Signal and Image Processing

Programme course

6 credits

Signal- och bildbehandling

TSBB14

Valid from: 2017 Spring semester

Determined by
Board of Studies for Chemistry, Biology and Biotechnology

Date determined
2017-01-25

Main field of study
Biotechnology, Electrical Engineering

Course level
First cycle

Advancement level
G2X

Course offered for
- Engineering Biology, M Sc in Engineering

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
One- and multidimensional calculus, Programming.

Intended learning outcomes

The course intends to give fundamental knowledge about signal and image processing. It is then used to solve application oriented problems in technique, medicine and biology. This means that a student which has taken this course is expected to be able to:

- Describe basics regarding 1-D signal processing: deterministic signals, convolution, continuous and discrete linear systems, continuous and discrete Fourier transform, sampling and reconstruction, the sampling theorem, aliasing, basic filters (low-pass, high-pass, and band-pass).
- Perform computations on signals and systems by using the following techniques: convolution, Fourier series, Fourier transform and z-transform (simple problems).
- 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.
- Interpret the result of a 2-D Fourier transform of an image, such as what is a spatial frequency? Be acquainted with the most common convolution kernels and describe their appearance in the spatial and Fourier domain, respectively.
- Describe some classical operations for image processing such as histogram, thresholding and morphological operations. Understand how measurements such as area, length and perimeter can be performed in images.
- Produce an oral and Power-Point presentation in English or Swedish of an application related to the theory described in the course.

Course content

- 1-D signal processing: Signals and their characteristics. Fourier series. Convolution. The Fourier transform and its accompanying theorems. TDFT and DFT. The Dirac impulse. Sampling and reconstruction. The z-transform. 1D correlation. Continuous and discrete linear systems. System characteristics such as linearity, time invariance, causality and stability.
- 2-D signal processing: From 1-D to 2-D Fourier transform. Continuous and discrete Fourier transform, TDFT and DFT. 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, high-pass, and derivative (sobel). Edge detection using the magnitude of the gradient. Re-sampling and interpolation. Histogram and thresholding. Binary image processing. 2-D correlation.
- Application examples: Signal processing of ECG-signal, computed tomography (CT), magnetic resonance imaging (MRI), 3-D visualization, analysis of microscopy images, image compression, signal processing in a CD-player, phase vocoder.

Teaching and working methods

The course consists of lectures, lessons, laboratory assignments based on Matlab, and a group project concerning an application studied by literature and laboratory Matlab work. The group project is examined with an oral and Power-Point presentation in English or Swedish.
The course runs over the entire autumn semester.

Examination

LABA	Laboratory work	2.5 credits	U, G
TENA	Written examination	3.5 credits	U, 3, 4, 5

Grades

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

Department

Institutionen för systemteknik

Director of Studies or equivalent

Klas Norberg

Examiner

Maria Magnusson

Course website and other links

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

Education components

Preliminary scheduled hours: 71 h
Recommended self-study hours: 89 h

Course literature

Additional literature

Books

Compendia

Laborationshäfte: Signal- and Image Processing.
Signal- och 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.