T-61.5070 Computer Vision

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Answers can be given in English, Finnish or Swedish.

1. Explain briefly, with 30–50 words, a mathematical definition and/or an illustration, the following concepts or abbreviations: 6p.

(i) crack edges
(ii) invariance of features
(iii) B-spline
(iv) scale-space methods
(v) point distribution model
(vi) grassfire metaphora

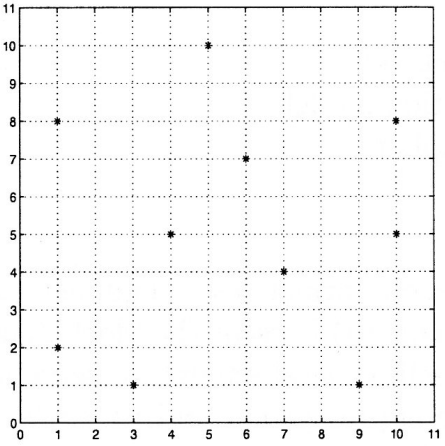
2. (i) Explain the general principles and guidelines in designing and implementing a computer vision system. (ii) Present the block diagram of a computer vision system which is simple but still general enough to serve as an example. Explain the tasks and operation of the entire system and its parts. (iii) Specify what kinds of data structures and control strategies are being employed in your exemplary system and in computer vision systems in general. 6p.

3. (i) What does the division of textures between *fine* and *coarse* ones mean? (ii) What does the division of textures between *weak* and *strong* ones mean? (iii) Form a symmetric co-occurrence matrix from the below image with four grey levels. Use the displacement of $(\Delta x, \Delta y) = (0, 1)$. (iv) From the co-occurrence matrix, calculate the following features: energy, entropy, and contrast. (v) Why are co-occurrence matrices and other descriptors of second order statistics widely used in texture analysis instead of histograms and descriptors of higher order statistics? (vi) Explain in general, in which machine vision tasks texture can be utilized. 6p.

		x				
		1	2	3	4	5
	1	2	0	1	2	0
	2	2	3	0	2	3
y	3	1	2	0	1	2
	4	0	2	3	0	2
	5	0	1	0	0	1

Turn page!

4. (i) Explain what Delaunay triangulation means and perform it to the set of data points shown below. (ii) Explain what Voronoi diagram or tessellation means and perform it to the set of data points shown below. (iii) Explain how Delaunay triangulation and Voronoi tessellation are duals to each other and how that is visible in the case of this set of data points. (iv) Explain what the convex hull of a point set means and what is its relation to Delaunay triangulation. Draw it in the same figure with the triangulation. (v) How is the convex hull of an image area in general, what are its parts and how can it be solved? (vi) In what tasks of computer vision the above techniques could be used? 6p.



5. In the 8-grey-level image a) below, one should separate an object and the background from each other. One knows that the grey levels $f(x,y)$ in the background obey the uniform distribution $P(f(x,y) \mid f(x,y) \in \{1,2,3,4,5\}) = \frac{1}{5}$ whereas in the object they obey the uniform distribution $P(f(x,y) \mid f(x,y) \in \{4,5,6,7\}) = \frac{1}{4}$. (i) Form a grey level histogram and analyze it. (ii) Segment the image assuming that the *a priori* probabilities of the object and the background are equal in the pixels. (iii) Segment the image now assuming that the *a priori* probability of the object is $\frac{1}{3}$. (iv) Segment the image now assuming that the area of the object is eight (8) pixels. (v) Segment the image by using iterative threshold selection and assuming that both the object and background are equally probable and normally distributed with an equal variance. In the first step, assume that the corner pixels of the image constitute the background. (vi) Segment the image by matching it with the template shown as image b). Evaluate the different segmentation results you have obtained. 6p.

4	4	4	3	2
4	5	5	5	2
4	5	7	6	2
3	5	6	3	1
1	2	3	1	1

a)

3	6	3
6	6	6
3	6	3

b)