



DEPARTMENT OF CLINICAL NEUROSCIENCE

K8F5685, Introduction to Image Processing Using MATLAB: with a Focus on Neuroscience, 1.5 credits (hec)

Introduktion till bildbehandling med MATLAB: med fokus på neurovetenskap, 1,5 högskolepoäng

Third-cycle level / Forskarnivå

Approval

This syllabus was approved by the The Committee for Doctoral Education on 2023-12-27, and was last revised on 2024-02-07. The revised course syllabus is valid from autumn semester 2024.

Responsible department

Department of Clinical Neuroscience, Faculty of Medicine

Prerequisite courses, or equivalent

No prerequisite courses, or equivalent, demanded for this course.

Purpose & Intended learning outcomes

Purpose

This course introduces the basics of image processing concepts with a particular emphasis on using MATLAB to perform practical image processing methods in neuroimaging as well as biological/medical applications. This includes basic techniques for data extraction, histogram/thresholding/morphological operations, noise removal, image quality enhancement, filtering, segmentation, and registration. The contents of this course (both theoretical concepts and MATLAB codes/functions) will be useful for various image-processing applications from the microscopic workflow (e.g., cell counting, detection, labeling, classification, and tissue segmentation) to animal/human brain image analyses (e.g., structural and functional images collected by CT, PET, and MRI).

Intended learning outcomes

At the end of the course, the students are supposed to be able to:

- explain the main theoretical concepts behind image processing methods

- implement MATLAB for image-processing of their own data
- explain the image processing theories behind the software/packages designed for neuroimage processing/analysis, such as FSL and SPM in neuroimaging

Course content

Image Representation: read the matrix of data, understand the concepts of image pixel/voxel, image resolution and dimension, visualize 2D and 3D images, save the matrix of data

Image operations: count, find min and max, perform add/subtract/divide/multiply, binarize an image, create a mask

Image histogram: understand the concepts of image intensity, colormap, and intensity/color distribution, and change the contrast of the image

Image size and dimension: resampling and cropping

Edge detection, Object labeling, Object dilation, and erosion

Image Filtering: noise removal, smoothing

Image Segmentation: segment/parcellate the image objects

Image Registration: align images from different subjects or from different modalities, overlay images, perform mask-based image operations

Forms of teaching and learning

The theoretical content of the course will be taught in a form of lectures and pre-recorded videos with subsequent discussions using flip-the-classroom teaching methods. Besides the theoretical content, a series of MATLAB-based examples will show students how to implement image processing techniques in MATLAB. Teaching sessions will be complemented by hands-on sessions to help students practice their programming skills in MATLAB. Finally, there will be some hands-on projects to test how well students can apply the image processing methods with MATLAB.

Language of instruction

The course is given in English

Grading scale

Pass (G) /Fail (U)

Compulsory components & forms of assessment

Compulsory components

Attending lectures and hands-on sessions is mandatory. Absence from a lecture or session may be compensated by doing the hands-on for the corresponding topic. Reporting the codes of hands-on projects is mandatory. The examination is compulsory.

Forms of assessment

The examination will be based on the assigned hands-on projects. In the last session, the

theoretical explanation of the assignment as well as the results of the project (performed on MATLAB) will be presented in front of the other students.

Course literature

Recommended resources:

- Digital Image Processing Using MATLAB, 3rd Ed. Gonzalez, Woods, and Eddins, 2020
- MATLAB for Neuroscientists. An Introduction to Scientific Computing in MATLAB. Pascal Wallisch, Michael E. Lusignan, ... Nicholas G. Hatsopoulos. 2014
- McAndrew, Alasdair. "An Introduction to Digital Image Processing with Matlab Notes for SCM2511 Image Processing 1 Semester 1, 2004."
- <https://mathworks.com/products/image.html>