T-61.5070 Computer Vision

EXAM 5.4.2016

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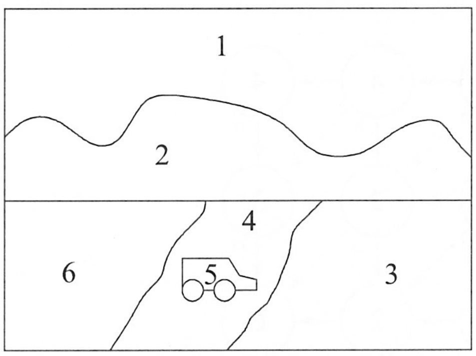
Answers can be given in English, Finnish or Swedish.
Allowed equipment: calculator, pen, pencil and eraser.
By giving course feedback you can get one extra point in this exam!

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

(i) Canny edge detector
(ii) generalized Hough transform
(iii) point distribution model
(iv) texture gradient
(v) moments as object descriptors
(vi) co-occurrence matrix

2. (i) Explain the role of image segmentation in computer vision systems. (ii) Why is the successful operation of the segmentation stage often a key factor for the performance of the whole system? (iii) Name different techniques for implementing the segmentation stage and discuss, in length, their underlying assumptions and pros and cons. 6p.

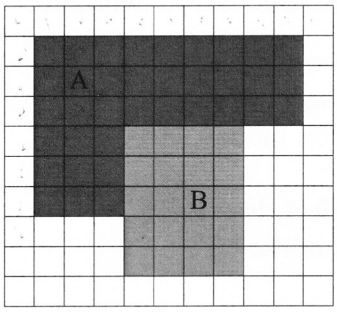
3. Below, there is an image segmented to regions 1, 2, ..., 6. We know that region 5 is moving. The image is being labeled with discrete relaxation by using the constraints on the right of the image. (i) Draw the region adjacency graph corresponding to the image. (ii) Show all steps by which the discrete relaxation algorithm finds a mutually consistent labeling of the regions of the image. (iii) 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? (iv) Explain how constraints "f" and "g" differ from the other constraints. What would happen if either one were removed? (v) How does probabilistic relaxation differ from discrete relaxation? 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. Car (C) is adjacent to road (R).
b. Road is adjacent to grass (G).
c. Grass is adjacent to trees (T).
d. Road is adjacent to trees.
e. Sky (S) is adjacent to trees.
f. Sky is the highest region.
g. Car is moving.

Turn page!

4. In the image below, there are two objects A and B adjacent to each other and the background. (i) Form for both objects the 4-connected inner boundary and 8-connected outer boundary. (ii) Accordingly, form the 8-connected inner boundaries and 4-connected outer boundaries. (iii) Form the extended boundaries of the objects. (iv) Calculate the lengths of all the above-mentioned boundaries. (v) Also, calculate in different ways the length of the boundary between A and B. (vi) Discuss your results. 6p.



5. In the below image, optimal path is searched for from the starting point **A** to the end point **L**. The cost for traversing through each node is marked within the node. The cost for traversing between the nodes is one (1) for the solid lines and five (5) for the dashed lines. The xy-coordinates are show below the nodes. (i) By using graph searching, find the path with the minimum total cost. Use in the nodes as the predicted total cost function $f(n_{xy})$ the real until then accumulated cost $g(n_{xy})$. At each step, draw a figure which shows the arrival directions, calculated and predicted costs and the last expanded node. (ii) Redo and redraw the graph search by using in the nodes the predicted total cost function

$$f(n_{xy}) = g(n_{xy}) + 2((3 - x) + (3 - y)) + |x - y| \, .$$

What is the influence of cost prediction on the obtained solution in general and in this case in particular? What effect does the form of the prediction have on the result? (iii) Resolve the problem again now with dynamical programming on layers. At each step, draw a figure which shows the until then calculated costs and arrival directions. (iv) Compare graph searching and dynamical programming as solution techniques. (v) What is meant by the principle of optimality? (vi) In what machine vision tasks can graph searching and dynamic programming be exploited? 6p.