Oppgave 1

EKSAMEN I EMNE
TDT4195 BILDETEKNIKK
ONSDAG 25. MAI 2005
KL. 09.00 - 13.00

Løsningsforslag - bildebehandling

A. Theme: Image processing fundamentals and filtering.

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

The flash attached to a digital camera is quite strongly directional. The flash source is displaced from the optic axis of the camera so that the 'red eye' effect will be minimised. The effect is that depth discontinuities in the objects being imaged can lead to shadows. The laws of diffuse reflection imply that the reflected light intensity from strongly directional illumination will vary with the angle of incidence. Near normal reflection will return more energy to the camera that glancing incidence.

A cosine law (possibly raised to a small integer power) is a reasonable model.

The result is that there will be a wide range of brightnesses recorded by the camera when there is a range of angles on incidence in the scene.

Ambient light is probably less directional. There will be fewer (softer) shadows and the range of brighttnesses will tend to be less.

b. What quantisations occur when an image is captured?

An image is a quantisation in space and brightness. If the scene is time varying, then there is also a quantisation in time.

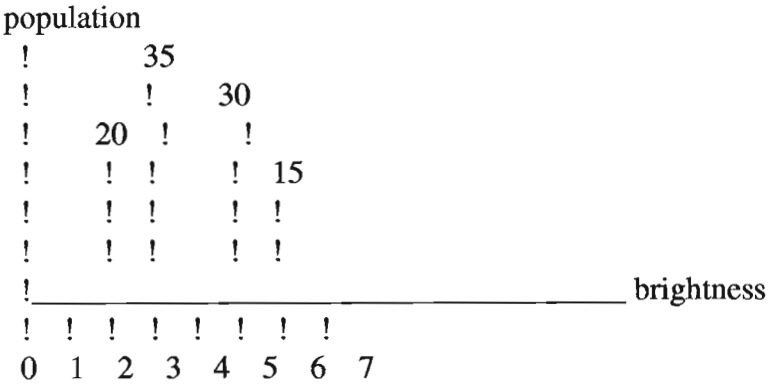
The point spread function of the camera, convolved with the return light that is reflected from the projection of each element of the array onto the scene, gives the brightness of the corresponding pixel. This is quantisation in space. The brightness is truncated to a byte by the camera logic. This is quantisation in brightness. Time varying scenes are represented by the quantisation of the time average of the received energy.

c. List FOUR image processing applications that use signals other

than the wavelengths of light visible to a human.

Xray imaging
CAT imaging
NMR
ultrasound
acoustic imaging (eg. dolphins)
radar (SAR preferred)
thermal imaging (FLIR)

d. An image that has a size of 10*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.

*20 pixels at old brightness 2 moved to new brightness trunc(8*20/100)=1*

*35 pixels at old brightness 3 moved to new brightness trunc(8*55/100)=4*

*30 pixels at old brightness 5 moved to new brightness trunc(8*85/100)=6*

*15 pixels at old brightness 6 moved to new brightness trunc(8*100/100)=7*

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

f(x,y) = flp(x,y) + fhp(x,y)

where flp (x,y) is the result of low pass filtering f(x,y),
and fhp (x,y) is the result of high pass filtering f(x,y).

Your final result should be an expression using f(x,y), flp(x,y) and numbers and constants.

rearrange

$$f(x,y) = flp(x,y) + fhp(x,y)$$

$$fhp(x,y) = f(x,y) - flp(x,y)$$

boost the high frequency component with factor A

$$A*fhp(x,y)=A*(f(x,y)-flp(x,y))$$

the high boost image is $A*fhp(x,y)+flp(x,y)$

high boost image $fhb(x,y) = A*f(x,y)-(A-1)*flp(x,y)$

Oppgave 2

B. Theme: Segmentation, description and recognition.

a. What is meant by 4-connectedness' in a region?

4-connectness in a region is present when it is possible to travel from any pixel in the region to any other pixel by a sequence of steps that involve only other pixels in the region and each step is a 4-connected step.

b. What is meant by region based segmentation'?

Region based segmentation is a method of segmentation that identifies uniformities in a connected set of pixels and allocates the same label to members of the connected set. Examples of the uniformity criterion are pixel values within a given range and colour ratio within a given range,

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

Region based segmentation gives connected sets of pixels as its output. The elements of the connected sets satisfy a uniformity condition. Edge based segmentation identifies transitions. Transitions occur between regions. Thus edge based segmentation and region based are duals in the sense that they fit together with edge markings between regions. The regions that satisfy a uniformity criterion are separated by portions of the image that are transitions.

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,

The parts of the image that are of interest (foreground) are composed of pixels with intensities above the chosen threshold value. This is an example of the range of pixel values forming the uniformity criterion.

2. thresholding with a local threshold value,

The parts of the image that are of interest (foreground) are composed of pixels with intensities that are above a local threshold value that responds to the average value of the local neighbourhood.

3. watershed segmentation?

The image is understood to be plotted on an x/y base with the brightnesses as heights in the z direction. The pixels of the image that are of interest (foreground) are sets of pixels that are connected and belong to the same 'mountain' peak. This peak is bounded by notional 'watercourses' that are local minima. The precise values in the peaks need not be specified. It is the membership of the structure that is the important criterion.

e. What is meant by shape number'?

The shape number is obtained from the chaincode for a shape. The steps are:

1. *compute differences between elements of codes obtained by the boundary trace note that the difference is calculated as the number of steps to match the new direction in a clockwise direction. Difference are wrapped from first to last element of the code.*
2. *Roll around the first difference to become its lowest numerical value.*