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特征保持点云数据精简

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Feature preserving point cloud simplification

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摘要 图/表 参考文献 相关文章 (3)

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摘要 由于三维扫描设备采集的点云数据庞大,本文提出了一种特征保持的点云精简方法以在减少冗余数据的同时更好地保持原始曲面的几何特征。首先,利用*K*均值聚类法在空间域对点云全局聚类,对点云构建*K*-d树并以*K*-d树的部分节点作为初始化聚类中心。然后,用主成分分析法估计点云法矢和候选特征点,遍历每个聚类,若类中包含特征点则将该类细分为多个子类,细分时将聚类映射到高斯球。最后,基于自适应均值漂移法对高斯球上的数据进行分类,高斯球上的聚类结果对应为空间聚类细分结果,各聚类中心的集合为精简结果。以多个实物模型为例验证了算法的有效性。结果表明,本文方法精简的点云在平坦区域保留少数点,在高曲率区域保留更多的点。相比于非均匀网格、层次聚类、*K*均值点云精简法,该方法对包含尖锐特征的曲面精简误差最小,更好地保留了原始曲面的几何特征。

关键词 : 点云精简, 主成份分析, *K*均值聚类, 均值漂移, 高斯映射

Abstract : 3D scanning devices generally produce a large amount of dense points. This paper presents a feature preserving point cloud simplification method to reduce redundant points while preserving original geometric features well. Firstly, *K*-mean clustering algorithm was employed to globally gather similar points in a spatial domain. By constructing a *K*-*d* tree structure for the point cloud, some nodes of the *K*-*d* tree were used as initial clustering centroids. Then, normal vector of point cloud and candidate feature points were estimated with principal component analysis method. Traversing every cluster, if feature points were contained in the cluster, the cluster was subdivided into a series of sub-clusters and the cluster was mapped to a Gaussian sphere. Finally, adaptive mean shift algorithm was employed to classify the data in Gaussian sphere and the clusters in Gaussian sphere were corresponded to the sub-clusters in the spatial domain. The cluster centroids present the simplification data. Several real object models were used to verify the effectiveness of the proposed method. The experiment results demonstrate that the proposed method generates sparse sampling points in flat areas and high density points in high curvature regions. As comparing with the non-uniform grid, hierarchical agglomerative, and *K*-means methods, the proposed method obtains the smallest simplification error and preserves original geometric features.

Key words : point cloud simplification principal component analysis *K*-mean clustering mean shift Gauss mapping

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