Bildanalys – ESS060

Date, time and location: 2005-12-13, afternoon, V-building

Allowed material: Anything but personal advisors will be allowed, i.e. calculators, math tables and course book (Sonka, Jain, or Gonzales/Woods), lecture notes, exercises and personal notes.

Exam rounds: We will visit you at approximately 45 minutes after the beginning of the exam and one hour before the end.

Results: Results will be available on January 16.

Solutions: Solutions will be posted on the website shortly after the second exam

Requirements for grades:

3:>=28
4:>=40
5:>=50

Project report and labs should be submitted before January 1, 2006.

Good luck, Merry Christmas and a Happy New Year – Tomas Gustavsson

Problem 1

Consider the image grayscale, r, to be a continuous random variable with the range [0,1]. The image is subject to a piece-wise linear grayscale transformation, T(r), uniquely defined by

$T(0) = 0.0$
$T(0.2) = 0.2$
$T(0.4) = 0.6$
$T(0.8) = 0.8$
$T(1) = 1.0$

Answer *correct, not correct, or inconclusive* (it is not possible to answer the question given the problem formulation). Each correct answer gives you one point. You may motivate your answer but no additional points are given.

a) The contrast increases in the range [0.0,0.1]
b) The contrast increases in the range [0.25,0.35]
c) Edges in the image will be enhanced.
d) If one point in the input image is brighter than another point (located elsewhere) in the image), the first point will still be brighter in the output image.
e) The mean image intensity will be preserved by the transformation
f) A small object in the image will be better visualized against it local background (local contrast in the neighborhood of the small object will increase).

The input image, following grayscale transformation as defined above, is subject to a filtering step applying the operator

10 20 10
20 40 20
10 20 10

Consider the filter to be normalized before it is being applied. Compare the two images before and after filtering and answer correct, not correct, inconclusive. Each answer may give you one point.

g) The histogram of the output image will be more smooth
h) The mean image intensity will be preserved by the filtering
i) If one point in the input image is brighter than another point (located elsewhere) in the image), the first point will still be brighter in the output image.
j) The contrast increases in the range [0.25,0.35]

Problem 2

Consider two images I_1 and I_2. Extracted from the Fourier magnitude spectrum, F, nine texture features have been computed for both images. Consider a polar representation of the magnitude spectrum, F(r, fi). The frequency range is normalized to [0,1]. The values of the computed features are as follows:

$f_{1,1}$ $(0.0<r<0.1, 0<fi<360) = 100$	$f_{2,1}$ $(0.0<r<0.1, 0<fi<360) = 10$
$f_{1,2}$ $(0.4<r<0.5, -10<fi<10) = 10$	$f_{2,2}$ $(0.4<r<0.5, -10<fi<10) = 10$
$f_{1,3}$ $(0.4<r<0.5, 35<fi<55) = 100$	$f_{2,3}$ $(0.4<r<0.5, 35<fi<55) = 10$
$f_{1,4}$ $(0.4<r<0.5, 80<fi<100) = 10$	$f_{2,4}$ $(0.4<r<0.5, 80<fi<100) = 10$
$f_{1,5}$ $(0.4<r<0.5, 135<fi<155) = 100$	$f_{2,5}$ $(0.4<r<0.5, 135<fi<155) = 10$
$f_{1,6}$ $(0.9<r<1.0, -10<fi<10) = 10$	$f_{2,6}$ $(0.9<r<1.0, -10<fi<10) = 10$
$f_{1,7}$ $(0.9<r<1.0, 35<fi<55) = 10$	$f_{2,7}$ $(0.9<r<1.0, 35<fi<55) = 10$
$f_{1,8}$ $(0.9<r<1.0, 80<fi<100) = 10$	$f_{2,8}$ $(0.9<r<1.0, 80<fi<100) = 100$
$f_{1,9}$ $(0.9<r<1.0, 135<fi<155) = 10$	$f_{2,9}$ $(0.9<r<1.0, 135<fi<155) = 100$

Answer *correct, not correct, or inconclusive* (it is not possible to answer the question given the problem formulation). Each correct answer gives you one point. You may motivate your answer but no additional points are given.

a) I_1 is overall smoother (has got more slowly varying pixel intensities) than I_2.
b) I_1 is more high-frequency at 45 degrees.
c) I_1 is more high-frequency at -135 degrees.
d) I_1 is more high-frequency at 145 degrees.
e) Counting from left to right, I_1 has got more transitions from darker to brighter pixels in the horizontal direction
f) Counting from top to bottom, I_2 has got more extremely rapid transitions from darker to brighter pixels in the vertical direction

Consider two 2-bit images I_3 and I_4 with range [0,3] The associated non-normalized GLCM (dx=+-1, dy=0) are presented below (origo, is at the underlined position):

GLCM I_3	GLCM I_4
$\underline{01}$ 19 10 20	$\underline{40}$ 40 40 80
19 01 19 10	40 40 40 40
10 19 01 10	40 40 40 40
20 10 10 01	80 40 40 40

g) By computing the GLCM texture Contrast, it can be seen that I_3 is more low-frequency in the horizontal direction.
h) The relative occurrence of pixel transitions from graylevel 2 to 3 is the same for the two images.
i) By computing the GLCM texture Contrast, it can be seen that I_3 is more high-frequency in the vertical direction.
j) I_3 is the only image that could have produced GLCM I_3

Problem 3

Consider the filter kernel presented below.

