T-61.5070 Computer Vision

Jorma Laaksonen

EXAM 09.01.2012

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.

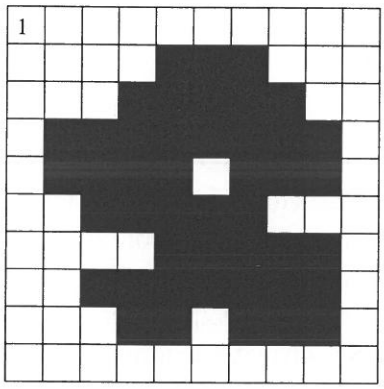
(i) moments as shape descriptors
(ii) point distribution models
(iii) scale space methods in computer vision
(iv) hysteresis in thresholding
(v) principle of optimality in dynamical programming
(vi) texture gradient

2. (i) Explain the problems of 3D machine vision systems and the general lines of the design and implementation of such systems. (ii) According to Marr, what are the stages of a bottom-up-type 3D vision system? (iii) What kinds of techniques do exist for acquiring depth information? (iv) What kinds of models can be used for processing 3D information? (v) Explain the line labeling algorithm. (vi) Explain by using an example how 3D object recognition of top-down type can be implemented. 6p.

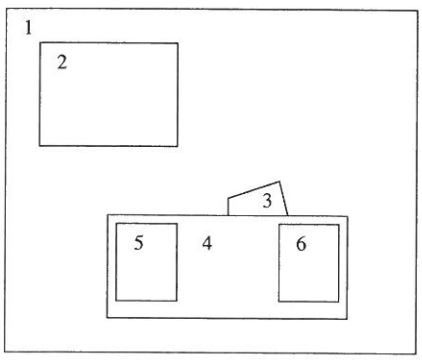
3. Let us assume that a two-eyed creature's eyes are 100 mm apart and the focal length of the eyes is 50 mm. The midpoints of the image planes are symmetrically located on both sides of the origin along the x coordinate axis. The eyes are parallelly oriented in the direction of positive z axis. (i) Draw a figure illustrating the stereo geometry in the described system. (ii) Calculate the projections of the points in the xz plane in the coordinate systems of both eyes. (iii) Plot the difference of the x_l and x_r coordinates as a function of the distance z. (iv) What is the range where the described eye pair is usable for distance measurement, when the resolution of the eyes is 50 lines/mm? (v) What is the resolution of distance information when the distance is 10 meters? (vi) What size of an object at the distance of 100 meters is seen as the size of one pixel in the eye's image plane? 6p.

Turn page!

4. Below, there is a binary image where it is known to exist one contiguous black object on white background. (i) Explain and visualize how that object's 4-connective inner border can be found. Starting from the top left corner of the image, number all examined pixels by 1,2,3,.... Circle the pixels constituting the inner border. (ii) Explain how the 8-connective outer border can be traced simultaneously when the 4-connective inner border is formed. Draw rectangles around the pixels constituting the outer border. (iii) Explain how the extended boundary can be formed starting from the 8-connective outer border. Draw a separate picture to illustrate the forming of the extended boundary in the case of the image below. (iv) What general problems exist in defining and interpreting different types of borders in binary images? What kinds of solutions do exist? 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.