Centre for Mathematical Sciences, Mathematics, LTH, September 2013

Image Analysis, Handin 2

These are distributed during the lecture September 13, 2013 and has to be finished by September 20, 2013. Written solutions are handed in either (i) at the lectures or (ii) to the box entitled 'inlämningsuppgift bildanalys' in the corridor on the third floor of the math building, near room MH:333.

Note: Write your solutions neatly and explain your calculations. All exercises should be done *individually.*

1. Interpolation

Assume a one-dimensional image (or signal)

$$f = \begin{bmatrix} 1 & 4 & 6 & 8 & 7 & 5 & 3 \end{bmatrix} \ .$$

Explain what linear interpolation means. Sketch what the function f looks like after linear interpolation.

Interpolation can often be expressed using the following equation

$$F_g(x) = \sum_i g(x-i)f(i) \ , \tag{1}$$

where the function $g(x)$ is different for different types of interpolation. Which function $g(x)$ correspond to linear interpolation?

Assume that the position for the seven pixels are $0, 1, 2, 3, 4, 5, 6$. What is the intensity and the derivative of the intensity between the pixels, i.e. at positions $x = 0.5, 1.5, 2.5, 3.5, 4.5, 5.5$. Calculate the derivative both by differentiating the equation (1) with respect to x and evaluating the result, and graphically using the figure obtained above.

What is the connection between the derivative of F_g at points $x = 0.5 + k, k = 0, \ldots, 5$ and the discrete 'differentiation' $f * w$, where $w = [1 \ -1]$.

Give one example of an interpolation function $g(x)$ in equation (1) such that

$$\frac{dF_g}{dx}(k) = (f * w_2)(k), \quad k = 1, \ldots, 5 \ ,$$

where $w_2 = \begin{bmatrix} 1/2 & 0 & -1/2 \end{bmatrix}$.

2. Feature extraction

Given a binary image B (thus only with zeros and ones), study the region of pixels that are equal to one. Use your imagination to define at least 6 different features, that does not depend on which position the region has. In other words, if the regions is shifted in the x or y direction, then the same features will be obtained.

Write a function in matlab that, given such and image matrix B as input, returns a feature vector (with $n \geq 6$).

$$x = \begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix} \quad .$$

One suitable function name is

```
function x = segment2features(B);
```

Suggestion: One could try using moments, histograms, the sum of the pixel values along a row or in a subregion. To remove the influence of the position one could first translate the image so that the centre of mass is in the origin.

On the course home page there is a zip-file `inl_OCR.zip`. Here you can find both images and an unfinished routine `inl2_stomme.m` that can be used to load images. Try both `im2segment` (from Handin 1) and then `segment2features` on such images. Do you get similar feature vectors for the same character? Do you get different feature vectors for different characters?

In the written solution to the feature extraction problem, describe and motivate your features, supply both code (e.g. matlab code) and a printout the results of using your algorithm, i.e. supply examples of input data (e.g. as images) and the corresponding feature vectors, both for different characters and for different images of the same character.