TECHNISCHE UNIVERSITÄT KAISERSLAUTERN

Module Handbook

TUK MODHB Homapage

Course MAT-65-10-K-4

Foundations in Mathematical Image Processing (4V+2U, 9.0 LP, AUSL)

Course Type

SWS	Type	Course Form	CP (Effort)	Presence-Time / Self-Study	
-	K	Lecture with exercise classes (V/U)			
4	V	Lecture	6.0 CP	56 h	124 h
2	U	Exercise class (in small groups)	3.0 CP	28 h	62 h
(4V+2U)			9.0 CP	84 h	186 h

Basedata

SWS	4V+2U
CP, Effort	9.0 CP = 270 h
Position of the semester	1 Sem. irreg.
Level	[4] Bachelor (Specialization)
Language	[EN] English
Lecturers	Steidl, Gabriele, Prof. Dr. (PROF | DEPT: MAT) + further Lecturers of the department Mathematics
Area of study	[MAT-SPAS] Analysis and Stochastics
Livecycle-State	[AUSL] Phase-out period

Notice

The course was offered for the last time in SS 2017.

Possible Study achievement

- Verification of study performance: **proof of successful participation in the exercise classes (ungraded)**
- Examination number (Study achievement): 84036 ("Exercise Class Foundations of Mathematical Image Analysis")
- Details of the examination (type, duration, criteria) will be announced at the beginning of the course.

Contents

- Digital image (format, color spaces, sampling, quantization, basic task of image processing),
- Basic Cluster and segmentation algorithms (Mittel, K-means-Algorithms),
- Intensity transformations (Gamma correction, histogram specification),
- Filter (linear filter, bilateral filter, M-regularisator, in particular: median filter),
- Fourier series and discrete Fourier Transform (Series convergence, DFT, FFT),
- Multidimensional Fourier series (DFT, applications in image processing),
- Continuous Fourier Transform,
- Windowed Fourier Transform (Heisenberg's Uncertainty Principle, Gabor Transform).

Competencies / intended learning achievements

The students know the basic questions, concepts and methods of mathematical image processing. By concrete examples, they have gained a clear understanding of the concepts and the application of the methods. They understand the mathematical background required for the methods used (in particular: Intensity transformations, Linear and Nonlinear filters) and they are able to critically assess the possibilities and limitations of the use of these methods.

In addition, the students have learnt the basic problems and concepts of classical Fourier analysis with its numerous practical applications. They have mastered the most important methods and will be able to apply them to selected tasks from image processing.

Literature

Literature on mathematical fundamentals:

- K. Bredies, D. Lorenz: Mathematische Bildverarbeitung. Einführung in Grundlagen und moderne Theorie,
- T. Chan, J. Shen: Image processing and analysis. Variational, PDE, Wavelet, and Stochastic Methods,
- O. Scherzer, M. Grasmair, H. Grossauer, M. Haltmeier, F. Lenzen: Variational Methods in Imaging.

Literature on computer science aspects:

- R. C. Gonzalez, R. E. Woods: Digital Image Processing,
- B. Jähne: Digital Image Processing,
- C. Solomon, T. Breckon: Fundamentals of Digital Image Processing. A Practical Approach with Examples in Matlab.

Literature on Fourier Analysis:

- G. Folland: Fourier Analysis and its Applications,
- G. Folland: Real Analysis,
- T. Körner: Fourier Analysis,
- H. Nussbaumer: Fast Fourier Transforms and Convolution Algorithms,
- J. Ramanathan: Methods of Applied Fourier Analysis.

Materials

Further literature will be announced in the lecture; Exercise material is provided.

Registration

Registration for the exercise classes via the online administration system URM (https://urm.mathematik.uni-kl.de).

Requirements for attendance (informal)

Modules:

- [MAT-10-1-M-2] Fundamentals of Mathematics (M, 28.0 LP)
- [MAT-14-11-M-3] Introduction to Numerical Methods (M, 9.0 LP)
- [MAT-14-14-M-3] Stochastic Methods (M, 9.0 LP)

Courses

- [MAT-12-23-K-3] Introduction to Functional Analysis (2V+1U, 4.5 LP)

Requirements for attendance (formal)

None

References to Course [MAT-65-10-K-4]

Module	Name	Context	
[MAT-65-10-M-4]	Foundations in Mathematical Image Processing	P: Obligatory	4V+2U, 9.0 LP, AUSL

Course-Pool	Name
[MAT-70-KPOOL-4]	Specialisation Analysis and Stochastics (B.Sc.)
[MAT-80-4V-KPOOL-4]	Elective Courses Modelling and Scientific Computing (4V, B.Sc.)
[MAT-80-KPOOL-4]	Specialisation Modelling and Scientific Computing (B.Sc.)