Camera Calibration

1 Suggested reading

The theory for this exercise is presented in chapters 13.1-13.3 of the course book (Bigun, Vision with Direction, Springer, 2006)

2 The world coordinate frame

The image *S7img1.gif* (*imread* can be used to retrieve the included colourmap) represents an object of known shape that will be used for calibration. The three images *S7orthN.gif* detail the geometry of the object and the choice of the world reference frame. When looking at *S7img1.gif*, the origin of the world coordinate frame is located at the lower leftmost corner of the object (the point marked 1 in *cal_points.gif*). The Y axis is parallel to the vertical edge of the image and points upwards, the Z axis is parallel to the horizontal edge of the image and points to the right, and the X axis is perpendicular to the image plane and points into the image. Looking at the orthogonal projections and *cal_points.gif* will help you understand the geometry of the problem.

3 Locating calibration points in the image

In order to perform camera calibration, the coordinates of at least six points must be known both in the image and in the world reference frame. The points must not all be coplanar. For numerical reasons, it is desirable to use more than 6 points. Image *cal_points.gif* shows the positions of the 14 points we will use for calibration. The world coordinates of these points are already coded in the script *calibration.m*. Find their corresponding image coordinates in *S7img1.gif*. Ideally, this task should be performed automatically on a simple, high-contrast calibration object, but implementing this is beyond the scope of this exercise. We will use the Matlab command *impixel* instead.

4 Finding the camera parameters

Find the camera parameters according to the procedures outlines in chapter 13.3 of the course book. From the world and image coordinates you should obtain the matrix B (Eq 13.61) and compute M from B using the equations in section 13.3. Calculate the intrinsic and extrinsic camera parameters from M.

The following results should be included in the report:

- Values of R and t.

- The relationship between the world reference frame and the camera reference frame. This is best illustrated by a sketch of the two frames and their relative positions.

- The pixel coordinates of the image centre (c_0, r_0).

- Given that the focal length f is 9 world units (e.g. metres), give the number of pixels per world unit on the x and y axes.

- Compare your results with those in S7README.txt and comment on the difference, if there is any.

- **Optional** Test the effect of using fewer points empirically. Comment on the effect on your results.