A NOVEL SEGMENTATION METHOD FOR 3D SURFACE MESHES [1]

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We propose a novel method for the problem of 3D surface mesh segmentation. This segmentation method is based on geodesic distance and differential geometry information such as Gaussian curvature and mean curvature. Mesh segmentation is essential for many applications, e.g., feature detection, model fitting, and sub-part analysis, etc. The mesh segmentation problem is defined as clustering of vertices in a mesh such that vertices in the same cluster must (i) have similar curvature quantities, (ii) connect to each other, and (iii) be close to each other in terms of geodesic distance.

Geodesic distance can be estimated from the shortest path between vertices, which can be computed by applying well-known shortest path algorithms such as Dijkstra's and Floyd-Warshall methods [1]. However, the problem is that the computational time of geodesic distance for every pair of vertices is very large. In our proposed method, shortest path algorithms are applied to mesh partitions, which are locally generated based on an adjustable threshold computed from Euclidean distance information. Our method also applies the depth-first search algorithm for testing of mesh partition and vertex reachability. Moreover, a region growing technique is used for mesh segment initialization. Gaussian curvature and mean curvature are calculated by discrete differential-geometry operators [2, 3], and used for surface type classification of vertices in meshes [4]. These surface types are peak, pit, ridge, valley, saddle ridge, saddle valley, minimal surface, and flat. For segmentation, we define four types of segments: (i) peak-type, (ii) pit-type, (iii) minimal surface-type, and (iv) flat-type. Peak-type segments contain vertices with the peak, ridge and saddle ridge surface types. Pit-type segments contain vertices with the pit, valley and saddle valley surface types. Minimal surface-type segments only contain vertices with the minimal surface type. Flat-type segments also contain vertices with only the flat surface type. Our method has been implemented and tested with several 3D mesh model structures. It gives satisfactory results such that surface regions of salient features can be extracted. These salient features are very useful for further analysis. Currently the method has been developed as a part of our surface matching system.

References

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