Medical Image Analysis

Programme course

6 credits
Medicinsk bildanalys
TBMI02
Valid from: 2019 Spring semester

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

Date determined
2018-08-31
Main field of study

Electrical Engineering, Biomedical Engineering

Course level

Second cycle

Advancement level

A1X

Course offered for

- Master's Programme in Biomedical Engineering
- Information Technology, M Sc in Engineering
- Computer Science and Engineering, M Sc in Engineering
- Biomedical Engineering, 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

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Grade</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>TEN2</td>
<td>A written examination</td>
<td>U,3,4,5</td>
<td>4 credits</td>
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<tr>
<td>LAB1</td>
<td>Laboratory work</td>
<td>U,G</td>
<td>2 credits</td>
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Grades
F, 3, 4, 5

Other information

Supplementary courses:
- Multidimensional Signal Analysis
- Computer Vision
- Medical Imaging
- Neural Networks and Learning Systems

Subject area

Other Subjects within Technology

Disciplinary domain

Technology

Department

Department of Biomedical Engineering (IMT)

Director of Studies or equivalent

Marcus Larsson

Examiner

Anders Eklund

Education components

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

Course literature
Books

Granlund, Gösta, Knutsson, Hans, (1995) *Signal processing for computer vision*
Dordrecht : Kluwer, cop. 1995
ISBN: 0792395301

Compendiums

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

Other

*Utdelat material*