Lab3: Image enhancement

Student name: **Total mark:** / 3

Student number: **TA signature:**

Instructions

- Bring a printed copy of the lab sheet to the lab.
- Complete all three parts of the lab below.
- Part IV is optional. It is recommended you complete it on your own.
- Answer all questions using complete sentences in the boxes provided. Answers may be typed or hand-written **legibly**. You may exceed the box size if necessary.
- Before leaving the lab, give the completed lab sheet to the TA.

* See the MATLAB documents of "imfilter", "fft2", "ifft2", "fftshift", "ifftshift", and others in detail at the MathWorks website.
* To display an image, use “imagesc(im)” or “imshow(im, [ ])” so that the display intensity range is automatically optimized. Always display the color bar using “colorbar” to verify the intensity range.

Part I [1 mark]: Averaging filter (spatial domain) ______/ 1

(1) Download a medical image of your choice. Resize the image smaller if it is bigger than 300 x 300 pixels using “imresize”. If the image data is color, convert it to grayscale using “rgb2gray”. Convert gray to double using “im2double”. Show the image, f(x,y).

(2) Add noise signals, given by $n(x,y)=0.5\sin(0.4\pi x)+0.5\sin(0.4\pi y)$, to the image f(x,y). Show the noisy image fn (=f+n).
Hint: To create n use [x y] = meshgrid(1:width, 1:height) *to get (x,y) for n(x,y) above.*
Give an example of the type of noise that is being simulated here. Give an example of a different type of noise and an example source (i.e. non-sinusoidal)

(3) Create an averaging filter h using “ones(k)”, where k is the mask (kernel) size. Remove the noise signals n from fn using h by the convolution mask, g=fn*h in spatial domain. Convolution mask operation can be performed by “imfilter”. What is the optimal size k? Justify your answer.

Optimal k =

(4) Compare and discuss the original image f, noisy image fn, and filtered image g.

Part II [1 mark]: Low pass filter (frequency domain) ______ / 1

(1) Apply 2-D Fourier transform "fft2" on the images, f, n and fn, used in Part I. Set the origin of the spectrum (u,v)=(0,0) at the center of the image display using "fftshift". Display its magnitude using "abs". You may also take "log" of the magnitude to have a great dynamic range if necessary. Display and compare these spectrums.

(2) Create a low pass filter L(u,v) with the same pixel dimension of the image fn using "ones" and "zeros". You may design the filter with a rectangular (not circular) shape. Display the L(u,v). What are the cut-off frequencies, u_c, v_c, (pixel numbers) to remove n from fn?

u_c = __________ v_c = __________

(3) In frequency domain, remove the noise n from fn using the low pass filter designed. Display frequency spectrum of the filtered image. Rearrange the filtered complex spectrum data (not the magnitude spectrum data) using "ifftshift". Then, apply an inverse Fourier transform "ifft2" to reconstruct a spatial domain image. Show the image and compare it with the original image f. What features have change in the resulting image?

Part III [1 mark]: Band limit filter (frequency domain) ______ / 1

(1) Repeat (2)-(4) with a band limit filter to remove only the noise frequency bands in frequency domain. Compare the reconstructed image with the original image f and the image obtained in Part II (4). Discuss whether the band limit filter more effective at removing noise?

(2) Would a band limit filter be effective at removing thermal noise? Explain your answer.

Part IV: Additional suggested work (Optional, no mark)

(1) Try with a different image having a bigger or smaller pixel dimension.
(2) Sharpen the blurred (filtered) image.