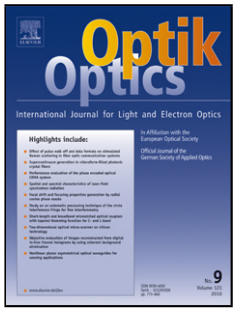

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PII: S0030-4026(18)31076-3
DOI: https://doi.org/10.1016/j.ijleo.2018.07.103
Reference: IJLEO 61259

To appear in:

Received date: 11-5-2018
Revised date: 19-7-2018
Accepted date: 24-7-2018

Please cite this article as: Tongtong L, Changying L, Yang L, Tianhao W, Dapeng Y, Binocular stereo vision calibration based on alternate adjustment algorithm, *Optik* (2018), https://doi.org/10.1016/j.ijleo.2018.07.103

Binocular stereo vision calibration based on alternate adjustment algorithm

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Abstract: This paper presented a high precision camera calibration algorithm of binocular stereo vision system based on alternative adjustment. This method could be achieved by taking multiple pictures on a professionally designed calibration board in different directions. The watershed algorithm is used to extract feature points, and time domain coding is used to match image pairs. The camera initialization parameters including radial and tangential distortion coefficient are obtained by the classical monocular camera calibration algorithm. We built a binocular vision calibration system which is based on the left and right camera coordinates as the reference coordinate system respectively, and the internal parameters of the two cameras are optimized by alternately adjusting experiments to obtain the optimal value. Then, all the internal parameters are used to optimize the external parameters, so as to obtain the optimum distortion parameters and internal and external parameters. Compared with Zhang's calibration method, the results show that the mean absolute relative error of the two camera parameters is less than $3.45e^{-6}$, and the mean re-projection error of the 10 sets of data is about 0.0725 pixels. The mean re-projection error obtained from the distorted model of Zhang is about 0.0852 pixels. Compared with other calibration methods, the proposed algorithm has higher accuracy and convenient, cost-effective and easy to implement.

Keywords: distortion model; binocular stereo vision; camera calibration; correction

I. INTRODUCTION

Binocular stereo vision has many advantages such as high measurement accuracy, high intelligence, strong adaptability, high measurement efficiency, wide measurement range, etc. It is an emerging research field closely related to other disciplines and daily life production[1]. Its application principle is to obtain accurate three-dimensional depth information from two-dimensional images. Camera calibration is a prerequisite for the binocular stereo vision system, and the accuracy of the calibration parameters plays a crucial role in the later research of the system[2].

At present, there are many ways to achieve the stereo vision system calibration. QiangJi proposed a camera calibration method based on genetic algorithm, which can obtain approximate optimization solutions accurately[3]. Xia proposed a fully automatic camera calibration method based on circular mark points. 5 azimuth circles are added to the board of the traditional circular mark point. The result of the matching is directly used as the input of the Zhang algorithm, and the internal and external parameters of the camera are obtained. Achieved the effect of avoiding manual intervention during the calibration process[4]. Wang proposed a linear array camera calibration method based on virtual stereo targets[5]. Cui proposed a non-measurement camera calibration method for spatial sequence image coplanar conditions, which does not require an external calibration object[6]. Palmieri G proposed a global calibration method including hand-eye pose estimation based on the error kinematic model[7].

This paper studied a high precision binocular vision system calibration algorithm. The radial and tangential distortion models of lens are given. The calibration board can be photographed from different directions by using binocular camera, and the camera or calibration board can move freely. Start with the existing monocular camera calibration algorithm and perform nonlinear optimization. Then the radial and tangential lens distortions are modeled separately. Finally, the binocular vision system is corrected by alternation adjustment algorithm. Compared with the traditional calibration method, this method is high precision and easy to implement.