Medical Image Analysis

Programme course

6 credits

Medicinsk bildanalys

TBMI02

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
Electrical Engineering, Biomedical Engineering

Course level
Second cycle

Advancement level
A1X

Course offered for
- Information Technology, M Sc in Engineering
- Computer Science and Engineering, M Sc in Engineering
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- Applied Physics and Electrical Engineering, M Sc in Engineering
- Biomedical Engineering, Master's programme
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Computer Science and Software Engineering, 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
Basic Linear Algebra: bases, scalar product, least squares problem, eigenvalue problems. Basic signal processing (corresponding to Linear Systems): sampling, convolution and Fourier transform of one-variable signals. Basic skills in Matlab is recommended.

Intended learning outcomes

The aim of the course is to give profound knowledge of how different medical images, volumes and sequences are generated and analyzed. Focus is especially on techniques and methods related to magnetic resonance tomography (MRT). A central part of the course is devoted to the design of multi dimensional filters and algorithms for the purpose of extracting different types of information from the medical data sets. After the course the student will be able to:

- Be able to optimize multi dimensional filters with respect to both frequency and spatial requirements.
- Compute local structure descriptors (Tensors) from image data.
- Use the local structure description to perform adaptive image enhancement.
- Describe image segmentation methods as: watershed, levelsets, and region growing. Implement a segmentation algorithm using active contours.
- Describe transformations and similarity measures for registration/fusion of images. Be able to implement a simple registration.
- Explain the behavior of multi-dimensional signals in the Fourier domain.
- In detail tell how the MRI data are sampled in k-space, and how to avoid related sampling problems.

Course content

Medical imaging systems: Physical principles and image reconstruction algorithms for magnetic resonance tomography (MRI), ultrasound and computer tomography (CT). Analysis methods: Multidimensional Fourier analysis, local structure analysis in 2D, 3D and 4D (3D + time), motion/velocity estimation, registration, segmentation using adaptive contours and surfaces. Applications: Image enhancement, image registration, functional magnetic resonance imaging (fMRI).

Teaching and working methods

The course consists of lectures, laboratory exercises and a mini project. Lab exercises and the mini project are done in groups of 2 students. Lab exercises are presented orally at scheduled seminars. The mini project consists of 3 scheduled lab sessions and is presented in a written report. To pass the laboratory work you have to show the working code for the lab instructor, participate
in the lab seminars and present the written mini project report.

Examination

LAB1	Laboratory Work	2 credits	U, G
TEN2	Written Examination	4 credits	U, 3, 4, 5

Grades

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

Other information
Supplementary courses: Multidimensional Signal Analysis, Computer Vision, Medical Imaging , Neural Networks and Learning Systems

Department
Institutionen för medicinsk teknik

Director of Studies or equivalent
Linda Rattfält

Examiner
Hans Knutsson

Course website and other links

Education components
Preliminary scheduled hours: 48 h
Recommended self-study hours: 112 h

Course literature
Kompendium om MR, registrering och segmentering. A. Eklund, M. Andersson och H. Knutsson. IMT 2010. Utdelat material

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.