NTNU
Norges teknisk-naturvitenskapelige universitet

Fakultet for informasjonsteknologi, matematikk og elektroteknikk

Institutt for datateknikk og informasjonsvitenskap

EXAMINATION IN
TDT4195 IMAGE TECHNIQUES
WEDNESDAY MAY 25, 2005
TIME 09:00 – 13:00

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 15

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.

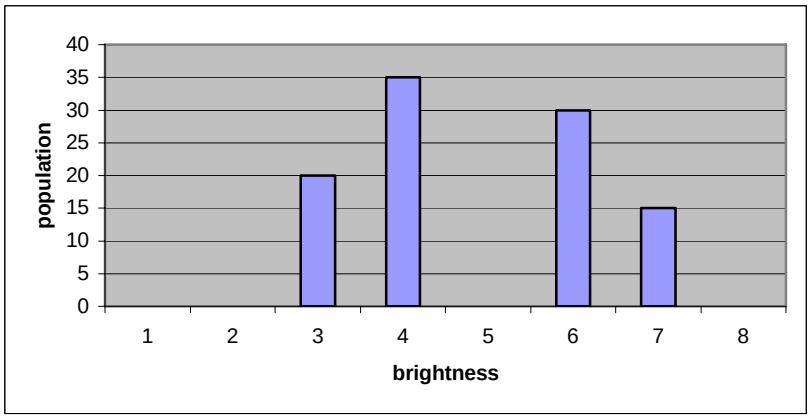
PROBLEM 1 Image processing – Fundamentals and filtering (100 points)

a) What differences are likely to be found between images that are captured using a flash attached to a digital camera and ambient light?

b) What quantisations occur when an image is captured?

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

d) An image that has a size of 10 x 10 pixels and 8 grey levels per pixel has statistics represented by the histogram below:



Work through the histogram flattening procedure and show the flattened histogram as your answer.

e) $f_{hb}(x,y)$ is the high boost filter of image f(x,y). Develop a formula for $f_{hb}(x,y)$from the starting point of representing the image f(x,y) as

$$f(x,y) = f_{lp}(x,y) + f_{hp}(x,y)$$

where $f_{lp}(x,y)$ is the result of low pass filtering f(x,y), and $f_{hp}(x,y)$ is the result of high pass filtering f(x,y).

Your final result should be an expression using f(x,y), $f_{lp}(x,y)$ and numbers and constants.

Problem 2 Image processing - Segmentation, description and recognition (100 points)

a) What is meant by 4-connectedness in a region?

b) What is meant by region based segmentation?

c) Why are edge based segmentation and region based segmentation duals of each other?

d) All methods of segmentation attempt to allocate a label to each pixel. Each method assumes, a-priori, that there is some rule defining how labels should be allocated based on pixel value, possibly in the context of the local neighbourhood. What rules are assumed for each of the methods:

1. thresholding with a global threshold value,

2. thresholding with a local threshold value,

3. watershed segmentation?

e) What is meant by shape number?

PROBLEM 3 Graphics – Fundamentals (25 points)

a) What is the relationship between *graphics primitives* and *graphics attributes*?

b) What are the steps in the *viewing pipeline* for 3D graphics as described in the textbook? Give a short description of the processes performed by each of the steps. Between which two steps should clipping take place and why at that place?

PROBLEM 4 Graphics – Miscellaneous methods (75 points)

a) The function gluLookAt specifies the viewing parameters in OpenGL. The parameters of the function are two points and a vector. The two points are the eye point and the reference point respectively. The vector is the view-up vector. OpenGL utilizes these parameters to set up the viewing reference frame (the camera coordinate system). Show how the parameters are used to set up a right-handed viewing reference frame.

b) Write pseudo code for the area filling algorithms *boundary-fill* and *flood-fill*. In which situations will it be rewarding to use each of them?

c) Specify the steps necessary to rotate an object 30 degrees about an axis that goes through the points (1,1,1) and (1,1,2). The steps have to be given in the right order. Write down the transformation matrices with expanded matrix elements. Concatenation is not required.

PROBLEM 5 Graphics – Antialiasing (60 points)

a) Explain briefly the meaning of *antialiasing*.

b) Explain briefly how *supersampling*, *subpixel weighting masks* and *filtering* can be used for antialiasing thin lines. Which of the three methods do you think will give the best visual result and why is it so?

c) Explain briefly how *the area sampling technique* is used for antialiasing thick lines.

PROBLEM 6 Graphics – Line drawing algorithm (40 points)

Describe *the midpoint algorithm* used for line drawing.