The Hebrew University of Jerusalem

Syllabus

Medical Image Processing - 67705

Last update 21-09-2023

<u>HU Credits:</u> 3

<u>Degree/Cycle:</u> 2nd degree (Master)

<u>Responsible Department:</u> Computer Sciences

<u>Academic year:</u> 0

<u>Semester:</u> 1st Semester

<u>Teaching Languages:</u> English and Hebrew

<u>Campus:</u> E. Safra

<u>Course/Module Coordinator:</u> Leo Joskowicz

<u>Coordinator Email:</u> josko@cs.huji.ac.il

<u>Coordinator Office Hours:</u> By appointment only

<u>Teaching Staff:</u>

Prof Leo Joskowicz,
Dr. Assaf Hoogi

Course/Module description:
The use of medical images in the medical practice is growing.
Medical images are becoming increasingly available. They are used for all aspects of patient care, from diagnosis and assessment of the patient's status, through planning of surgical interaction, direction during surgery, and up to assessing the patient's post-surgery status.

The purpose of this course is to introduce students to technologies related to images of medical imaging and the techniques used to process them.

Course/Module aims:
To familiarize students with the basics of medical imaging and with the main medical image processing algorithms

Learning outcomes - On successful completion of this module, students should be able to:
The students will have a working knowledge of the basic workings of the main medical imaging modalities, including Xray, CT. MRI, Ultrasound and video. They will master the main methods of medical image processing, including segmentation, registration, visualization, and 3D object reconstruction. They will be able to analyze, design and develop new methods in these fields.

Attendance requirements(%):
80

Teaching arrangement and method of instruction: Frontal lectures, a programming exercise and a semiar-style lecture by each student

Course/Module Content:
The syllabus of the course is as follows:

1. Introduction and Motivation

2. Medical imaging devices:
• Xrays – film, digital, C-arm, Iso-Carm
• Ultrasound

- *CT*
- *MRI and protocols*
- *Functional imaging: fMRI, SPECT, PET*

3. Visualization: volume rendering

4. Segmentation techniques
a. Manual methods
b. Thresholding and classification
- *Shape-based histogram techniques*
- *Non-parametric optimal thresholding*
- *Parametric optimal thresholding*
- *Minimum distance methods*
- *Maximum likelihood methods*
c. Edge-based techniques
- *Border tracing*
- *Graph searching*
- *Dynamic programming*
- *Hough transforms*
d. Region growing techniques
- *region growing*
- *region splitting and merging*
- *connected components labeling*
- *watershed segmentation*
e. Deformable models
- *active contours*
- *snakes*
- *level-set*
f. Morphological operators: opening, closing, erosion, dilation
g .Hybrid methods
h. Deep learning methods

5. Marching cubes algorithm

6. Medical image fusion
a. Basics of registration
b. Rigid registration techniques
c. Deformable registration techniques
d. Examples: neurosuregery, orthopaedics

7. Uses of medical images
a. Visualization and diagnosis
b. Augmented reality
c. Image-based intraoperative navigation
d. Computer Aided Radiology and Diagnosis

Required Reading:
 Medical Imaging Systems.
 A. Maier et al, Springer
Open access
2018

 Additional Reading Material:
  Deep Learning for Medical Image Analysis, S.K. Zhout et al, Acadeci Press, 2017.

Applied Medical Image Processing. W. Birkfellner. CRC Press, Taylor and
 Francis, 2010.
 • Medical Image Registration. J.V. Hajnal, D.L. Hill, D.J. Hawkes, CRC Press, 2001.
 • Imageguided
Interventions: Technology and Applications. T. Peters, K. Cleary
 eds, CRC Press, 2008.
 • IGSTK: ImageGuided
 Surgery Toolkit: an Open Source C++ software library. K.
 Cleary, P. Cheng, A. Enquobahrie, Z. Yaniv. Insight Software Consortium, 2009.

 Grading Scheme:
  Presentation / Poster Presentation / Lecture/ Seminar / Pro-seminar / Research
proposal 70 %
  Active Participation / Team Assignment 10 %
  Submission assignments during the semester: Exercises / Essays / Audits / Reports
/ Forum / Simulation / others 20 %

Additional information:
  See Moodle 2023-34 page for the course 67705 --