RRY025-- Image Processing

Exercises 2 – Lecture 2 – Image Enhancement II

EX 1. Image smoothing

ANSWER: The SNR increases with the square root of the amount of data (pixels). Therefore, it increases linearly with the width (=radius) of the gaussian (because Npixels $\propto R^2$). Thus, the needed increase of data is: $(3 / 0.2)^2$, yielding 225 for SNR=3.

There is some ambiguity regarding what should be regarded as “area” in case of a Gaussian.

One reasonable solution is to say that 1) the area relevant for the noise in the original image is 1 pixel, and 2) in the smoothed image, the sigma of the smoothing Gaussian is the proxy of the size.

To increase the S/N ratio by a factor of 15, one needs to increase the amount of data by a factor of $15^2 = 225$. In other words, the smoothing Gaussian should cover 225 pixels. Following the assumption (2) above, we thus need the sigma of: $A = \mathrm{pi}\ r^2 \rightarrow 225 = \mathrm{pi}\ \mathrm{sigma}^2 \rightarrow \mathrm{sigma} = 15 / \mathrm{sqrt(pi)} \sim 8.5$ pixels.

With this kind of setting, the image reveals Saturn.

If one significantly increases the SNR, the g_sigma becomes comparable to the size of Saturn in the image. As a result, the image starts to loose details and one might not recognize Saturn anymore. SNR = 3 is probably close to the best filtersize for this image.

Useful limits are set by getting some increase in SNR (> a few pixels) and size of the details one wishes to see in the image (perhaps around 20-30 pixels in this image).

EX 2. Unsharp masking; high-pass imaging

Example given as a Matlab script.

The high-pass image (original - smoothed) captures the edges of features in the image. The average pixel value is close to zero.

Insight: The procedure of subtracting a smoothed image from the original equals to a derivative (sharpening) operation. In the next exercise, one shows this by computing the sharpening as a convolution of the original image with a sharpening kernel.

High-boosting makes the edges in the images a bit more prominent, but overall, the sharpening with such a simplistic method looks a bit artificial. A = 2-3 is not a bad choice…

EX 3. High-pass filtering – computed as a convolution filtering

Example given as a Matlab script.

EX 4. Edge Detection

Example given as a Matlab script.

EX 5. Noise Reduction via image Smoothing

ANSWER: The experiments should show that ’salt and pepper’ noise is better removed using median filter. This is because the averaging filter makes the ‘salt’ and ‘pepper’ values (1 and 256) bleed to the surrounding pixels. Median, however, is good in removing such outliers from the data.