Self-Adaptive Point Cloud Simplification with Feature Preservation

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ABSTRACT

With advancements in photogrammetry and computer vision, optical point clouds generated by stereo matching are widely used. However, processing large point cloud data consumes significant time and storage, necessitating data reduction while maintaining geometric accuracy. Existing simplification algorithms often rely on empirical rules and cannot adapt to regional characteristics.

This study enhances a method for point cloud simplification using edge, feature, and non-feature points. The improvement is that the neighborhood size for each point is adaptively determined based on point cloud characteristics. First, the topological structure of the point cloud is established, and adaptive neighborhood size is determined using curvature features and entropy from Principal Component Analysis (PCA). The point cloud data is divided into sparse and regular areas, and different neighborhood calculation methods are applied to each area. A partitioning strategy simplifies the point cloud, with edge points extracted using normal vector angle differences and a region-growing segmentation method dividing the point cloud into feature and non-feature regions. In each feature region, points are traversed, and their importance is calculated by summing weighted differences in normal vectors, projection distances, spatial distances, and curvature differences with their neighborhoods. Each feature point's importance is compared to a threshold; if greater, the point is retained; if less, it is combined with the non-feature region as a non-feature point, and the number of non-feature points to retain is calculated by taking the ratio of local curvature to global curvature into consideration. Finally, edge, feature, and non-feature points are combined as the simplified point cloud.

Preliminary experimental results indicate that this method effectively simplifies point clouds while preserving features, indeed resulting in light point clouds with quality geometric structure and content.

Keywords: point cloud simplification, self-adaptive neighborhood, feature preservation, principal component analysis, region growing segmentation