
OMC Product Guide – Camera Calibration Software

OMC camera calibration software provides the means to calibrate virtually any camera to a high level of accuracy



Introduction

This product guide describes the use of OMC software to calibrate cameras in a close range application. Other schemes are available to be used in other circumstances e.g. for calibration multiple camera systems.

Camera calibration example

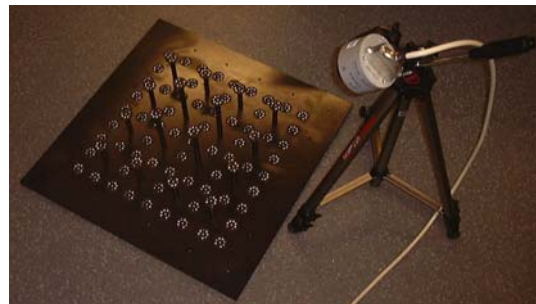
Camera calibration is relatively quick and easy for standard applications that do not require higher accuracy than $1/5 - 1/10$ of a pixel where a flat calibration object can be used. When higher accuracy and more complex situations are encountered further work is usually entailed and often requires some expertise. Examples could be the calibration of a zoom lens or calibration of a camera in a confined space. The following sequence illustrates how camera calibration is performed in using OMC software.

Step 1. Prepare your calibration object.

The user selects a coded target size suitable for the sensor/lens and object distance combination. The coded targets are a collection of white dots on a circular black background that are radiometrically and geometrically coded so that each target is individually numbered. An array of these targets is then printed onto the type of paper used for labels using a standard printer - a laser printer gives the best results. For basic image correction a flat object can be used such as a stable material such as a piece of thick plywood. The paper sheets are stuck to the object and when the object is bigger than the printer page size multiple sheets are used. This scheme is very convenient and easy to use. For higher accuracy a 3-D object is necessary.



Flat calibration artifact



3-D calibration artifact

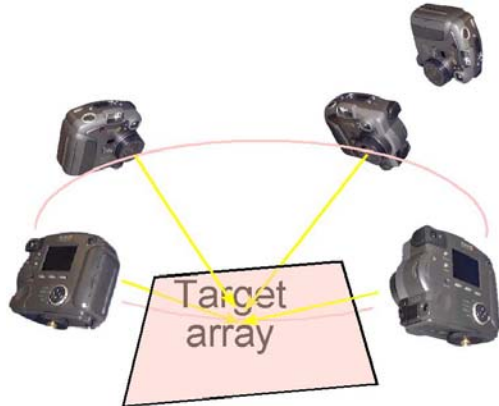
Step 2. Set up the camera and lens.

The lens should be focussed at roughly the same distance as the desired working distance for the camera after calibration. (Tip - open the aperture wide and do the focussing with the narrow depth of field before returning to your desired setting so that the focal setting is roughly in the middle of the depth of field at the normal setting) The aperture should then be set to ensure good contrast for the white dots. If possible the focus setting should be locked in this position or if no lock is available the taped aperture ring should be restrained with tape.

Step 3. Take pictures of the object from a variety of angles.

The pictures should fill or exceed the field of view of the camera and be taken with about a forty-five degree angle between the camera and

the normal to the flat surface. Four pictures taken in each of four quadrants and four further with the camera rolled through 90 degrees are sufficient for most applications.



Ideal locations of the cameras with respect to the calibration object - the camera outside the ring illustrates the 90 degree camera roll that is required for the further eight images

Step 4. Load images into software and locate features.

The images are loaded into a computer where the images are processed to locate the white dots with sub-pixel accuracy and identify the coded target features to give each target a unique number. Typically 500 dots are used in each calibration.

Step 5. Estimate camera locations and rough 3-D co-ordinates of the object.

At the same time as the paper sheets are produced a file is produced that gives the approximate locations of each of the targets. This information is sufficient to estimate the position and orientation of each of the cameras and then the approximate 3-D locations for each of the targets. The positions of the cameras and 3-D co-ordinates of the targets are then refined further without calibrating the cameras internal parameters. Typically the average variation between the estimated 3-D spots projected into the image and the spot locations will be around 0.5 to 1 pixel.

Step 6. Refine parameters.

The next step estimates the interior parameters in addition to the exterior parameters and this process often happens in a step by step manner so that the user can see that the solution is improving. If there are no problems the process will converge so there is little to be gained in continuing with the iterations and the camera can be considered to be calibrated. If the solution fails to converge there may be problems with certain targets being falsely identified, after rectifying the fault a successful calibration is likely to result.

Step 7. View results.

The results from the calibration process can be viewed by looking at the parameters and their standard deviations or by seeing the differences between the 3-D co-ordinates projected into the image and the spot image locations (usually called image residuals).

Step 8. Correct image data or images.

The final step is either to correct the images for distortion or to correct the data derived from the images. Correcting the images involves warping the image to an undistorted shape and hence will mean that pixel values are interpolated from surrounding values. The size of any resulting image may also need to be changed to accommodate the stretching or shrinkage at the edges.

A flat calibration artifact provides the quickest and easiest route to calibration provided the subpixel accuracy is not expected to exceed 1/10 of a pixel. When higher accuracy is required the use of a 3-D test artifact is recommended and the number of pictures and the diversity of image locations would generally be greater. For some applications, stereo systems for instance, the exterior orientation parameters for the cameras are required. This information is a useful by-product of the calibration procedure.