# Exam introduction to image processing
# February 15th, 2011

***18.30-21.15***

Please return forms with questions together with your answers to supervisor
Do not take them outside of the exam room

The total number of points to be earned is: 36.
Marks are calculated as 1 + (number of points)/4.

In all cases motivate your answer.

**Question 1.**
a. (2 points) Give a detailed description of the goal of histogram equalization.
b. (4 points) Give a detailed description of a method for histogram equalization.
c. (1 point) Describe in words the appearance of the cumulative distribution function plotted as a function of intensity for an image that has undergone the histogram equalization operation.
d. (2 points) Is histogram equalization a separable operation? Explain.

**Question 2.**
We want to register one brain MR image (Image 1) onto another brain MR image (Image 2), and therefore want to calculate a linear co-ordinate transformation that performs this mapping. The two images have average signal intensities for different brain tissues as follows:

| | Image 1 | Image 2 |
|---|---|---|
| Gray matter | 80 | 700 |
| White matter | 120 | 1300 |
| CSF | 40 | 350 |

We have two choices for the interpolation function: nearest neighbor or tri-linear interpolation.

a. (1 point)
Is the sum of squared differences as the cost function for the registration a good choice? Why/why not?

b. (2 points)
Give an advantage and a disadvantage of choosing nearest neighbor interpolation.

c. (2 points)
Give an advantage and a disadvantage of choosing tri-linear interpolation.

Secondly, we want to bring additional various types of images, that are in the same space as the first image, into the space of the second image, using the transformation calculated in the first part.

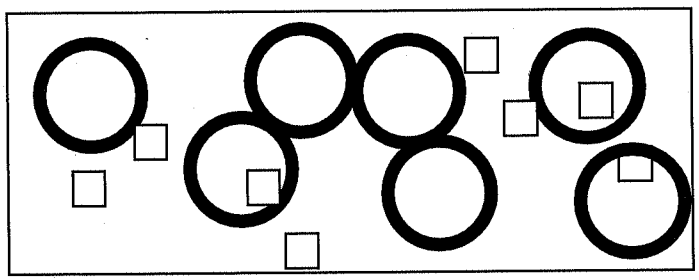
d. (2 points) Give an example of a type of image for which nearest-neighbor interpolation is preferred, and explain.

e. (2 points) Give an example of a type of image for which tri-linear interpolation is preferred, and explain.

**Question 3.**

a. (3 points)
Give a precise description of a gray scale closing operator.
b. (3 points)
Under which conditions is a morphological gray scale dilation equivalent to a binary dilation?
c. (3 points)
What is the mathematical relation between a local max operator and a gray scale dilatation? Explain.

**Question 4.**
Consider the binary image below. The width of a circle boundaries is a few pixels. Apart from some noise pixels (not visible in the figure), the background is null.



a. (5 points)
Describe an algorithm to count the number circles automatically, using a connected components algorithm. What are the underlying assumptions?

b. (4 points)
Describe an algorithm to count the number of squares. What are the underlying assumptions?