論文の内容の要旨

Size Aware Contouring based on Level Set Method and Its Applications

(レベルセットに基づく形体サイズ依存の輪郭抽出法とその応用)

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This dissertation contributes a novel concept for size dependent level set method for use in image segmentation, mesh segmentation and fixture design. The concept forces zero-level set to stop only at the boundaries of large features, which makes the small features removable and discriminable. Here, small feature indicates a feature with a small size in its cross section compared with a user defined threshold.

There are many challenges to overcome in order to turn the concept into a reality. First of all, we have to know whether a feature is small considering the size of its cross section. To this end, uniform grid points are introduced into the domain where a given model is contained. Then the number of grid points is used to approximate the sizes of features on condition that the interval between grid points is known. Therefore, counting the number of grid points in or near a cross section of a feature enables us to know its size. Zero-level set of a predefined level set function serves as cutting surface used to generate the cross sections of all features of the given model while it evolves under the control of a proposed speed function. Waiting time function is involved in the speed function so as to ensure the intersections of zero-level set and features are the cross sections that accurately represent the sizes of those features. With this idea, it is possible to clearly discriminate the small features with regard to a user-defined threshold.

The ability of discriminating small features is beneficial to many applications. For example, in image segmentation, once the interesting object intersects with others, the problem becomes challenging, especially when the two objects are similar in certain characteristic that usually used for segmentation. However, the interesting object can be extracted by contour simplification by removing the intersecting object. Moreover, mesh model simplification is always necessary to prepare a model for physical based simulation, which is commonly done by removing some of relatively negligible, small features like holes and extrusions. But this work is not trivial because features in mesh model are not shown characteristically any more. The usage of discriminated small features by the proposed method makes simplification easy to do. In addition, surfaces in CT models generated from CT images may be undesired connected to each other through some small holes which are brought about by errors that took place during scanning. The ability of small feature discrimination of the proposed method makes the separation of those surfaces simple, so benefits any bone surfaces based applications such as customized fixture design.