SGN-12006 Basic Course in Image and Video Processing

EXERCISE 9

09.11.2015-11.11.2015

This exercise consists of both lab exercises and homework. Complete the lab exercises and present your results for the TA. Prerequisite for submitting the homework is attendance in an exercise session. Homework should be submitted only online using Moodle2.

Follow the naming format 'ExN_surname_ID.pdf' (N is the number of exercise). Also please clearly write down your full name and student number in the document. The homework report should be no more than 1 page long and it should be done individually (no pairs allowed). Questions on this exercise should be addressed to TA's email address: (firstname.surname@tut.fi).

Lab exercise

For simplicity, we will assume an ideal image restoration procedure.

1. Image Restoration (3 points)

(Hint: If division by values close to zero causes problems, add a small constant value to the denominator.)

a. Implement a motion blurring filter as follows:

$$H(u,v) = \frac{T}{\pi(ua+vb)}\sin\left[\pi(ua+vb)\right]\exp(-j\pi(ua+vb)),$$

where *T* is the exposure time of the camera and *a* and *b* are the total distances covered by the motion of the imaged objects relative to the camera, in time T, for the x- and y- directions respectively.

Blur image *DIP.jpg* in the 135º direction (considering the unit circle) using T=1 and the total distances covered by the motion is 0.1.

```
[u, v] = meshgrid(-row/2+1:row/2, -col/2+1:col/2);
```

b. Apply *H(u,v)* to the image *DIP.jpg* to generate a motion blurred image.

c. Apply inverse filtering to restore the image.

d. Display the images in a row sub-plot: original, degraded (1b), result (1c) and add Mean Squared Error values.

2. Image Restoration via Wiener Filtering (3 points)

a. Add noise to the blurred image with zero mean and a variance of 50. (help `randn`)

b. Apply simple inverse filtering.

c. Apply the Wiener filter:

$$\hat{F}(u,v) = \frac{1}{H(u,v)} \left[\frac{|H(u,v)|^2}{|H(u,v)|^2 + \frac{S_n(u,v)}{S_f(u,v)}} \right] G(u,v)$$

d. Display the images in a row sub-plot: original, degraded (2a), result (2b), result (2c).

e. What would the restoration using the Wiener Filter look like if, as in most cases, you do not have the undegraded image. Compare to 2c.

Homework: (4 points)

a) Explain why simple inverse filtering generally cannot recover problems such as 2a). (1 point).

b) What are the drawbacks of the two Wiener filter versions applied in 2c and 2e? (1 point)

c) Constrained Least Squares filtering is another approach tackling image restoration. What are the main differences compared to Wiener filtering? (2 points)