T-61.5070 Computer Vision

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EXAM 9.1.2009

Answers can be given in English, Finnish or Swedish.

1. Explain briefly, with 20–40 words or a mathematical definition, the following concepts or abbreviations: 6p.

(i) geodesic transforms in morphology
(ii) granulometry in computer vision
(iii) Euler's number
(iv) Moravec detector
(v) principle of optimality in dynamic programming

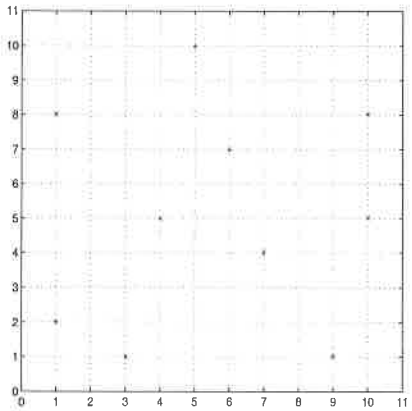
2. (i) Explain the general lines of the design and implementation of machine vision systems. (ii) Explain in general and by giving examples how *a priori* information can be utilized in machine vision systems. (iii) Let us assume that your task is to design a machine vision system for aiding a medical doctor in diagnosing angiographic x-ray images of arteries of a human heart. Show the block diagram of the system and explain the used control strategies. Explain the functions of each part and mention some algorithm capable for that purpose. 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.

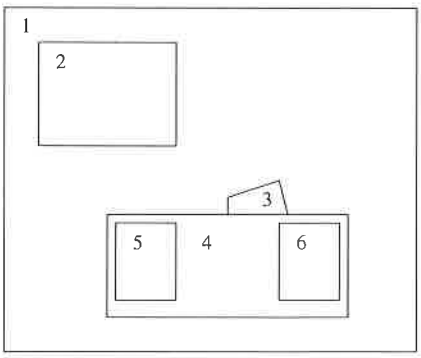
		x				
		1	2	3	4	5
	1	2	0	1	2	0
	2	2	3	0	2	3
y	3	1	2	0	1	2
	4	0	2	3	0	2
	5	0	1	0	0	1

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. Below, there is an image segmented to regions 1, 2, ..., 6. The image is being labeled with discrete relaxation by using the constraints on the right of the image. (i) Show all steps by which the discrete relaxation finds a mutually consistent labeling of the areas of the image. (ii) What would have followed, if a consistent labeling had not been found? What could have been the reasons for such a situation? What would have been done next? (iii) Explain, how constraint d. is ambiguous and unreliable. Make it better! (iv) How does probabilistic relaxation differ from discrete relaxation? (v) How could the image interpretation task of this problem be transformed to be probabilistic relaxation? (vi) In what other tasks of computer vision can relaxation be used? 6p.



a. Window (W) is rectangular.

b. Table (T) is rectangular.

c. Table drawer (D) is rectangular.

d. Telephone (P) is on the table.

e. Table drawer is inside the table.

f. Background (B) is adjacent to the image border.