CAMcal: A Program for Camera Calibration Using Checkerboard Patterns

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1 Description

CAMcal is a light-weight, easy-to-use program for calibrating cameras based on planar checkerboard patterns. The program takes a sequence of images of the checkerboard calibration pattern, extracts the grids automatically, and computes the camera's intrinsic parameters (focal length, principal point, radial distortion coefficients) and extrinsic parameters (position and orientation of the camera with respect to the pattern). All a user need to do is to take a sequence of images of the calibration pattern and load them into the CAMcal program.

We use a variant of the standard checkerboard pattern as shown in Figure 1. The pattern can be easily printed with a laser printer and attached onto a flat board. The three circles are used for fixing the orientation of the camera with respect to the pattern coordinate frame. If only intrinsic parameters are of interest, standard checkerboard patterns can be used.

There are two main stages in calibrating a camera using a pattern. The first one is to extract features from the images of patterns and match them with those of the patterns. Once the correspondences between points in the images and points in the pattern are established, the second stage is to solve for the camera parameters by certain numerical procedures. Here, we use the OpenCV library [1].

The main strength of this program is its robustness in extracting the grids under different lighting conditions and lens distortions. We use a new method that exploits the topological structure of the checkerboard pattern. The main idea, detailed in [2], is to use Delaunay triangulation to connect the corner points found with the Harris corner detector. Neighboring pairs of triangles with similar colors are merged into quadrilaterals that match the squares in the pattern. We introduce an efficient data structure to facilitate the manipulation and traversal of the triangular and quadrilateral meshes. Figure 3 illustrates the process of grid finding.

Figure 2 shows the user interface of CAMcal. The functionalities include reading image files, extracting the grids, intrinsic calibration, and extrinsic calibration. It provides an image viewing function for visualizing both the original images and the grids extracted. The users are able to step through the images. For calibrating extrinsic parameters, the program assumes the intrinsic parameters are known. Users can also save the positions of the grid points for use in other applications. This feature is useful in the case that users want to test another calibration algorithm.

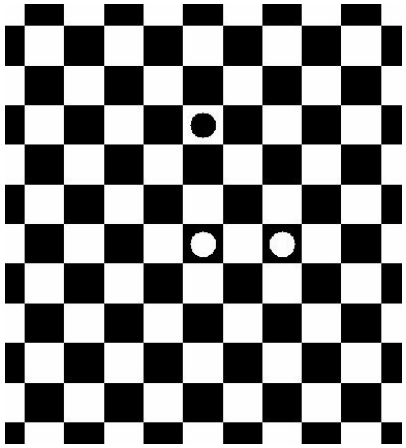


Figure 1: Checkerboard calibration pattern

CAMcal can be downloaded freely from `http://www.cv.iit.nrc.ca/research/CAMcal`.

References

[1] OpenCV. *Open Source Computer Vision Library*. `http://www.intel.com/research/mrl/research/opencv/`.

[2] Chang Shu, Alan Brunton, and Mark Fiala. Automatic grid finding in calibration patterns using Delaunay triangulation. Technical Report NRC-46497/ERB-1104, National Research Council of Canada, Institute for Information Technology, 2003.

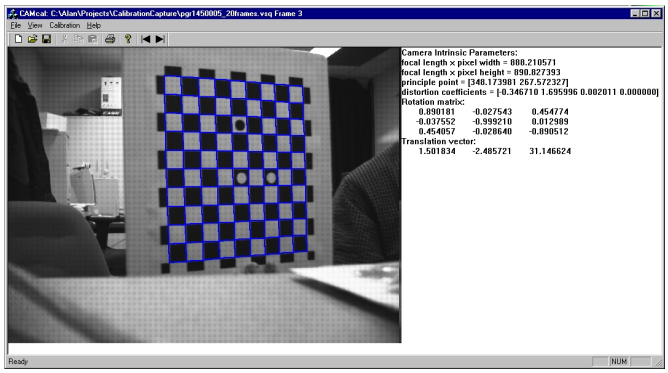
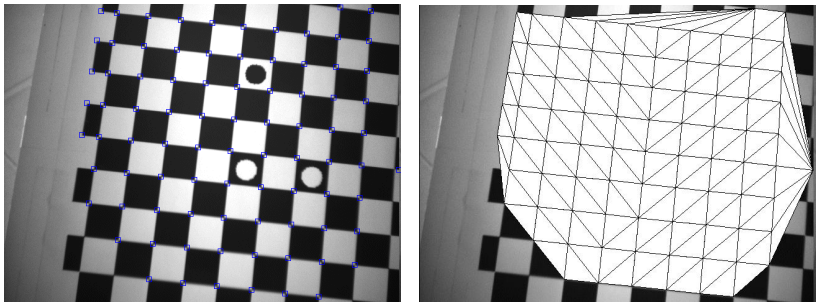
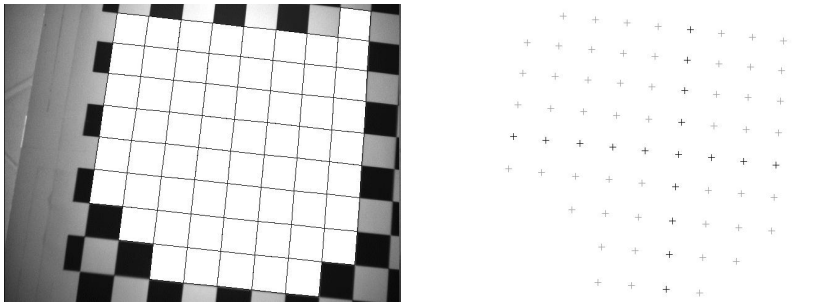


Figure 2: CAMcal user interface



(a) (b)



(c) (d)

Figure 3: The grid finding process