NTNU
Norges teknisk-naturvitenskapelige universitet

Fakultet for informasjonsteknologi, matematikk og elektroteknikk

Institutt for datateknikk og informasjonsvitenskap

EXAMINATION IN TDT4195/SIF8043 IMAGE TECHNIQUES WEDNESDAY MAY 29, 2004 TIME 09:00 – 14:00

Contact persons during examination:

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Permitted facilities:
No printed nor hand written material.
Specific simple calculator permitted.

Examination results to be announced on:
June 9

Answer all seven problems. Total maximum score is 800 points.

A piece of advice: Read all of the examination paper before starting answering. Thus you may improve your chances for efficient time utilisation and at the same time you may have more questions for the professors when they come on their rounds.

PROBLEM 1 Image processing - Fundamentals (100 points)

a) An image that is 1024*1024 pixels that can represent 1024 grey levels is to be transmitted by serial line at 9600 baud. The pixels of the image must be composed of whole bytes and no compression scheme is used.

1. How many bytes must be transmitted?

2. How long will the transmission take?

3. Briefly suggest an application in which 1024 grey levels may be more useful than the usual 256.

b) Draw two labeled diagrams that contrast the image processing steps appropriate for:

1. automatic pattern recognition and

2. presentation to a human observer.

c) State what data types are exchanged between the processes in the diagram given as the answer to problem part b), point 1, above.

PROBLEM 2 Image processing - Segmentation and description (100 points)

a) Describe two methods for enhancing edges in an image.

b) Distinguish between the meaning of the term 'edge' in a 2-D image and in the real world.

c) Answer the following questions:

1. Give a definition of a connected region.

2. Write pseudo code that expresses the growing of a region, R, held as a set of coordinate pairs, <x , y>, based on a membership condition P(R).

d) What is meant by the 'structuring element' in morphology?

PROBLEM 3 Image processing – Representation (100 points)

a) Calculate the Euler number for the figure 1.

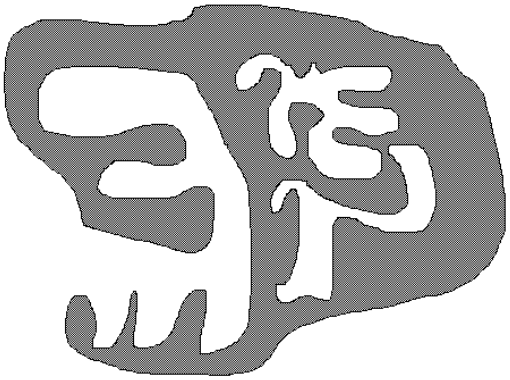

Figure 1

b) Answer the following questions:

1. Define an 8-way chain code.

2. Obtain the chain code for a COUNTER CLOCKWISE journey around the contour shown in figure 2 starting from pixel **A**.

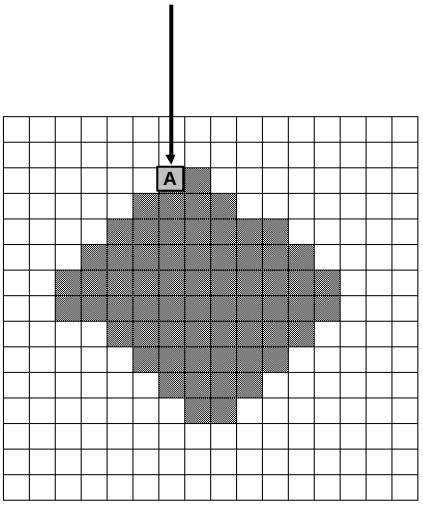

Figure 2

c) Answer the following questions:

1. Define the Fourier descriptor of a shape.

2. As successively more terms of the Fourier descriptor are included, what happens to the detail of the shape being represented?

PROBLEM 4 Image processing - Representation and recognition (100 points)

a) Draw a diagram that shows the structure of a neural net.

b) What is meant by training the neural net?

c) What limitations are met with when neural nets are applied to images?

d) Explain, with the help of a diagram, what is meant by a linear decision surface.

e) What type of decision surface is implemented by a neural net with at least 3 layers?

PROBLEM 5 Graphics – Projection and camera coordinate system (100 points)

We want to make a perspective view of a model. The point (x_{vp}, y_{vp}, z_{vp}) is the projection centre. The coordinates are referred to the world coordinate system. The viewing direction (the optical axis of the camera) is parallel to the plane $z = 0$ of the world coordinate system. The angle between the orthographic projection of the optical axis in the plane $z = 0$ and the world coordinate system's x-axis is 30º. The view plane is orthogonal to the optical axis at a distance d from the projection centre.

There is no connection between the following two questions a) and b):

a) We would like to have a matrix that gives the image coordinates in world coordinates when it is applied to the object coordinates also referred to the world coordinate system. Derive the matrix!

b) Derive the matrix for transforming world coordinates to camera coordinates for the configuration described!

OPPGAVE 6 Graphics – Clipping (140 points)

a) Liang-Barsky's algorithm uses the parametric form of the line equation.

   1. With which type of clipping window can it be used?

   2. How is parallelism with the clipping window edges detected?

   3. Explain the principles of the algorithm! Use figures to support the explanations

b) Explain Weiler-Athertons algorithm for polygon clipping by means of sketches and pseudocode.

OPPGAVE 7 Graphics – The midpoint method (160 points)

Apply the midpoint method to derive an algorithm to draw the parabola:

$$y = x^2$$

in the x-interval where the tangent's slope is in the interval from 0 to 1.