 2013-08-09 最后修改时间： 2014-03-23

中文关键词: 树 模型 三维 交互式 稀疏图像

英文关键词:trees models three-dimensional interactive sparse image

基金项目:国家高技术研究发展计划（863计划）（2013AA10230402）；国家自然科学基金（61303124）；中央高校基本科研业务经费（QN2011135）

作者	单位
胡少军	1. 西北农林科技大学信息工程学院，杨凌 712100
耿楠	1. 西北农林科技大学信息工程学院，杨凌 712100
张志毅	1. 西北农林科技大学信息工程学院，杨凌 712100
杨沛	1. 西北农林科技大学信息工程学院，杨凌 712100
何东健	2. 西北农林科技大学机电学院，杨凌 712100

中文摘要:

真实环境中树的三维重建可在虚拟现实、景观设计及农林业应用方面发挥重要作用，为解决真实环境中树的三维重建问题，该文提出一种基于稀疏图像的交互式建模方法。在自然环境下采集2幅相差90°的树图像及对应4～7幅中间图像，采用交互式编辑方法在夹角相差90°的1幅图像上获取各级树枝二维投影位置及粗度信息，再通过中间图像找到各级树枝在另一幅图像上的匹配树枝，并交互式调整树枝位置信息，然后进行透视校正，生成树枝三维几何模型，最后根据叶序规则添加树叶完成重建。通过对苹果树、樱桃树和枫树的重建结果表明，该方法交互性好，对图像拍摄数量与角度要求不高，重建时间在55～125 min之间，且能较好保持树的拓扑结构，可为虚拟植物建模、虚拟修剪试验和植物拓扑结构分析等提供参考。

英文摘要:

Abstract: The creation of realistic outdoor trees is a challenging problem in the area of modeling natural phenomenon because trees have complex geometric structures. Currently, there are two major methods to achieve this goal. One approach models trees from image sequences. This approach requires more than 16 images and wide view angles to reconstruct tree point clouds and camera pose, and the reconstruction process is not easily implemented for non-expert users because of some complex computer vision techniques. The other approach uses a laser range scanner to acquire a point cloud for modeling trees. However, we need expensive hardware to obtain the point cloud. Furthermore, the background segmentation, the hole filling and the registration process of a point cloud is very cumbersome. In this paper, we present a low cost interactive modeling method to reconstruct real-world trees from sparse images. Our method has the advantage of preserving the branch structures of real trees with few images and limited viewing angle. Based on two input photographs taken from different views with the coverage of 90 degrees and 4 to 7 in-between photographs, we developed an interactive editing system to extract the node positions, the thickness of branches and the tree hierarchy from the front view image. The interactive editing system consists of branch (or node) drawing and modifying, branch (or node) inserting and deleting, thickness modifying, Hermite spline interpolation and tree hierarchy reconstruction parts. Next, we chose main branches as references, and interactively matched the corresponding branches from the side view image by making use of the in-between images. Then, we adapted the node positions using the editing system to obtain the depth information for each branch. By combining the extracted two dimensional node positions and the thickness of branch from the front view and the depth information from the side view, we drew the three dimensional tree using generalized cylinders. However, the reconstructed tree model showed distortion where the branches in the distance appeared smaller and the branches at close range appeared larger compared with the branches in the photograph. It can be explained by the double perspective projection phenomenon where the real-world objects have been transformed twice through taking photographs and through perspective transformation in OpenGL. We propose a perspective calibration method to avoid the distortion of reconstructed tree models. Leaves are difficult to be identified from images even by the interactive method. Thus, we designed a leaf arrangement algorithm and added leaves to each branch according to leaf phyllotaxis. Finally, we demonstrated the realistic reconstruction of a variety of tree species including apple trees, cherry trees and maple trees. The number of nodes of the reconstructed trees ranges from 736 to 1250, and the average reconstruction time is around 80 minutes for a medium scale tree. The result showed that our method is effective to model real world trees having clear branches and sparse leaves.

查看全文 下载PDF阅读器

关闭

主办单位：中国农业工程学会 单位地址：北京朝阳区麦子店街41号

服务热线：010－65929451 传真：010－65929451 邮编：100125 Email：tcsae@tcsae.org