An Automatic 3D Point Cloud Registration Method Based on Regional Curvature Maps

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An Automatic 3D Point Cloud Registration Method Based on Regional Curvature Maps

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Abstract

3D point cloud registration is a fundamental and critical issue in 3D reconstruction and object recognition. Most of the existing methods are based on local shape descriptor. In this paper, we propose a discriminative and robust local shape descriptor-Regional Curvature Map (RCM). The keypoint and its neighboring points are firstly projected onto a 2D plane according to a robust mapping against normal errors. Then, the projection points are quantized into corresponding bins of the 2D support region and their weighted curvatures are encoded into a curvature distribution image. Based on the RCM, an efficient and accurate 3D point cloud registration method is presented. We firstly find 3D point correspondences by a RCM searching and matching strategy based on the sub-regions of the RCM. Then, a coarse registration can be achieved with geometrically consistent point correspondences, followed by a fine registration based on a modified iterative closest point (ICP) algorithm. The experimental results demonstrate that the RCM is distinctive and robust against normal errors and varying point cloud density. The corresponding registration method can achieve a higher registration precision and efficiency compared with two existing registration methods.

Keywords*:* 3D point cloud; local shape descriptor; regional curvature distribution; 3D surface registration

1. Introduction

3D surface registration is a crucial and active issue in computer vision with numerous applications including 3D modeling, object recognition, scene understanding, 3D shape detection, etc. [1, 2] Due to the self-occlusion of 3D object, 3D scanner can only obtain a partial 3D point cloud associated with a single coordinate system from one viewpoint. In order to reconstruct the whole 3D shape, we must transform the 3D point clouds captured from different viewpoints into a common coordinate system according to rigid transformations. The aim of 3D surface registration is to compute the rigid transformation between 3D point clouds and recover the complete 3D shape of the object automatically.

Most of the existing shape-based 3D registration methods consist of initial registration and fine registration. In initial registration, local shape representation and matching [3-8] are crucial steps for recovering a coarse rigid transformation. An accurate initial transformation can improve the optimization efficiency and reduce the optimization error in the following fine registration [9, 10]. So far, fine registration methods are well-developed with the wide