Robotics: Assignment III
(Team Assignment)

Robot Vision

Due: 2015/11/16 13:00 pm

Camera is one of the most commonly used sensor for robot to gather visual information of the environment. With the help of image processing, the robot can analyze the image of the immediate environment imported from the camera and use the result to determine the appropriate action to take.

In this assignment, you will learn how to model the relationship of an image and the real environment with camera calibration and to use the camera model to estimate the position of an object in the real world.

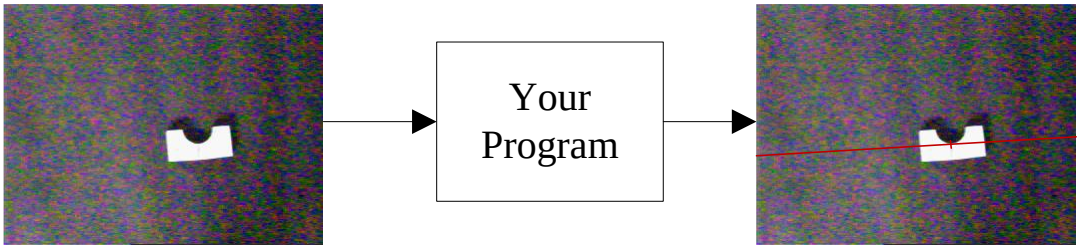
Part A: Camera Calibration

Camera calibration is the process of estimating the parameters of a pinhole camera model, such as focal length and principle point. This process is required for cameras before doing image processing. In this part, you should get familiar with the camera model, and the meaning of camera parameters.

1) There is a C/C++ implementation in OpenCV library [1]. For those who use OpenCV first time, you can refer to [2]. Follow the example code it provides. If you are more familiar with Matlab, you can also download the toolbox [3].
2) Print the checkerboard pattern in "AssignmentIII\part_a" on a sheet. Measure the size of the squares.
3) Find a camera that you want to calibrate, e.g. your phone's camera, webcam etc. Use the camera to capture 20 images with checkerboard for calibration. Try to shoot from different angle for each image. Please provide a clear description about what camera you use.
4) Follow the instructions on the webpage to get all intrinsic parameters. Describe, in your own words, the physical meaning of each intrinsic parameter in report.
   For those who use Matlab, please refer to
   http://www.vision.caltech.edu/bouguetj/calib_doc/htmls/example.html
5) Undistort 20 images you have captured and a new image of anything but checkerboard. Show those 21 sets of original and undistorted images in report.

Part B: Object Detection

Given an image taken from a camera, please use the algorithm you have learned in the section of binary machine vision in Lecture 6 (p.25 - p.40) to write a program to process the image and to mark the foreground object(s). We have provided some examples of basic image processing functions in OpenCV (main.cpp), for Matlab user, you can still find corresponding functions in Matlab.



Centroid = (150, 200)
Principle angle = 92 degree

Input:

We provide 4 images in "AssignmentIII/part_b/images" for testing. Your program should take the file name of the image from the standard input.

Output:

Your program should output the coordinate of the centroid of the object(s) and the principle angle of the object(s) in the following format:

centroid_x (pixel) centroid_y (pixel) principle_angle (degree)

e.g. 150 200 92

Submission

One of the team members should upload the source code of part b (hw3_b.cpp/hw3_b.m) and a report (hw3_report.**pdf**) in a **zip** file to CEIBA. The report should include the division of work in your team.

Reference

[1] Camera Calibration and 3d Reconstruction in OpenCV
http://docs.opencv.org/trunk/doc/tutorials/calib3d/camera_calibration/camera_calibration.html

[2] "A very brief Introduction to OpenCV.ppt" in AssignmentIII.zip

[3] Jean-Yves Bouguet. Camera Calibration Toolbox for Matlab.
http://www.vision.caltech.edu/bouguetj/calib_doc/