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Research on a three-dimensional reconstruction method based on the feature matching algorithm of a scale-invariant feature transform

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ABSTRACT

Currently, reverse engineering has attracted increasing attention in the non-destructive detection field, since it is a viable method to create a three-dimensional (3D) virtual model of an existing physical part. Feature points matching and 3D reconstruction are critical processes in reverse engineering of binocular stereo vision. In this paper, we present a 3D reconstruction method based on the feature matching algorithm of a scale-invariant feature transform (SIFT). First, we find the paired matching pixel points in the two corresponding digital images by using the SIFT matching algorithm. Second, the middle points on the common perpendicular of non-coplanar lines are exploited to estimate the 3D points. Finally, experimental results are presented to demonstrate the practicality of the proposed method.

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1. Introduction

In reverse engineering, three-dimensional (3D) coordinate measuring has been divided into a contact-based approach and a non-contact-based approach. The contact-based approach may harm fragile objects, and it requires long periods of time to build an accurate 3D model. Non-contact scanners address these limitations by observing, and possibly controlling, the interaction of light with the object. For non-contact measurements, the approach based on binocular stereo vision is an important way to digitize the physical object. From two corresponding digital images of the physical object taken from different viewpoints, this approach can create a 3D virtual model for the physical object. The general processes for binocular stereo vision include digital image acquisition, camera calibration, feature point extraction, feature points matching and 3D reconstruction. In the world coordinate system, a spatial 3D point on the physical object respectively maps a pixel point on the two digital images. Feature points matching involves searching the two corresponding digital images and finding the paired homologous pixel points, while 3D reconstruction involves computing the coordinate values in the world coordinate system on the basis of these two paired matching pixel points and the calibrated parameters of the cameras. The development of both a feature points matching algorithm and a 3D reconstruction approach is very important for both system performance and the accuracy of the reconstruction points; these issues also remain open and challenging problems in the field.

The reference papers [1,2] suggest matching the feature pixel points with the aid of a semiconductor linear laser transmitter, and then calculating the 3D world coordinate values of the points on the physical object by the established mathematical model. In this paper, we propose to match the feature points by using the scale-invariant feature transform (SIFT) algorithm [3,4]. The advantage of our proposal is that the feature points matching is fully accomplished by computer vision knowledge, and no additional physical devices are needed.

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