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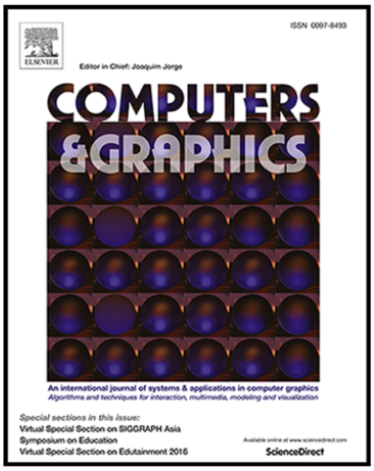

Towards Globally Optimal Normal Orientations for Thin Surfaces

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Towards Globally Optimal Normal Orientations for Thin Surfaces

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ABSTRACT

Globally unified normal orientations for unorganized point set are essential for reconstruction, rendering, texture mapping etc. Although there is a large body of literature on dealing with various difficult cases to get consistent normal orientation, effective approaches are not available yet to handle a point cloud with thin surfaces, to our best knowledge. The difficulty lies in that thin structure doesn't have a strong coherence between locations of surface points and their normal orientations. In this paper, we propose a novel approach for computing globally optimal normal orientations to facilitate high-quality surface reconstruction from a point cloud with thin structures. The key idea is to generate an uniform particle set constrained on an offset surface that is topologically identical to the real target surface and further use the particle set to compute and refine the normal vector at each primitive point. Our strategy for inferring the globally consistent orientation is much different from the conventional paradigm that computes unoriented normal vectors and then re-orients them coherently. Experimental results on natural and man-made models with noise and thin parts show that our algorithm outperforms existing approaches on normal consistence and is able to produce a desirable global optimal normal orientations with which a structurally sound thin shape can be finally reconstructed by the well known screened Poisson reconstruction approach.

1. Introduction

Recent innovation in 3D acquisition technology has enabled digitization of complex 3D objects or scenes, generally in the form of point clouds. Reconstructing the target shape from an unorganized and noisy point cloud is a research-intensive yet challenging topic in computer graphics and computer vision. It is especially difficult to recover the intricate geometric structure when the underlying surface has thin parts or sharp features.

Globally unified normal orientations for unorganized point set are essential for reconstruction, rendering, texture mapping etc. There is a large body of literatures on finding consistent normal orientations, including surface-based methods [16, 15, 17, 20, 23, 31, 7, 33, 22] and volumetric methods [36, 25, 34, 10, 35]. Surface based methods assume that the change of normal vectors has a spatial coherence for those adjacent points. However, the assumption may lead to incorrect normal orientations in practice, e.g., for those thin structures of 3D objects. As shown in Fig. 1, the two point sets in (a) and (b) are completely identical and the underlying surface they intend to encode is a closed surface with a small thin volume, i.e. the inner loop shown in Fig. 1(b). Unfortunately, since the input point cloud is noisy and not dense enough, if we follow the as-