UiT

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EXAMINATION PAPER

Home Exam in:	**Fys-2010 Digital Image Processing**
Hand-out:	**Friday 4th March 2016 at 0900.**
Hand-in:	**Friday 18th March 2016 (1500 at latest)**

The exam contains 6 pages including this cover page and appendix.

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General Information

We will process images which may be downloaded from the website of the Gonzales and Woods course textbook:

`imageprocessingplace.com/DIP-3E/dip3e_book_images_downloads.htm`

MATLAB-code must be incorporated in your text or appended. Alternatively, you may also submit the code as a separate file in Fronter. The code should be commented in such a way that any person with programming knowledge should be able to understand how the program works.

Problem 1: Histogram Equalization

(a) Explain briefly what information an image histogram provides. Download the image **Fig0310(b)(washed_out_pollen_image).tif** from the book website and display the image and its histogram (you may use MATLAB's `hist` function if you wish). You should obtain something resembling Fig. 1. Comment the result.

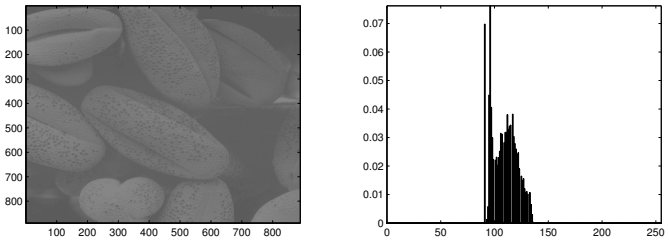

Figure 1: Low-contrast image and corresponding histogram.

(b) Explain the basis of histogram equalization and implement this procedure. Use the image from **(a)** and display the histogram equalized image and its histogram. Do not use a pre-programmed procedure such as MATLAB's `histeq`, but program your own script. You should obtain something resembling (not necessarily equal wrt. method of visualization) Fig. 2. Comment the result.

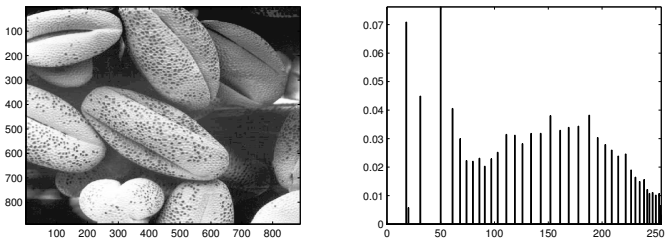

Figure 2: Histogram equalized image with corresponding histogram.

Problem 2: Spatial Filtering

(a) Write your own script performing two-dimensional convolution between a filter and an image. Do not use MATLAB's `conv2` function. Convolve an impulse image given by

$$f(x,y) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

with a filter

$$w(x,y) = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}.$$

What result do you get? PS: You can rotate a filter 180 degrees e.g. by the MATLAB command `w180 = flipud(fliplr(w));`

(b) In the remainder of this exercise, we will focus on sharpening a medical image. For that purpose, download the medical image **Fig0343(a)(skeleton_orig).tif** from the book website. For the arithmetic operations, convert this image to *double*-format using `im2double` and convert back to *uint8*-format using `im2uint8` when displaying images on screen. The end result of the following problems should resemble Fig. 3.

Discuss the basis of image sharpening using Laplacian filters and implement the procedure using the following Laplacian filter

$$l(x,y) = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}.$$

Your script from (a) may prove useful.

(c) Implement a procedure that will transform the intensities of any image to the range [0,1]. Display the medical image, the corresponding Laplacian filter scaled to [0,1] and the corresponding Laplacian sharpened image.

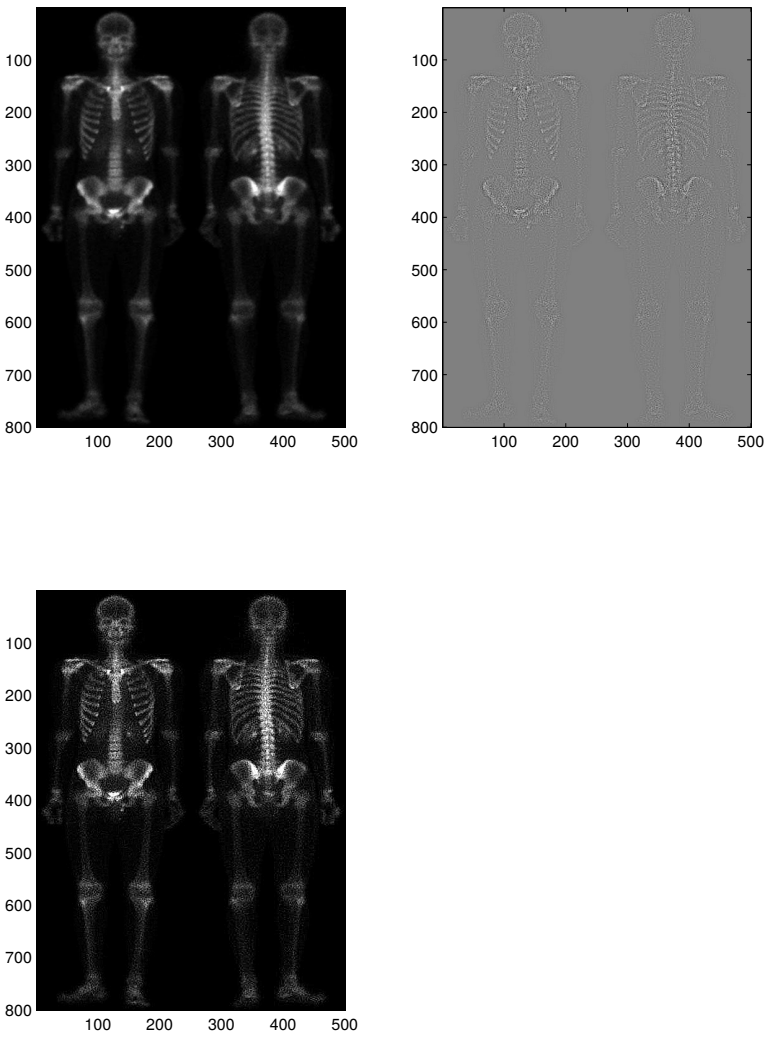

Figure 3: From top left to bottom right: Original image, Laplacian image, Laplacian sharpened image.

Problem 3: Denoising

Download the images **P3_fig1.png**, **P3_fig2.png** and **P3_fig3.png** from Fronter. These images are corrupted by additive noise and in this exercise your task is to remove the noise. You should implement your own procedures, and not use built-in MATLAB filtering functions.

(a) Investigate (visually and/or by other method) what type of noise has been added to each of the three images.

(b) For **P3_fig1.png**, select a spatial filtering technique for removing the noise and apply it to the image. Explain your choice of method and discuss the results.

(c) Describe the procedure of filtering images in the frequency domain, the importance of padding and the link between filtering in the spatial and frequency domain.

(d) Repeat question 3b), but this time remove the noise by filtering in the frequency domain. Explain your choice of method and discuss the results.

(e) For **P3_fig2.png**, select a filtering technique for removing the noise and apply it to the image. Explain your choice of method and discuss the results.

(f) Repeat question 3e) for **P3_fig3.png**.