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Institute for Biomedical Engineering

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BSc/MSc Course – Biomedical Imaging (6 ECTS)

Content

The course introduces the concepts of diagnostic medical imaging procedures based on electromagnetic and acoustic fields including X-ray planar and tomographic imaging, radio-tracer based nuclear imaging techniques, magnetic resonance imaging and ultrasound-based procedures. The principles of field generation, field interaction in biological tissue and detection are discussed along with data reconstruction methods to obtain image information. The various imaging concepts are assessed using linear system theory. Alongside, application examples are provided to illustrate use and value of the different techniques in clinical practice and research.

Learning Objectives

Upon completion of the course students are able to:

- explain the physical and mathematical foundations of diagnostic medical imaging systems
- characterize system performance based on signal-to-noise ratio, contrast-to-noise ratio and transfer function
- design a basic diagnostic imaging system chain including data acquisition and data reconstruction
- identify advantages and limitations of different imaging methods in relation to medical diagnostic applications

Schedule

17.09.	**Introduction** (intro, overview, history)	Kozerke
24.09.	**Signal theory and processing** (foundations, transforms, filtering, signal-to-noise ratio)	Pruessmann
01.10.	**Ultrasound** (mechanical wave generation, propagation in tissue, reflection, transmission)	Goeksel
08.10.	**Ultrasound** (spatial and temporal resolution, phased arrays)	Pruessmann
15.10.	**Ultrasound** (Doppler shift, implementations, applications)	Pruessmann
22.10.	**X-rays** (production, tissue interaction, contrast, detection)	Kozerke
29.10.	**X-rays** (resolution, point-spread function, Poisson noise)	Kozerke
05.11.	**X-rays** (Radon transform, filtered back-projection, computed tomography, dosimetry)	Kozerke
12.11.	**Nuclear imaging** (radioactive tracer concept, tracer production, spect/pet)	Kozerke
19.11.	**Nuclear imaging** (detection principles, image reconstruction, resolution limits, kinetic modeling)	Kozerke
26.11.	**Magnetic Resonance** (magnetic moment, spin transitions, excitation, relaxation, detection)	Pruessmann
03.12.	**Magnetic Resonance** (plane wave encoding, Fourier reconstruction, pulse sequences)	Pruessmann
10.12.	**Magnetic Resonance** (contrast mechanisms, gradient- and spin-echo, applications)	Pruessmann
17.12.	**Summary, example exam questions**	Kozerke

Exercises

Matlab based exercises. Submitted exercise results are graded. A maximum bonus of 0.25 can be achieved and is added to the exam grade if a minimum of 9 exercises has successfully been accomplished.

Lectures	Tue	13-15	HG E7
Exercise (intro)	Tue	15-16	HG E7
Exercise (computer)	Mon	13-15	HG E19 (Computer room)

Book

Introduction to Medical Imaging: Physics, Engineering and Clinical Applications (A. Webb) (available online in ETH e-library)