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Non-contact Human Body Measuring Technology Based on Camera Calibration Technique ⋆

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Abstract

The basic theory of camera calibration is firstly introduced in this paper. The model of camera distortion is put forward. And discussed the parameters and the calibration process of the mathematical model of 3D human body reconstruction. In the process of camera calibration, an improved algorithm based on the two steps is proposed. This method has low requirements on experimental. This method has low requirement to experiment, and only with coplanar points to calibrate. By the process of fractional step calibration, the nonlinear equation is linear, which is beneficial to improve the calibration accuracy.

Keywords: Non-contact Human Body Measurement; Camera Calibration; The Radial Distortion; Non-linear Model

1 Introduction

Camera calibration is to determine the position and the property parameters of the camera, and also to set up the imaging model. Camera calibration is to determine the corresponding relation between the human body measurement points of world coordinate and their image points in the image plane. Camera calibration is the premise and foundation of obtaining 3D human body space coordinates. The results of camera calibration directly affect the accuracy of 3D human body measurement and the effect of human body coordinate reconstruction.

In the broad sense, the method of camera calibration can be divided into three categories, the traditional calibration method, the self calibration method and the calibration method based on active vision. The traditional camera calibration method needs to use the already known sizes of the calibration object, which is to establish the corresponding relationship between the 3D human body coordinate points and their image points [1]. This method can obtain higher accuracy of calibration, but it is not suitable for the non-use of calibration object. The self camera calibration

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method overcomes the shortcomings of the traditional calibration method. It does not require the use of a calibration object, and it only relies on the relationship between multiple image points to determine the internal and external parameters of the camera. At the beginning of 1990s, Luong and Faugeras and et al firstly proposed the concept of the self camera calibration method, which made it possible to calibrate the camera motion in the unknown scene [2]. All the self calibration capital just uses the constraints of the internal parameters of the camera itself, and it has nothing to do with the scene and the camera motion. As with the self calibration method, the method is also a calibration method for the corresponding points of the image. The method does not need calibration objects, but it need to know some special motion information of camera, such as rotation of around the optical center or a pure translation. The method is to calculate the parameters of the camera by using the special properties of the camera motion [3, 4]. The method is not suitable for the areas of having unknown or non-control motion parameters. And because the experimental equipment is expensive, and the experimental conditions are high, the calibration method based on active vision cannot be beard by the ordinary individual or units.

Since the human body measurement has a higher accuracy, the traditional camera calibration method is used to calibrate the system. Therefore, the following is a further overview of the traditional camera calibration method.

According to the method of calculating the calibration parameters, the traditional calibration method can be divided into three categories, that is, the linear method, the nonlinear optimization method and the two steps method [5].

The linear method is to set new variable among the variables of nonlinear equations, which is called the intermediate parameter. The original nonlinear equation is transformed into a linear equation with intermediate parameter. After using the least square method to solve the intermediate parameter, the value of the original variables is got [6]. The advantage of this method is that it does not need iteration, and the calibration speed is fast. The disadvantage of this method is that the system error and the lens distortion of camera are not considered. The nonlinear optimization method is used to solve the nonlinear equation by iterative algorithm [7]. The advantage of the method is that all of the aberrations can be covered. The method can be used to select any system error model, which can achieve high calibration accuracy. The disadvantage of this method is that the computational amount is very large.

The two steps method is a successful method of camera calibration in recent years. The two step method is to separate the inside and outside parameters of the camera and the distortion parameters, and then get the optimal solution step by step [8]. The iterative parameters of this method are less than those of the nonlinear optimization method, and the method can automatically provide better initial values. At the same time, the method has considered the partial distortion (mainly the lens radial distortion). The method has the advantages of high accuracy of nonlinear optimization and fast speed. The disadvantage of this method is that it is due to the two steps to be repeated, increasing the amount of computation. The two step method is represented by the camera calibration method proposed by Zhang [9] and Tsai [10], and it has been widely used.

2 Camera Distortion

In establishing the mathematical model of the structural light vision measurement, the pinhole