Module Imaging

Module Name: Imaging

Module Number	**X4M 2100**	Level Master	Short Name IM
Responsible Lecturers	Prof. Dr. Henrik Botterweck Dr. Mandy Ahlborg		
Department, Facility	THL, Applied Natural Sciences and UZL, Medical Technology		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	ECTS Credit Points	8
Semester of Studies	2	Semester Hours per Week	6
Length (semesters)	1	Workload (hours)	240
Frequency	SuSe	Presence Hours	100
Teaching Language	English	Self-Study Hours	140
Consideration of Gender and Diversity Issues	☒ Use of gender-neutral language (THL standard) ☐ Target group specific adjustment of didactic methods ☐ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	The students get a sound knowledge of the main imaging technologies concerning the applied principles and technologies. The students know about the great influence of mathematics on the result of computed images		

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Course 1: Imaging, Lecture

Course Number		Short Name	IML
Course Type	Lecture	Form of Learning	Presence
Mandatory Attendance	☐	ECTS Credit Points	3
Participation Limit	None	Semester Hours per Week	2
Group Size (practical training, exercises, …)	None	Workload (hours)	60
Teaching Language	English	Presence Hours	25
Study Achievements („Studienleistung“, SL)	None	Self-Study Hours	35
SL Length (minutes)	n. a.	SL Grading System	n. a.
Exam Type	Written Exam	Exam Language	English
Exam Length (minutes)	90	Exam Grading System	One-third Grades
Learning Outcomes	Students will be able to 'translate' the medical requirements of imaging diagnostics by users to technical terms for developers and engineers.		
Participation Prerequisites	Numerical Methods in Medicine (lecture), Mathematics and Physics on an graduate (engineering bachelor) level		
Contents	Principles and classification of medical imaging, Optical Imaging, Sonography, Doppler, Diagnostic use of X-Rays, Transmission Tomography, Emission Tomography, Physical principles of nuclear magnetic resonance, typical MR imaging sequences, principles of maximum likelihood/a posteriori reconstruction, basic image processing.		
Literature	Th. Buzug: Computed Tomography (Springer) O. Dössel: Bildgebende Verfahren in der Medizin (Springer)		
Remarks	None		

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Module Image Processing

Course 2: Image Processing, Lecture

Course Number		Short Name	IMP
Course Type	Lecture	Form of Learning	Presence
Mandatory Attendance	☐	ECTS Credit Points	3
Participation Limit	n. a.	Semester Hours per Week	2
Group Size (practical training, exercises, …)	n. a.	Workload (hours)	60
Teaching Language	English	Presence Hours	25
Study Achievements („Studienleistung“, SL)	None	Self-Study Hours	35
SL Length (minutes)	n. a.	SL Grading System	n. a.
Exam Type	Written exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	• Development of the basics of the 2D signal processing (colors spaces, image scanning, discretisation of two-dimensional signals, discrete geometry) • Getting to know simple signal processing methods concerning feature extraction, filtering, and contrast adaption • Getting to know different methods to restore an image • Getting to know the basics of different image processing methods such as image segmentation and image registration • Getting to know the mathematical description, numerical solutions, and algorithmic implementation in digital signal processing • Knowledge about lecturer´s current research projects		
Participation Prerequisites	Mathematical knowledge and knowledge in the field of signal-theory		
Contents	Medical image processing is an active area of research. This lecture aims at developing a principle understanding for methods used in medical image processing and image analysis. The lecture will cover the mathematical description, the numerical solution as well as the algorithmic implementation of different methods used in medical image processing. Apart from the introduction into very general image processing methods this lecture will also provide some insight into state-of-the-art image processing algorithms. This lecture is not thought as a brief overview of medical image processing and its applications. It is rather thought as a comprehensive discussion of some explicitly chosen methods in depth. Therefore, the students will not only learn how to process two dimensional signals but also gain a deep insight into applied mathematics and computer science.		

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	The developed mathematical and numerical understanding will not only allow to understand the beauty of medical image processing but also supply the students with a basic understanding of mathematical methods, which indeed is of great value in many other fields. In the very beginning of the lecture the students will be supplied with the basics of the representation of digital images. Subsequently several methods used for feature extraction, contrast enhancement and filtering in the spatial as well as the Fourier domain will be explained. These very lectures form the basis for the understanding of higher image processing methods such as image restauration, image segmentation and image registration, all of which to date still represent a highly active field of research with many unsolved problems. The lecture will not only focus on the theoretical background but will be accompanied with illustrative examples to further develop an understanding of the theoretically presented mathematical and numerical methods.
Literature	Gonzales, R. C.: Digital Image Processing, Prentice Hall, New Jersey, 2008. Jähne, B.: Digital Image Processing, Springer, Berlin Heidelberg, 2002. Lehmann, Th. et al.: Bildverarbeitung für die Medizin, Springer, Berlin Heidelberg, 1997. Pratt, W. K.: Digital Image Processing: PIKS Scientific Inside, John Wiley & Sons, 2007.
Remarks	None

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Module Numerical Methods in Medicine

Course 2: Numerical Methods in Medicine, Lab

Course Number		Short Name	IMNM
Course Type	Lab	Form of Learning	Presence
Mandatory Attendance	☒	ECTS Credit Points	2
Participation Limit	n. a.	Semester Hours per Week	2
Group Size (practical training, exercises, …)	n. a.	Workload (hours)	60
Teaching Language	English	Presence Hours	25
Study Achievements („Studienleistung“, SL)	Programs, graded lab reports, presentations	Self-Study Hours	35
SL Length (minutes)	n. a.	SL Grading System	One-third Grades
Exam Type	n. a.	**Exam Language**	n. a.
Exam Length (minutes)	n. a.	**Exam Grading System**	n. a.
Learning Outcomes	After getting to know the basic numerical approaches and methods in the lecture the students can learn and practise the concrete application to realistic medical problems in this lab. The students become aware of aspects and criteria of the implementation and improvement of an algorithm. Knowledge about lecturer´s current research projects		
Participation Prerequisites	Lecture „Numerical Methods in Medicine“		
Contents	Simple, yet realistic problems in the fields of • medical image processing and visualization, • tomographic reconstruction, • statistical data evaluation, simulation (epidemics...), and medical -/bio-informatics (large data-sets) are posed together with example input data. The students apply given numerical tools (Matlab) and/or develop simple programs given numerical libraries in order to model, solve and analyze the tasks. A critical assessment of the results (Are the chosen methods adequate? Is the outcome realistic? What is the range of applicability? What could be improved?) is an important part of the work.		
Literature	Computer (Programming/Simulation/Visualization tools), hand-outs, short presentation of results		
Remarks	None		