CS 4/791E Computer Vision

Spring 2003 - Dr. George Bebis

Programming Assignment 3

Due date: 4/27/04

This assignment is about camera calibration and has two parts. In the first part, you will use OpenCV's camera calibration routines. In the second part, you will implement the calibration technique based on the projection matrix (section 6.3).

Data

The data for direct camera calibration have been posted on the webpage of the course. You would need to capture your own data for the second part (calibration using the projection matrix).

Direct Camera Calibration

Use OpenCV's routine *cvCalibrateCamera_64d* to compute the intrinsic and extrinsic camera parameters. For a description of the method implemented in OpenCV as well as how to use *cvCalibrateCamera*, you should consult the OpenCV manual (pages 6-1 to 6-4 and 13-4). Perform the accuracy and projection tests as described below.

Camera Calibration Using the Projection Matrix

Implement and test the camera calibration method discussed in class based on the projection matrix. First, you need to compute the elements of the projection matrix. Then, you need to compute the extrinsic and intrinsic camera parameter as described in Section 6.3 of your textbook. Use Numerical Recipes' routine *svdcmp.c* (available from the course's webpage) to compute the SVD of the matrix A (see page 133). *Warning:* when using arrays, Numerical Recipes assume that the first array location is never used. If you need to use an array of size N, you would need to allocate an array of size $N+1$ and simply disregard the [0] location (i.e., your array index should go from 1 to N).

Experimentation and Comparisons

The following experiments should be done for each calibration method seperately.

Accuracy test: use the computed parameters to project all world points used for calibration to the image plane by computing the pixel coordinates (r, c) of every point using the estimated projection matrix. Then, compute the error between the computed (r, c) and the estimated $(\hat{r}, \hat{c})$ given to you in the course's webpage:

$$Error = \sqrt{(r - \hat{r})^2 + (c - \hat{c})^2}$$

Projection test: Compute the predicted row and column numbers (r, c) of some new 3D points (i.e., points that were NOT used during the calibration procedure) using the parameters you computed. Then, use *xv* to find the observed row and column numbers for that point from the image provided. Is the predicted projection very close to the observed one? Report the distance between the projected and actual points.