

High Speed Measurement for Handheld 3D Imaging System Based on Triple Epipolar Constraint

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Abstract

Handheld 3D imaging system has been widely used in areas of industry, medicine and aerospace, due to its good performances such as: noncontact, high flexibility, portability and high efficiency. It is often consisted of a stereo vision system, and realizes 3D reconstruction by projecting random or coded patterns to find point correspondences to calculate 3D space coordinates. Among optical 3D measurement techniques, fringe projection profilometry (FPP) has become one of the most popular techniques as a result of its simple system structure, high precision, full-field scanning, and automatic processing. However, FPP is rarely used in handheld 3D systems, the reason is that FPP has to project many patterns to acquire 3D information, which is not suitable for handheld condition, especially hand shaking will introduce huge error into depth measurement result. To overcome this, higher projecting speed and lower image counts for single view 3D measurement become hence necessary. In this paper, we propose to reduce the image counts by employing triple epipolar constraint, where the projector is treated as a camera, as shown in figure 1. As a result, with triple epipolar constraint, correspondences can be found without phase unwrapping. For N-step ($N \geq 3$) phase shifting method, the system only projects N patterns. The projector speed is 120 frames/s, take $N=3$ as an example, the reconstruction speed can reach 40 frames/s. With image multiplexing, as shown in figure 2, the reconstruction speed reaches projecting speed. In hence, the paper realizes high speed measurement for handheld 3D imaging system with FPP.

Keywords: handheld 3D imaging, epipolar constraint, FPP, high speed

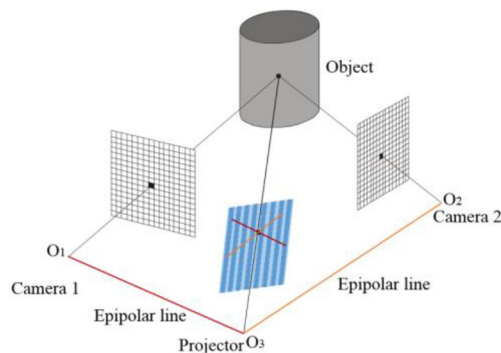


Fig. 1 FPP system with triple epipolar constraint

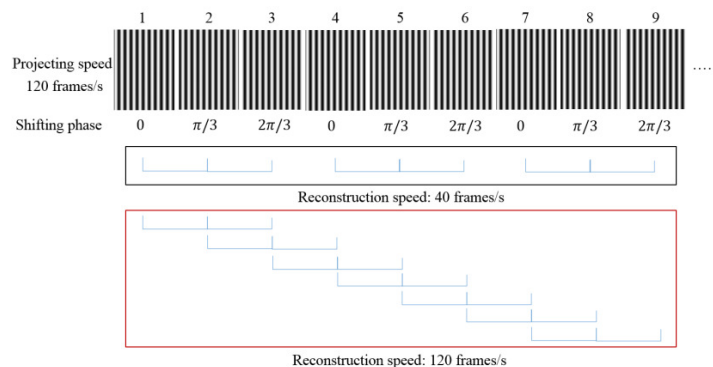


Fig. 2 Image multiplexing for high speed reconstruction

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