Computer Assisted Image Analysis II

HT 2012

Exam 2013-04-?? (re-exam)

time:	??.00–??.00	
place:	Polacksbacken, Skrivsal	
tools:	pen or pencil and paper, 1 hand-written sheet with notes	
grades:	0–17	fail
	18–24	3
	25–32	4
	33–40	5

OBS: Please use drawings and figures to illustrate your answers when suitable. Use a new page for each new question, make sure that you write your exam code (or name) on each page, and remember that the top left corner will be hidden by the staple. It is OK to use both front and back sides of the paper. You may write your answers in English or Swedish, but not with red ink.

Results will be forwarded to the student office no later than April ??.

GOOD LUCK!

1. Distance transform (Robin)

a) Explain how the weighted distance transform can be computed by raster scanning and by wave-front propagation. (2p)

b) Why does the fast-marching algorithm not always give exact distance values? (1p)

c) For a distance function d to be a metric, it should fulfil the triangle inequality – for any three points p, q, r, $d(p,r) \leq d(p,q)+d(q,r)$. Show by an example that the distance function defined by $d(p,q)=\text{floor}(\|p-q\|)$, i.e. the largest integer smaller than or equal to the Euclidean distance between p and q, is not a metric. (2p)

2. Interpolation (Cris)

a) Sort the following interpolation methods:

1) lanczos (with parameter a=4)
2) linear
3) cubic spline

according to the following criteria:

i) computational cost
ii) precision
iii) applicability to the hexagonal grid

Explain your reasoning! (2p)

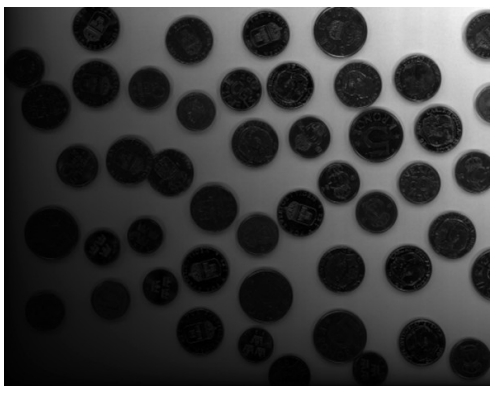
b) Why don't we use the ideal interpolator? (isn't it ideal?) (1p)

c) Can normalized convolution be used for interpolation? If yes, how? If no, why not? (2p)

3. Segmentation (Ida-Maria)

a) Otsu is a common and powerful thresholding method that maximizes the between-class variance. Describe how the threshold level is found assuming an image with two classes, foreground and background. (1p)

b) Describe two different approaches based on thresholding to successfully segment the image below. What/if any pre-processing/post-processing is done, how do you choose parameters etc.? (2+2p)



4. 3D and STEREO (Anders)

a) Explain why structured light is helpful when estimating the 3-D structure of an object. (1p)

b) Derive the equation for stereo estimation based on disparity using two pinhole cameras. Explain your reasoning with suitable figures and basic geometry. (2p)

c) Design a system for 3-D estimation of a scene based on a single pinhole camera and a live ant walking around. What assumptions do you have to make? What things do you need to measure in order to compute the 3-D positions of points in the scene that the ant visits? (2p)

5. High-throughput screening (Carolina)

When developing a method for automated image analysis, it is important to have a ‘ground truth’ so that the performance of the method can be evaluated, or ‘bench marked’.

a) Give some examples of ground truth. (2p)

b) How can the human factor be taken into account when creating ground truth? (3p)

6. RANSAC (Anders)

a) The RANSAC algorithm is a robust method for finding parameters. What does robust mean? (1p)

b) Demonstrate how a RANSAC algorithm fits a line in three iterations, i.e. the algorithm succeeds to find a match on the third try. You select a suitable dataset to prove your point. (2p)

c) An image of 10 round coins of different sizes on a table has been analysed by an edge detector. The 2-D point dataset of edge features is relatively clean and contains only little noise. In order to match a circle model (x, y, radius), three edge points from a coin is sufficient. Compute the probability of RANSAC succeeding for a given iteration of the algorithm, where three points are randomly drawn from the entire dataset of edge points. Then the probability of success within 100 iterations. You may assume that each coin contributes with equal number of edge points. (2p)

7. Classification (Vlada)

a) Let us consider a set of binary shapes that represent all Asian countries using the ratio 1:100000. Explain how will you classify these shapes into three different groups. Explain which features do you plan to use for this task. How does the decision boundary look like in that case? Give a detailed explanation. (2p)

b) The following eight points are given: A_1=(1,2), A_2=(1,3), A_3=(1,5), A_4=(0,7), A_5=(3,1), A_6=(3,2), A_7=(3,4), A_8=(3,6). Apply hierarchical clustering assuming single linkage and city block distance. Construct the dendrogram. What seems to be the optimal number of cluster to choose? (3p)

8. Measurement (Cris)

a) What can you learn about a specific animal tissue and the cells it is composed of, by examining one or a few cross-sections of that tissue, and assuming you know the total volume of the tissue. What measurements do you need to perform to derive that knowledge? (3p)

b) Given one of the cross-sections above, you segment the tissue outline using a snake. You are interested in measuring the perimeter of the outline in this cross-section. How would you proceed? What are possible sources of bias? (2p)