Digital Image Processing in Astronomy

Please write your results in a textfile or m-file and send it to me by e-mail at the latest on 26/05/2014. Group work is permitted but text and programs should be written by yourself.

Exercise 1: *Correlation and convolution [2 Points]*

(a) What is the difference between correlation and convolution?

(b) Compute the correlation and convolution of A with the filter w.

$$A = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 10 & 10 & 10 & 10 & 0 & 0 \\ 0 & 0 & 10 & 10 & 10 & 10 & 0 & 0 \\ 0 & 0 & 10 & 10 & 10 & 10 & 0 & 0 \\ 0 & 0 & 10 & 10 & 10 & 10 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad w = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 0 & 0 \\ 1 & 1 & -1 \end{bmatrix}$$

Exercise 2: *Filter in the spatial domain [2.5 Points]*

Pick three images of your choice: Two pictures of different light-dark shades and the third with many edges.
(Note: Convert color images into grayscale images.)

(a) Create a "Gaussian" kernel and filter the first picture with that using *imfilter*.
Describe the changes in image as you change the σ-parameter.

(b) Add "Gaussian" noise to the first image and apply an appropriate filter to remove that noise from the picture.

(c) Add "Salt-&-Pepper" noise to the second image. Remove that noise with a suitable kernel and with different parameters.

(d) Take the third picture and try by appropriate filter to enhance

(1) horizontal,

(2) vertical, and

(3) diagonal lines.

Exercise 3: *Resolution [3 Points]*

Create an 8-bit image with the following content: A black background with nine white stripes of 7 pixels width and 210 pixels height. The distance between the white stripes should be 17 pixels.

(a) Now filter the image using arithmetic mean, goemetric mean, and harmonic mean filters of different sizes.

(b) At what filter size are the stripes no longer sharply resolved?

(c) Describe what happens while applying the different filters to the image.

Exercise 4: *Filter in the frequency domain [2.5 Points]*

Create a 3×3 filter mask that averages the 4-adjacent neighbours of a centre point $P(x, y)$ but excludes that point itself from the average.

(a) Find an equivalent filter $H(u, v)$ in the frequency domain.

(b) Show that $H(u, v)$ acts like a low-pass filter.

(c) Apply your filter to an image of your choice.

(d) A Gaussian low-pass filter in frequency range has the form:

$H(u, v) = Ae^{-(u^2+v^2)/2\sigma^2}$

Show that the corresponding filter in spatial domain is of the form:

$h(x, y) = A2\pi\sigma^2 e^{-2\pi^2\sigma^2(x^2+y^2)}$

For questions or problems with the exercise, contact us at:

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