BME42-731/ ECE18-795/CB02-740 Bioimage Informatics
Spring 2014
Project Assignment #3

Microscope characterization & curvilinear feature detection

Assigned on Mar-19-2014
Report due on Apr-09-2014 in class or by 5PM in TA's office.
Groups 2 & 4 will give presentations on Apr-09.

A. Overview

This assignment is organized into two parts. In the first part, we will develop several techniques for microscope characterization. In the second part, we will implement Steger's curvilinear feature detection algorithm [1].

The total score for this project assignment is **100 points** (part I: 50 points; part II: 50 points). There are two extra credit questions for a total of 20 points (part I: 10 points; part II: 10 points).

B. Part I: Microscope characterization (50 points + extra credit 10 points)

B.1 Image data

Images for this part of the project should be downloaded from the CMU Blackboard portal. The file name is "microscope_char.rar".

B.2 Characterizing fluorescence image background noise (20 points)

- Write a program that first crops a sufficiently large rectangular region from the background of the image series and saved the cropped region into a series of images that are named sequentially (such as background001.tif, background002.tif, …). Remember to turn off compression when saving the images (5 points).

- Analyze the saved background images to address the following three questions (10 points)

    B.2.1 What distribution does the noise signal follow? Is it a normal distribution? Is the noise white? Why?
    B.2.2 Does the noise distribution change over time?
    B.2.3 Does the noise distribution change over space?

- Answer question B.2.1 on background noise of the two images of Questions 2 & 3 that we used in Project Assignment 01. For the second image, analyze the channels separately (5 points).

B.3 Characterizing illumination uniformity (10 points)

Define and implement you own quantitative descriptors to characterize the uniformity of illumination. (Hint: analyze image intensity distribution in the background area with no image features)

B.4 Microscope pixel calibration (20 points)

As demonstrated in the lab visit, a micrometer slide from TedPella was used for microscope calibration. Detailed specifications can be found at http://www.tedpella.com/histo_html/2280-10.htm

The slide that we use is No. 2280-16.

B.4.1 Develop a manual/interactive approach to calibrate pixel size under different magnifications using the images provided (10 points).

B.4.2 Develop a semi or fully automated method to calibrate pixel size (10 points)

B.5 (extra credit 10 points): Implementation of a directional anisotropic filter
Implement the anisotropic Gaussian filter described in the following paper (only the non-iterative form).

J.-M. Geusebroek, A. W. M. Smeulders, and J. van de Weijer, Fast anisotropic Gaussian filtering, *IEEE Trans. Image Processing*, vol. 12, no. 8, pp. 938-943, 2003.

Use the image from Question 2 of Project Assignment 01. Apply an anisotropic filter at 30, 60, 90, 120, 150 degrees with σ=10 in the longitudinal direction and σ=5 in the lateral direction. Display the result images.

C. Curvilinear feature detection (50 points + extra credit 10 points)

Three test images are provided (curv_det_01.tif, curv_det_02.tif, curv_det_03.tif).

C.1 Implementation of the Steger's algorithm (50 points)

For this part, we will only implement the case with the same contrast on both sides and will only implement identification of pixels on the curvilinear feature.

C.2 (extra credit 10 points): Implementation of the pixel linking operation

We will link the identified pixels into curves.

D. Report format

Please follow the recommended report format as described in Lecture 09.

Page size: letter
Line space: single
Page margins: no less than 1 inch
Font size: 12 points for the main text; 10 points for listed references

E. Submission of MATLAB code and results

We will follow the same protocol of code and results uploading as in previous project assignments.

Reference

[1] C. Steger, An unbiased detector of curvilinear structures, *IEEE Trans. Pattern Analysis and Machine Intelligence*, vol. 20, pp. 113-125, 1998.