

RRY025-- Image Processing

Exercises 4 – Lecture 4 – Fourier II

EX 4. 2D Fourier filtering basics.

Load the cameraman.tif image. Filter the image in the frequency domain using an ideal low-pass filter with cutoff equal to one-eighth of the maximum frequency along each axis, without zero padding.

HELP: Among the Matlab files of the course, there is a file raduv.m. Have a look and see if it is useful. You can use it, or program your own way of doing achieving the same.

Display the filtered image in the spatial domain. Apart from excessive smoothing, there is ringing. Can you explain why? HELP: Display the filter in the spatial domain...

Test also filtering the original image using an ideal high pass filter.

EX 5. ... continued...

Same as Ex 1, but using Butterworth filters. What are the main differences to the ideal filter in Ex 1? Can you recognise where those differences come from?

EX 6. ... continued...

Same as Ex 1, but using Gaussian filters. What are the main differences to the ideal filter in Ex 1? Can you recognise where those differences come from?

EX 7. Convolution theorem

Seek to prove the convolution theorem empirically, by convolving an image in both image domain (with filter2) and in Fourier domain using multiplication of the Fourier transform of the image and kernel.

Select an image to represent f .

Construct a 2D Gaussian kernel function, g , that has the window size of the image f ; the sigma of the Gaussian is given as an input parameter.

Smooth (=convolve) the image using the convolution theorem. Compare with the direct calculation of $g \star \star f$ in the image domain.

Hint: Remember that even though the Fourier transform of a Gaussian is a Gaussian, the sigma of that Gaussian changes during the Fourier transform. Be careful to use the right sigma in the right situation.

EX 8. Fourier filtering experiment from the scratch.

Use an image of your choosing (HINT: Astro pictures available at <https://www.eso.org/public/images/>). Try to first plan and then execute the following scenario.

Choose an image of your liking that has some recurrent features . This could be, for example, pattern in clothing, leafs of a tree, ants on a ground, stars on a sky, or nebulae in astro images.

Hypothesise which filtering technique could work well in emphasising those features. Write down a few lines for a hypothesis.

Experiment with highpass, lowpass, unsharp masking, or bandpass/reject filters on the image. See if you can find out a filter that emphasises the features you chose.

Go back and compare the experiments with your hypothesis. Consider what you understood or learned from filtering during this exercise. What remained unclear?