Digital Image Processing

Programme course

6 credits

Digital bildbehandling grundkurs

TSBB08

Valid from: 2017 Spring semester

Determined by
Board of Studies for Electrical Engineering,
Physics and Mathematics

Date determined
2017-01-25

Main field of study

Computer Science and Engineering, Electrical Engineering

Course level

Second cycle

Advancement level

A1X

Course offered for

- Computer Science and Engineering, M Sc in Engineering
- Industrial Engineering and Management - International, M Sc in Engineering
- Industrial Engineering and Management, M Sc in Engineering
- Information Technology, M Sc in Engineering
- Computer Science and Software Engineering, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering
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- Biomedical Engineering, Master's programme

Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites

1-D signal processing: deterministic signals, linear systems, convolution, continuous and discrete Fourier transform sampling and reconstruction, the sampling theorem, basic filters (low-pass, high-pass, and band-pass). Linear algebra: vector, matrix, determinant, scalar product, bases, the least square method. One- and multidimensional calculus. Programming in one of the following languages: C, C++, Java, Ada or Matlab.

Intended learning outcomes

The course aims to provide basic knowledge in 2D signal processing and a systematic description about the classical methods and tools for digital image processing. This means that a student which has taken this course is expected to be able to:

- Describe basics regarding the generalization from 1-D to 2-D signal processing: Continuous and discrete Fourier transform with accompanying theorems, sampling and reconstruction, convolution, re-sampling and interpolation, scale space.
- Interpret the result of a 2-D Fourier transform of an image, such as what is a spatial frequency and be acquainted with the most common convolution kernels and describe their appearance in the spatial and Fourier domain, respectively.
- Describe most of the classical image processing methods in the course content, see below.
- Solve simple image processing problems using Matlab.

Course content

The lectures:

- Concepts and definitions. From 1-D to 2-D Fourier transform. Continuous and discrete Fourier transform, DFT, FFT. Sampling and reconstruction. Convolution and filtering, translation, scaling, derivative, rotation, and other linear operations on digital images.
- Convolution kernels in the spatial and Fourier domain, low-pass, derivative (sobel).
- Resampling and interpolation. Scale space.
- Color models. Color transformations. Color segmentation.
- Segmentation: Regional growing, watersheds, labeling. Operations on histogram. Thresholding: automatic, local and with hysteres.
- Binary image processing: Morphological operations, distance transform, connectivity preserving operations, feature extraction, chain code, polygon approximation and Fourier descriptors.
- Matched filters and pattern recognition. Edge detection with Sobel and Canny. Hough transform. Line detection. Corner detection. The structure tensor.
- Image restoration: Inverse filtering, wiener filtering.
- Non-linear filters: Homomorphic filtering, median filter, max- and min-filter, etc.

The computer exercises:

- 1) Operations on gray scale images. Linear filters in the spatial and Fourier domain.
- 2) Resampling and interpolation.
- 3) Operations on binary images. Histogram and color tables.
- 4) Automatic thresholding and simple OCR (Optical Character Recognition).
- 5) Segmentation of cells in microscopy images.
- 6) Automatic counting of blood cells.
- 7) Image restoration. Edge detection with Hough transform and Canny. Non-linear filters.

Teaching and working methods

The course consists of lectures, lessons and laboratory assignments based on Matlab.

Examination

TEN1	Written Examination	U, 3, 4, 5	4 credits
LAB2	Laboratory Work	U, G	2 credits

Grades

Four-grade scale, LiU, U, 3, 4, 5

Other information

Supplementary courses: Multidimensional signal analysis, Computer Vision, Image Sensors, Image and Audio Coding, Neural Networks and Learning Systems, Medical Image Analysis, Visual Object Recognition and Detection, Project courses regarding images.

Department

Institutionen för systemteknik

Director of Studies or equivalent

Klas Nordberg

Examiner

Maria Magnusson

Course website and other links

https://www.cvl.isy.liu.se/education/undergraduate

Education components

Preliminary scheduled hours: 62 h
Recommended self-study hours: 98 h

Course literature

Additional literature

Books

Gonzalez och Woods, *Digital Image Processing*

Websites

Power-Pointpresentationer från föreläsningarna.

Compendiums

Laborationshäfte i digital bildbehandling.

Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.