NTNU
Norges teknisk-naturvitenskapelige universitet

Fakultet for informasjonsteknologi, matematikk og elektroteknikk

Institutt for datateknikk og informasjonsvitenskap

EXAMINATION IN TDT4195 IMAGE TECHNIQUES TUESDAY JUNE 3, 2008 TIME 09:00 – 13:00

Contact persons during examination:

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

Examination results to be announced on:
June 24

Answer all six problems. Total maximum score is 400 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.
- Give short and precise answers
- The questions of the part problems may most often be answered independently of each other

THEME 1 Image processing fundamentals and edges (50 points)

a) How can the effects of spatial quantisation be reduced when an image is captured and during image processing?

b) How can the effects of brightness quantisation be reduced when an image is captured and during image processing?

c) List FOUR image processing applications that use signals other than the wavelengths of light visible to a human.

d) Give the Sobel masks that enhance edges in an image.

e) Why is an edge in an image a vector quantity?

f) How do the masks you presented in answer to part d, above, relate to ∇, the gradient function?

g) How do edges in an image relate to edges in the real world?

THEME 2 Image processing - Fouriertransformen (50 points)

a) State both the convolution formula and algorithm.

b) State the convolution theorem. What are its image processing applications?

c) Sketch the Fourier transform of 1D sine, rectangular and Dirac delta functions.

THEME 3 Image processing – Image restoration (50 points)

Derive the homomorphic filter. State (only) the necessary assumptions.

THEME 4 Image processing – Segmentation, description and recognition (50 points)

a) Give a definition of a ‘connected region’?

b) In a segmented image, if R_i and R_j are the sets of pixels with region identifiers *i* and *j*, what would the property $R_i \cap R_j \neq \varnothing$ imply for the segmentation? ($\varnothing$ is the empty set.) Could this make sense at an intermediate stage of a segmentation algorithm?

c) Compare and contrast edge based segmentation and region based segmentation.

d) What is meant by a 'signature' as a method of describing the shape of a region?

e) What is meant by a 'feature space'?

f) What is meant by 'minimum distance classification'?

THEME 5 Graphics – Miscellaneous questions (100 points)

a) Which problem arises when rasterising two thick lines with a common joining point? Mention at least two methods for solving the problem.

b) Explain the aliasing problem and how the problem is solved for straight lines using supersampling.

c) How is it possible to expand the Cohen-Sutherlands for 2D line clipping to work for 3D line clipping?

d) Derive the formulas for transforming *x*- and *y*-coordinates for rotation about the *z*-axis and use the formulas to derive the rotation matrix. Useful trigonometric formulas:

$$\sin(\alpha + \beta) = \sin\alpha \cdot \cos\beta + \cos\alpha \cdot \sin\beta$$
$$\cos(\alpha + \beta) = \cos\alpha \cdot \cos\beta - \sin\alpha \cdot \sin\beta$$

e) Explain what ray tracing is. Apply sketches to make the answer clear.

THEME 6 Graphics – Midpoint algorithms (100 points)

The task is to develop the midpoint algorithm for circle drawing.