Visual Computing

Exercise 3

Note: All programming has to be done in MATLAB. It is not compulsory to submit your solutions for this exercise to the TA. However, you can still pass them your codes if you encounter any problems or you want them to help you check your solutions. You can contact Peidong Liu at peidong.liu@inf.ethz.ch regarding these kinds of enquiries.

Some MATLAB commands you might find useful:

- **conv2**: Two-dimensional convolution
- **fspecial**: Creates a two-dimensional Gaussian filter
- **fft2**: 2-D fast Fourier transform
- **ifft2**: 2-D inverse fast Fourier transform
- **fftshift**: Shift zero-frequency component to center of spectrum
- **tic**: Start stopwatch timer
- **toc**: Read elapsed time from stopwatch

3.1 Filtering

- Create a 5*5 Gaussian low pass filter with standard deviation 1. This filter will be referred as LPF.

- Create a 15*15 Gaussian low pass filter with standard deviation 3.5. Transform the filter into a high-pass one. This filter will be referred as HPF.

- Create a 15*15 Gaussian filter with standard deviations 0.5. Using this new filter and HPF, create a band pass filter. This filter will be referred as BPF.

Apply these three filters to the two sample images in spatial domain by convolving the image with the kernel, and once again in frequency domain by taking the Fourier transform of both the image and the filter kernel. Compare run times of the spatial and frequency domain filtering.

Compare the filtering results of two images by visualizing the filtered images in both spatial and frequency domains. Comment on frequency content of two images.

*Hint*: The high pass content of an image can be extracted by subtracting the low pass filtered image from the original image. Hence, to get a high pass filter kernel from a low pass one, you can subtract the LPF kernel from a unit impulse filter.
3.2 Sampling

Down-sample both images to one fourth of the resolution by taking every second row and column. Compare the results in terms of distortions and unexpected effects. Explain why the quality of two down-sampled images differs with each other.

Create three 15*15 Gaussian low pass filters with standard deviations 0.5, 1 and 1.5 and apply them to wall.jpg. Visualize the filtered images in frequency domain. Down-sample the three filtered images to one fourth resolution. Compare the resultant down-sampled images in terms of quality.

I Acknowledge Mr. Yagiz Aksoy from the CVG group for the permission to use his questions for this exercise.