Syllabus

Faculty of Biomedical Engineering

Introduction to Medical Image Processing

336027

Spring 2022

(2.5 credit points)

Description

Medical imaging is an exploding field. The technologies for visualizing the body (the imaging modalities) are becoming very powerful, providing exquisite images of tissue morphology, and revealing tissue function. Imaging is at the core of medical practice; nearly all patients have imaging of some sort during care, and many studies produce thousands of images. The growth in digital imaging is necessitating techniques for medical image processing and analysis.

This course will provide an overview of fundamental image processing concepts and algorithms applied to medical imaging data.

Instructor: Dr. Moti Freiman, Silver 239, moti.freiman@technion.ac.il,

Reception hour: Mon. 16:30-17:30.

T.A.: Nitzan Avidan, nitzanavidan@campus.technion.ac.il

Reception hour: Thues. 13:30-14:30 (Pre-arrangement by email)

Course location and time:

Lecture: Silver 202, Wed. 14:30-16:30

Recitation: Silver 301, Thurs. 09:30-10:30

Please schedule reception hour meetings by email. To facilitate communication, email subject must be: impr: <your subject> where <your subject> is the topic you would like to discuss with us.

The online meeting details are available at the course website.

Prerequisites

1. 044131 אותות ומערכות
2. 104016 אלגברה 1מ
3. 094423 סטטיסטיקה
4. 104034 הסתברות

Recommended prior knowledge:

1. Basic python programing
2. Basic Oobject oriented programming concepts

Textbook

1. Gonzalez and Woods, Digital Image Processing 4th edition, Pearson, 2017.
2. Birkfellner, Applied Medical Image Processing: A Basic Course, CRC press, 2010.

Course Objectives

1. To introduce the main concepts of medical imaging
2. To introduce the main concepts of medical image processing algorithms:
    a. 2D Fourier transform
    b. Medical image reconstruction
    c. Image enhancement
    d. Image quantization
    e. Image compression
    f. Image restoration
    g. Deep-leanring methods for medical image processing
3. To introduce the DICOM format for medical imaging data storage
4. To gain hands-on experience in developing image prrocessing algorithms for medical imaged MRI using the python programming language.

Learning outcomes:

At the end of the course, students will know:

1. To implement medical image processing algorithms in Python programming language
2. To determine which algorithm is suitable to solve a specific challenge in medical image processing
3. To develop algorithms to solve specific challenges in medical image processing

Course Topics

The course will cover the following topics:

Introduction to the field of medical image processing and its applications, 2D signal processing, 2D discrete Fourier transform and its application in medical imaging (MRI and CT reconstruction), Image enhancement (histograms, denoising, sharpening), Image quantization, Image Restoration, compression, DICOM format, Deep-learning methods for medical images, Python programming language for medical image processing.

Assignments

1. 4-5 assignments during course duration. Each assignment will include both theoretical questions and programming assignments in the python programming language.
2. Final exam – the exact format will be determined during the progress of the course due to the coronavirus outbreak.

Course grade: 50% exam + 50% assignments.

Exam: Term A: 20.07.2022

Term B: 29.09.2022

Tentative schedule:

Date	class number	Lecture topic	Assignment
23/3/2022	1	Intro/ Intensity transformations, histogram equalization	HMW0 warm up
30/3/2022	2	Filtering (mean/median), bilateral, sharpening/Gibbs artifact/morphological	HMW1 histogram equalization, mean filter, bilateral filter
6/4/2022	3	Edge detection	
13/4/2022	4	Hough transform	HMW2 implement Hough transform and edge detector
20/4/2022	Pesach vacation		
27/4/2022	5	Geometrical transformations/interpolation	
2/5/2022 (Mon.)	6	2d Fourier/Separability/Convolution theorem/Nyquist sampling	HMW3 bilinear interpolation and Fourier
11/5/2022	No Classes		
18/5/2022	7	Fourier-based image filtering/processing	
25/5/2022	8	Image restoration (mle/map/tv)	
1/6/2022	9	Image reconstruction	HMW4 image restoration
8/6/2022	10	Compression - Huffman	
15/6/2022	11	compression - image quantization/k-means/EM	HMW5 kmeans and EM
22/6/2022	12	Gaussian/Laplacian pyramids/wavelets	
29/6/2022	13	DL for image processing	

Online resources

1. Course website on the Technion's moodle: TBD
   all lecture notes/supplementary material/slides are available there.