Computer graphics

LBF/VAA011 Medicalbiophysics, biometrics and computer technology

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Digitalization

- image = two dimensional function $f(x, y)$
- digitalization = process that transform continual image into discrete image
- two steps
  - sampling
  - quantization
- pixel = element $f(x, y)$
- type of image = B/W, shades of gray, color (color depth)

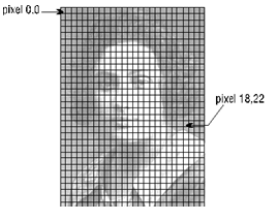


Image class

- Bilevel – B/W
- Gray scale – one value, 1 byte, from white(255) to black (0)
- Color image – RGB, CMY, 3 bytes, equal values = gray
- Palette – 1 byte, index into palette (255 colors)

Intensity transformations

- changing value of intensity for each pixel
- negative value
- log, gamma transformation
- changing contrast, brightness
- histogram processing

Brightness

- describe overall amount of light in image
- increasing brightness – value of pixel intensity increase
- decreasing brightness – value of pixel intensity decrease

Contrast

- degree of difference between brightest and darkest component in image
- pixel value is scaled by contrast value
- increasing contrast – spread the pixel values across a wider range
- decreasing contrast – squeezing values into a narrower range

Gamma correction

- special form of contrast enhancement – enhance contrast in very dark and very light areas

Task 1

`www.marketa-trneckova.cz/Control.docx`

- start **Micro image**

- open file 'PROBE.TIF'
- modify the intensity index of image
  - `Enhance -> Contrast Enhancement` (More - advanced mode)
- try change Contrast, Brightness, Gamma characteristic
- describe the changes of the image appearance

IMPORTANT! WHEN YOU FINISH DO NOT SAVE ANY CHANGES!

Histogram

- graph visualising how many pixels has same intensity
- x-axis – intensity (usually scale 0-255)
- y-axis – the number of pixels possessing that value

Task 2

- open file 'EXM50X.TIF'
- display the histogram
  - `Measure -> Histogram`
- increase/decrease the contrast or brightness
- describe the changes of the histogram

IMPORTANT! WHEN YOU FINISH DO NOT SAVE ANY CHANGES!

Task 3

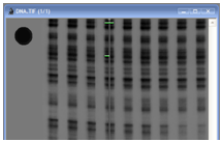
Bitmap analysis – allows you to display the values of individual pixels

- open file 'SPOTS.TIF'
- display the histogram
  - `Measure -> Bitmap Analysis`
- find values of the first pixel (0,0) and last pixel (424,377)
- do the same with file 'TISSUE.TIF'

Task 4

Line profile analysis – shows the pixel positions of the line along the x-axis and on y-axis measures the pixel value

- open file 'DNA.TIF'
- display the histogram
  - `Measure -> Line Profile`
- change the position of the defining line like on the picture



- find the position of dark belts in the line profile

Histogram equalization

- one of the advanced histogram manipulation
- enables to enhance the contrast and dynamic range of the image

Task 5

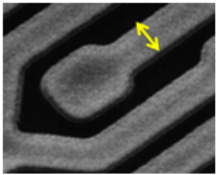
- open file 'NUCSTAIN.TIF'
  - `Enhance -> Equalize` and then `Best fit, Linear, Bell, Logarithmic, Exponential`
  - program will analyse an and automatically reshape the histogram

Manual Measurements

- measure the length of lines or polylines
- area of polygons
- angles of arcs
- automatically trace and measure the edges
- distance
- perform tolerance testing

Task 6

- open file 'CIRCUIT.TIF'
- measure the width of the highlighted structure



  - `Measure -> Measurements`
  - draw a line - find a value

Calibration

- measurement operations – in terms of pixel position
- length = number of pixels
- fit pixel-level measurements in terms of actual size
- for example 1 pixel means 1 cm

Task 7

- open file 'CIRCUIT.TIF'
- the image contains a calibration line – 1 μm
- calibrate the length
  - `Measure -> Calibration -> Spatial`
  - create new set of calibration values
- measure the same length as task 6 in new measure
  - `Measure -> Calibration -> Select Spatial`
- destroy the calibration
  - `Measure -> Calibration -> Select Spatial`
  - select none and click OK

Automatic Counting and Sizing

- colect multiple measurements of multiple objects within a single image
- for example – in image 'SPOTS.TIF', count number of cells, measure the area, roundness or perimeter

Task 8

- open file 'SPOTS.TIF'
- count the dark objects and measure their area
  - `Measure -> Count/size`
  - select 'Automatic Dark Objects' (`Measure -> Select Measurements`)
  - from list select 'Area' and 'Cluster'
- `Count/Size -> View -> Statistics`
- `Count/Size -> Measure -> Clusters`

Frequency Filtering

- spatial domain, frequency domain
- frequency domain – image is set of signals
- transition – (inverse) Fourier transform
- faster operations – filtering
- in Micro Image Fast Fourier Transform (FFT) (on the Process menu)

Task 9

- open file 'FFTPRINT.TIF'
- remove the periodic noise
  - `Process -> FFT` (forward)
  - remove the noise
  - noise - create area of interest around the noise
  - Apply
  - return to spatial domain – in FFT click on inverse
- present the result of your work to the teacher