Homework Assignment 2

CS223B, Winter 2005-06, Stanford University

Due: Wed, Feb 1, 11:59 PM

Assignment Overview

This assignment is worth 10% of your total grade. It is graded out of a total of 100 points. It consists of three problems: one programming problem, and two written problems.

What to Hand In

You will electronically submit the following items:

- The required submission materials for Problem 1.
- The "`ANSWERS`.txt/pdf" file containing the answers to the written portion of this assignment (Problems 2 and 3). Include the names, email addresses, and su-id's of all of your group members.

To submit your completed assignment, email a single ZIP or TAR archive containing all of the above components to cs223b+submit@gmail.com. You must include all of the components; we will not accept partial submissions.

1: Camera Calibration (60 Points)

Objective

In this problem, you are required to write a program for determining the intrinsic parameters of a camera (refer to Section 6.2.1, textbook):

- (f_x, f_y): focal lengths in horizontal and vertical pixels, and
- (o_x, o_y): coordinates of the image center.

What we provide

We snapped 10 images of a planar checkerboard pattern (with 32, 0.75 in x 0.75 in, black squares) using the camera from various poses. These images are available at

`/afs/cs.stanford.edu/class/cs223b/www/homework/hw2/images/checker`

and

`http://cs223b.stanford.edu/homework/hw2/images/checker`

Your program is required to take these images as inputs, extract the corners of the checkerboard pattern in the images, and use the extracted corners to determine the intrinsic parameters of the camera.

You may use the Harris corner detection Matlab code presented in the lecture (Mon, Jan 23) to detect the checkerboard corners. You may have to filter any out non-checkerboard corner detected by the detector. The code is available as "harris.m" in the same directory as the checkerboard images.

Submission

For this problem, you are required to submit the following materials:

- The "`solutions`.txt" file containing just 4 lines corresponding to the numerical values of f_x, f_y, o_x, and o_y, respectively, computed by your program using the provided checkerboard images.
- The source code. Please make an effort to submit neat, commented code so that we can give you partial credit if your numerical answers are not accurate.
- The "`README`.txt" file containing the instructions to compile and execute your source code.
- The "`WRITEUP`.txt/pdf" file containing a description of your approach. Include the names, email addresses, and su-id's of all of your group members.

Honor Code

You are free to use Matlab, OpenCV, or any other computer vision libraries, except the existing camera calibration routines.

2: Sobel Operator (10 Points)

Prove mathematically that the Sobel operator (the two image convolution masks) is decomposable.

3: Harris Corner Detector (30 Points)

(a) Is the Harris corner detector a linear filter? Argue why or why not.

(b) Recall that SIFT features are invariant to scaling, rotation, change of illumination, and (within limits) change of perspective. Which of those apply to the Harris corner detector? Explain your answers.

(c) Suppose we applied the Harris Corner detector to an unsmoothed raw image. What type of image would trigger the detector at places that clearly don't contain a corner?