1 1 1
0 0 0
1 $\underline{1}$ 1
0 0 0
1 1 1

Answer *correct, not correct, or inconclusive* (it is not possible to answer the question given the problem formulation). Each correct answer gives you one point. You may motivate your answer but no additional points are given.

a) The filter performs smoothing in all directions and at all frequencies.
b) The filter performs smoothing in all directions.
c) The filter performs high-pass filtering in the vertical direction at the highest possible frequency.
d) The filter performs low-pass filtering in the vertical direction at the lowest possible frequency.
e) If the underlined mid-coefficient is changed from zero to six, it will not change any important characteristic of the filter.
f) The filter performs less well as compared to an unweighted averaging filter.

g) What is the Fourier transform of this filter? (2p)
h) Apply this filter (normalized) to the small pattern (only at underlined pixels) presented below (2p)

3 3 3 2 2 3 3
2 2 2 2 2 3 3
3 $\underline{3}$ 3 2 $\underline{2}$ $\underline{3}$ 3
2 $\underline{2}$ 2 2 2 3 3
3 3 3 2 2 3 3
2 2 2 2 2 3 3

Problem 4

Consider the two patterns below:

```
00000000000000          0000000000000
00000000111000          0011111111000
00111111000000          0011111111000
00000000000000          0011111111000
00000000000000          0000000000000
```

a) Apply a 3x3 max filter of rank type to the left patter. Explain what happens (1+1 p)
b) Apply a 3x3 min filter of rank type to the right patter. Explain what happens (1+1 p)
For both a) and b), consider points outside the patterns as zeroes.

Consider the pattern below:

```
00000000111111111
00000000111111111
00000000111111111
00000000111111111
```

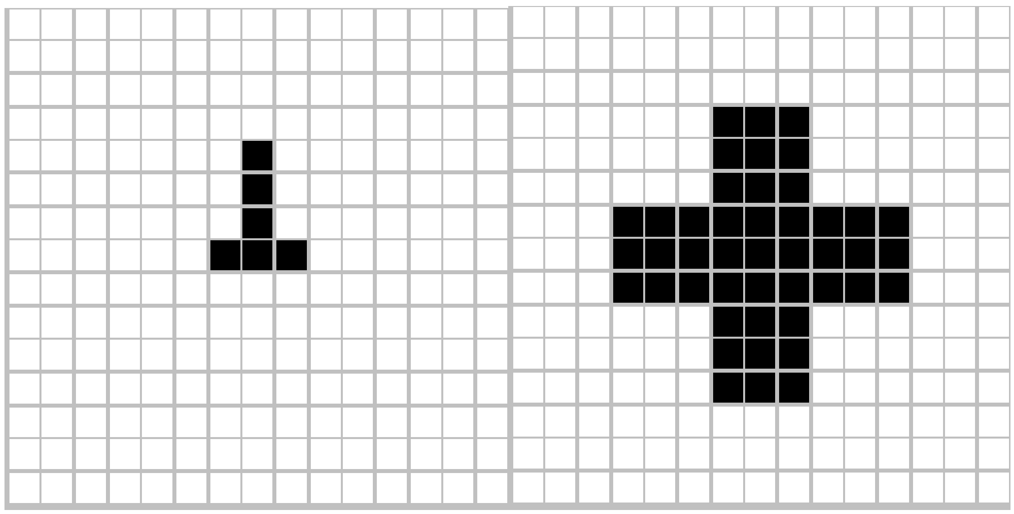
c) Apply a 3x3 range filter. Explain what happens (1+1 p)

Answer *correct, not correct, or inconclusive* (it is not possible to answer the question given the problem formulation). Each correct answer gives you one point. You may motivate your answer but no additional points are given.

d) The median filter performs better than the mean in the presence of salt-and-pepper noise.
e) The median filter performs better than the mean in the presence of Gaussian noise.
f) The Fourier transform of the median is very close to that of the mean
g) The median may remove single pixels at object corners.

5a) Compute numerically a scale invariant version of the second order moment $u_{2,0}$.

(5p)



b) Why are the scale-invariant values of $u_{2,0}$ different for the two objects (1p)

Answer *correct, not correct, or inconclusive* (it is not possible to answer the question given the problem formulation). Each correct answer gives you one point. You may motivate your answer but no additional points are given.

c) Moments can not be used if difference in shape is the only thing that matters.

d) Fourier Shape Descriptors can not be used for object characterization and classification if not only shape but also difference in structure inside the object matters.

d) For any rectangular shape, the second harmonic will contribute a lot to shape reconstruction from Fourier decomposition.

e) For any ellipsoid shape, the second harmonic will contribute a lot to shape reconstruction from Fourier decomposition.

Problem 6

Answer *correct, not correct, or inconclusive* (it is not possible to answer the question given the problem formulation). Each correct answer gives you one point. You may motivate your answer but no additional points are given.

a) Active Shape Modeling (ASM) performs better for object segmentation than Active Contour Modeling (ACM).
b) Dynamic Programming always gives one unique solution.
c) Dynamic Programming is computationally less expensive than ACM.
d) Using weighted variation modes of the Point Distribution Model, it is impossible to synthesize shapes which have not been seen in the training set.
e) The histogram of an image depicting a dark object against a bright background is modeled as an additive mixture of Gaussian distributions. Setting the threshold to a value lower than that associated with minimizing the number of misclassified pixels leads to an increase in specificity.
f) Local thresholding is equivalent to point-wise subtraction between the input image and a small local average.
g) Local thresholding is superior to global thresholding.
h) The Canny Edge Detection algorithm makes use of two thresholds in order to obtain edges which are one pixel thick.
i) A sequence of erode and dilate followed by another sequence of dilate and erode will always take you back to the original image.
j) The course ESS060 Bildanalys is the best course currently available in the curriculum