Camera Calibration with a Viewfinder

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Abstract

To answer the industrial need for simple camera calibration procedure, we propose a new method that requires a simple calibration object composed simply of a box and two crosses. The box is opened in the front where a large cross, made of wires, is attached while another is drawn (or attached) at the bottom. Both crosses are perfectly aligned similarly to a viewfinder. The viewfinder is first oriented with respect to camera such that the optical axis of the camera passes by the center of both crosses, allowing the display of a single (superimposed) cross and an immediate reading of the coordinates of the optical axis. Then, using the similar triangles theorem, the focal distance can be easily estimated. In addition, if necessary, the method can determine the orientation of the CCD matrix if it is not perfectly perpendicular to the optical axis by solving a simple linear system. This method should be particularly useful for calibration of cameras in situ, such as microscopes or embedded cameras.

1 Introduction

Calibration is a heavily worked on area in vision because it is necessary to estimate 3D distance information contained in an image. It allows to model mathematically the relationship between the 3D coordinates of an object in a scene and its 2D coordinates in the image [1,2].

The parameters of the camera are classified in two categories: internal parameters which define the properties of the geometrical optics and the external parameters which define position and orientation of the camera. More specifically, the camera calibration consists in determining the intrinsic (focal length, optical center, scaling factors) and/or the extrinsic (camera rotation and translation) parameters [4,5].

Numerous techniques use an object of calibration of known dimensions for this purpose. This object could be a plane [3,4,6,9,10,13], a cube [1,2] or a sphere with several landmarks (e.g. crosses, circles or squares) on it.

Most methods have in common the same geometrical model, the pinhole model, and sometimes takes into account optical distortions. They typically integrate the size of the pixels since this is typically provided by the CCD matrix manufacturer and assumed accurate [5,7].

The classical method uses equations of linear perspective projection (pinhole model) to extract intrinsic as well as extrinsic parameters. It requires the resolution of a linear system of 2n equations, where $n \geq 6$ is the number of non-coplanar points (landmarks of known 3D positions). Other methods such as calibration from vanishing points and self-calibration are also possible. However these methods are not simple and require several landmark identifications or detections [1,2].

In this paper we suggest a very simple procedure to obtain the camera intrinsic (and extrinsic) parameters that is as easy as aiming through a viewfinder.

2 Background

An ideal camera [3] (pinhole model), with an image plane without distortion and governed by the laws of projective geometry is assumed (figure 1).

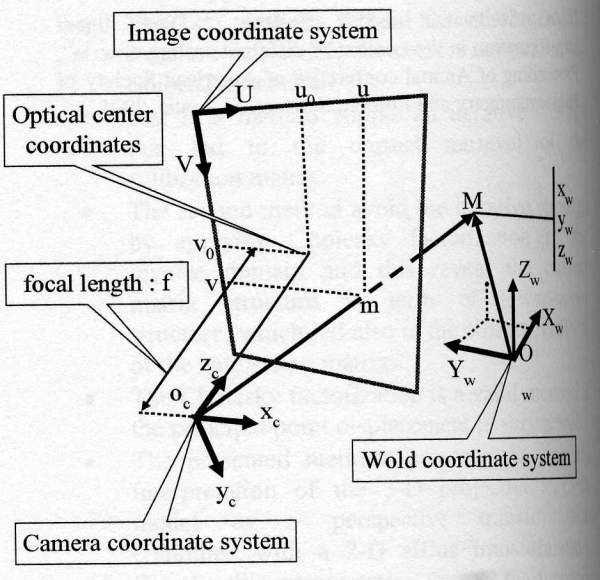

Figure 1 : Perspective projection.