Mandatory exercise 2
Signal and Image Processing 2012

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In total, the uploaded answer to this exercise must be held within 4-5 A4-pages, so choose your examples/images carefully and write concisely. The answers must be typed, handwritten reports will not be accepted.

Question 2.1

Implement a 2-D filtering program "package" that makes the filtering in the Fourier domain, given either the impulse response of the filter in the spatial domain, or the transfer function in the Fourier domain. You may use the MATLAB implementation of the FFT (and fftshift, ifftshift) and but other parts of the programme you should program yourself (not to use functions from the image processing toolbox). Your implementation must have the capabilities to:

(a) Extend the image and the filter by zero padding to avoid wrap around error.

(b) Performing the filtering in the Fourier domain.

(c) Visualise the image, the filter, and the filtering result, in both spatial and Fourier domain, so that the the frequency response is centred on the Fourier domain.

Test the implementation, by filtering the given test image *testimg.tif* by 5×5 averaging filter, and the ideal low pass filter, and compare the results. Explain what you did and the results you obtained.

Question 2.2

Implement the Gaussian lowpass and high pass filter (GW Sec. 4.8.3 and 4.9.3) and apply it to the *barbara.tif* image. Evaluate the filtering result on couple of cut-off frequencies and explain the results you get. Then using the Gaussian high pass filter, implement a high-frequency emphasis filter for sharpening an image. Try to invert your low-pass filtered result above by filtering it with the high-frequency emphasis filter (GW Sec. 4.9.5). Explain the results you get. Is the inversion feasible?

Question 2.3

Implement image resizing using signal processing techniques. Do not use the image resizing tools available in image processing toolbox.

In the downsamping, design as good anti-aliasing filter as you can, and shrink the original *barbara.tif* image by the factor of 4 by simple resampling with and without using the anti-aliasing filter, and compare the results. Illustrate the spectrum before and after using the anti-aliasing filter. Report how you designed the anti-aliasing filter you chose, and why.

In the upsampling, pad zeros between the original samples so that the image size grows by the factor of 3 in both dimensions. Illustrate the spectrum before and after adding the zeros and design an appropriate filter to remove the mirrored parts of the spectrum as well as possible. Explain what you did and the reflect the results.

Question 2.4

The image *interference.tif* has been corrupted by noise and a systematic interference pattern. Please describe the noise and inference patterns and develop, implement, describe, and apply a program for removing as much of the noise and interference pattern as possible. Show (and explain) the results. The program need not to be fully automatic, but may include interactive input, e.g. using the MATLAB-function *ginput*.