Multidimensional Signal and Image Analysis

Multidimensionell signal- och bildanalys
6 credits

Programme course

TSBB36

Valid from: 2025 Spring semester

Determined by	**Main field of study**	
Board of Studies for Electrical Engineering, Physics and Mathematics	Electrical Engineering	
Date determined	**Course level**	**Progressive specialisation**
2024-08-28	First cycle	G2F
Revised by	**Disciplinary domain**	
	Technology	
Revision date	**Subject group**	
	Electrical Engineering	
Offered first time	**Offered for the last time**	
Autumn semester 2024		
Department	**Replaced by**	
Institutionen för systemteknik		

Specific information

The course overlaps with TSBB06 Multidimensional Signal Analysis, and the two may not be part of the same degree.

Course offered for

- Master of Science in Engineering Mathematics

Prerequisites

Basic Linear Algebra: vector spaces, bases, scalar product, least squares problems, eigenvalue problems. Convolution and Fourier transform of one-variable signals. Basic skills in Matlab or Python is recommended.

Intended learning outcomes

An objective of the course is to provide a solid theoretical foundation for further studies and applications in 3D computer vision and in machine learning with images. Passing the course means that the student is able to use concepts and methods in signal and image analysis that are based on linear algebra. The student is then able to:

Goal 1: Explain and use homogeneous coordinates for geometric calculations in two and three dimensions. This includes points and lines in two dimensions, points, planes, and lines in three dimensions, homographies, camera projections, and epipolar geometry.
Goal 2: Explain and use least squares techniques to define estimation problems for different geometric objects. This includes triangulation, image filtering, and rigid transformations.
Goal 3: Explain and use bases, dual bases, and subspace bases to perform calculations for signal analysis.
Goal 4: Explain and use linear signal representations on practical problems, including: image filtering, image blending, and feature maps.

Course content

Signal spaces and signal bases, dual bases. Least squares problem, normalized convolution. Eigenvalue and singular value analysis. Principal component analysis. Feature maps. Projective spaces, homogeneous coordinates, homographies, camera projections, epipolar geometry. Representation and estimation of various types of geometric objects.

Teaching and working methods

The course has lectures that present basic concepts and theory. The course also contains lessons with a focus on calculations in order to concretise and emphasise the concepts and theory from the lectures. In a set of mandatory computer exercises, each participant must demonstrate the ability to carry out more complex calculation and answer related questions.

Examination

TEN1	Written Examination	4 credits	U, 3, 4, 5
LAB1	Laboratory Work	2 credits	U, G

Attendance is mandatory at the computer exercises. The “use” parts of Goals 1-4 are tested during the computer exercises, and during the written examination. Deeper understanding and ability to explain are tested by the written examination.

For grade 3, a pass on the computer exercises and the exam are required. For grades 4 and 5, it is additionally required to demonstrate, on the exam, a higher ability to use methods in combination and explain and conduct deeper reasoning concerning concepts and methods in the course.

Grades for examination modules are decided in accordance with the assessment criteria presented at the start of the course.

Grades

Four-grade scale, LiU, U, 3, 4, 5

Other information

Supplementary courses: 3D Computer Vision, Computer Vision for Video Analysis, Machine Learning for Computer Vision, Image and Audio Coding, Medical Image Analysis, Neural Networks and Learning Systems, Computational Photography

About teaching and examination language

The teaching language is presented in the Overview tab for each course. The examination language relates to the teaching language as follows:

- If teaching language is “Swedish”, the course as a whole could be given in Swedish, or partly in English. Examination language is Swedish, but parts of the examination can be in English.
- If teaching language is “English”, the course as a whole is taught in English. Examination language is English.
- If teaching language is “Swedish/English”, the course as a whole will be taught in English if students without prior knowledge of the Swedish language participate. Examination language is Swedish or English depending on teaching language.

Other

The course is conducted in such a way that there are equal opportunities with regard to sex, transgender identity or expression, ethnicity, religion or other belief, disability, sexual orientation and age.

The planning and implementation of a course should correspond to the course syllabus. The course evaluation should therefore be conducted with the course syllabus as a starting point.

The course is campus-based at the location specified for the course, unless otherwise stated under “Teaching and working methods”. Please note, in a campus-based course occasional remote sessions could be included.