EECE433/544
Medical Imaging:

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Connect site

http://elearning.ubc.ca/connect/

Most course enquires *should be made via the Connect site*, although queries can also be made to the instructor directly at rohling@ece.ubc.ca or 822-2045.

The Connect site can be used only by students enrolled in the course. Students use their CWL (Campus-Wide-Login) account userID's and passwords. The site is usually available after the first week of classes. Students will be able to access the course from both UBC and home. Instructions are given on the main Connect page.

The Connect page contains on-line versions of the lecture notes, labs, exams, solutions, and mailing lists.

Summary

Physical principles of ultrasound, magnetic resonance, computed tomography and X-ray projection imaging. Methods of feature detection, segmentation, registration and visualization of 2D and 3D images. Applications in diagnostics, therapeutics and interventions.

Rationale

A need exists to provide students with an understanding of the creation and analysis of medical images. Medical imaging is used in research areas ranging from surgical robotics to computer graphics. Students using medical images in their research need to know the fundamental limitations on their interpretation and use in computer analysis techniques. Students also need an awareness of how image analysis techniques are tailored to medical images.

Course Outline

Instructor: Dr. Robert Rohling

Part I: Physical Principles of Medical Imaging

1. Introduction
    a. Introduction to imaging modalities
    b. Image Quality
2. Xrays in Diagnostic Imaging
    a. X-ray production
    b. X-ray interactions
    c. X-ray spectra
    d. X-ray dosimetry
    e. X-ray detection
    f. Radiography
    g. Mammography
    h. Flouroscopy
3. Computed Tomography Systems
    a. Scanner design
    b. Reconstruction Techniques
    c. Image Quality
    d. Artifacts
    e. Multi-slice imaging
    f. Scanner performance
4. Magnetic Resonance Imaging
    a. Basic principles of nuclear magnetic resonance
    b. Image creation
        i. Slice selection
        ii. Frequency Encoding
        iii. Phase-encoding
        iv. Pulse Sequences
    c. Image characteristics and artefacts
    d. Hardware and software components
5. Ultrasound imaging
    a. The wave equation
    b. Impedance, power and reflection
    c. Acoustic properties of biological tissues
    d. Transducers, beam patterns and resolution
    e. Diagnostic imaging modes
    f. Doppler principles

Part II: Medical Image Analysis

6. Segmentation
    a. Image pre-processing
    b. Thresholding
    c. Edge-based techniques
    d. Region-based segmentation
    e. Classification
    f. Deformable models
7. Image Registration
    a. Geometrical Transformations
    b. Point-based methods
    c. Surface-based methods
    d. Intensity-based methods

8. 3D Visualization
    a. Pre-processing
    b. Scene-based visualization
    c. Object-based visualization
    d. Manipulation

Part III: Medical Applications

9. Medical Applications and Systems
    a. Diagnostics
    b. Therapeutics
    c. Interventions

Textbook: A "Custom Course Materials" package is made available to students. The material consists of various chapters from the Handbook of Medical Imaging, SPIE Press, 2000.

The other textbook that I use is "Ultrasonic Bioinstrumentation", D. Christensen, and is available at the bookstore (upon request) and library (on reserve).

Learning Objectives

The course is expected to appeal to students in Electrical and Computer Engineering, Mechanical Engineering, Computer Science, and Physics. The overall goal for all of these students is the same:

To achieve a sufficient understanding of the principles of the most common medical imaging techniques and be able to implement various analysis algorithms while understanding their limitations.

The specific objectives are as follows:

- understand the physical principles of radiography, computed tomography, magnetic resonance and ultrasound imaging
- understand how images are created
- understand the limitations of each imaging technique, including spatial resolution, temporal resolution, contrast, and artefacts
- understand the fundamental tradeoffs that exist amoung these limitations
- identify the relative advantages and disadvantages of the various types of medical imaging techniques
- understand the standard techniques in segmentation, registration and visualization
- be aware of the active areas of research in image analysis

By the end of the course, each student will have these specific skills:

- be able to interpret projection X-ray, computed tomography, magnetic resonance and ultrasound images
- be able to identify anatomical features, noise and artefacts
- be able to assess relative image quality
- be able to choose an appropriate imaging method for a given application
- be able to implement standard image analysis techniques in segmentation, registration and visualization
- be able to choose amoung the standard image analysis techniques for a given application
- be able to understand recent advances in image analysis techniques

By the end of the course, each student will have developed new attitudes including:

- an appreciation of the medical use of imaging for diagnostics, therapeutics and interventions
- an appreciation of how the design of medical systems differs from non-medical systems
- an appreciation of the rapid change of pace of medical technology
- an appreciation for the multi-disciplinary nature of biomedical research

Grading System

EECE433		**EECE544**	
Assignments:	4%	Assignments:	4%
Quizzes (2 x 3% each)	6%	Quizzes (2 x 3% each)	6%
Midterm:	30%	Midterm:	30%
		Project proposal:	5%
		Project report:	45%
Final:	60%	Presentation:	10%
Total:	100%	Total:	100%

Assignments will be given out periodically and form an important part of the course. Your solutions should be handed in at the end of the lecture on the day they are due. *Late assignments will be given a mark of zero*. Assignments are to be done individually, so copying is not allowed. Possible penalties for plagiarism include a mark of zero for all assignments.

There will be two quizzes that are done in class.

A description of the project part of the course will be given during the first few weeks. One-page proposals are due near the middle of the course to assess suitability of the projects. The project requires a short written report due at the end of classes. A short, informal poster session will follow where students will present their results and see the results of each other's projects.

Course Materials

- Additional, and data are available on WebCT Vista. Discussion boards are also available.
- The relevant chapters of the textbook are available as “Custom Course Notes” at the bookstore.
- “Ultrasonic Bioinstrumentation”, by D. Christensen is available at the bookstore (upon request) and library (on reserve).

Prerequisites

- The course is open to all students including E.C.E., C.S., Mech. Eng. and Physics
- Prerequisites for EECE433 are in the calendar. The mathematics and physics encountered in the course requires knowledge from typical first-year courses in these areas. This means students are expected to understand the differential equations describing the wave equation, the nucleus-electron model of the atom, the frequency spectrum of a signal, and so forth. No previous training in medicine or biology is needed.