Faculty of Science

MATC20, Mathematics: Image Analysis, 7.5 credits

Matematik: Bildanalys, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2016-04-04 and was last revised on 2016-04-04. The revised syllabus applies from 2016-07-01, autumn semester 2016.

General Information

The course is an elective component at first-cycle level for a Bachelor of Science or a Master of Science degree in Mathematics.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Mathematics	G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The main aim of the course is to provide a basic introduction to theory and mathematical methods in image analysis to such an extent that students could address an industrial image processing problem. An additional aim is to prepare students for continued studies in, for example, multispectral image analysis or statistical image analysis.

Knowledge and understanding

- clearly explain and independently use basic mathematical concepts within image analysis, particularly in regard to transform theory (regarding both space and frequency aspects), image enhancement methods, compression and pattern recognition,
- give a description and general explanation of the mathematical theory behind some of the central image processing algorithms (deterministic as well as stochastic),

- describe the statistical principles that form the basis for machine learning.

Competence and skills

- independently identify problems that can be solved by imaging techniques and select an appropriate method,
- independently apply basic imaging techniques that are relevant to image processing problems encountered in industry and research,
- use exact terminology in a well-structured and logically coherent account of the solution to an image analysis problem.

Course content

- *Basic mathematical concepts:* image transforms, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT).
- *Image enhancement:* grey level transformation, filtering.
- *Image restoration:* filtering, inverse methods.
- *Scale-space theory:* continuous versus discrete theory, interpolation.
- *Feature extraction:* filtering, edge and corner detection.
- *Segmentation:* graph methods, active contours, mathematical morphology.
- *Bayesian image processing:* MAP (Maximum A Posteriori) estimation, simulation.
- *Pattern recognition:* classification, Support Vector Machine (SVM), Principal Component Analysis (PCA), learning.
- *Registration:* transformation, e.g. using rescaling or rotation and different images in a coordinate system so that equivalent points on the object end up over each other.
- *Machine learning:* learning, testing, generalisation, hypothesis spaces.

Course design

The course is made up of lectures and resource time in the computer hall as assistance for written assignments. Compulsory written assignments are a component of the course.

Assessment

The assessment is based on written assignments during the course and possibly a written take-home exam and associated oral exam at the end of the course.

For a grade of Pass with Distinction, the student must pass the take-home exam, which is only offered to students who have passed all written assignments on the course. Students who perform sufficiently well on the take-home exam will also be given the opportunity to take an oral exam.

Students who fail the written assignments on the course will be given the opportunity to complement them shortly after the take-home exam. Students who fail the take-home exam will be given the opportunity for an additional take-home exam and associated oral exam.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
For a grade of Pass on the whole course, the student must have been awarded this grade on all written assignments. For the grade of Pass with Distinction, the student must also have been awarded this grade in the take-home exam and the associated oral exam. The final grade is determined by the grade on the take-home exam.

Entry requirements

To be admitted to the course, students are required to have knowledge equivalent to at least 60 credits in mathematics and numerical analysis including the courses MATB16 Linear Analysis, 7.5 credits, MATB22 Linear Algebra 2, 7.5 credits, and NUMA01 Computational Programming with Python, 7.5 credits.

Further information

The course is studied alongside the Faculty of Engineering (LTH) course, FMAN20 Image Analysis, 7.5 credits, and cannot be included in a degree with this, or with FMA170 Image Analysis, 6 credits.

Subcourses in MATC20, Mathematics: Image Analysis

Applies from H16

1601 Assignments, 7,5 hp
Grading scale: Fail, Pass
1602 Take-home Examination, 0,0 hp
Grading scale: Fail, Pass
1603 Oral Examination, 0,0 hp
Grading scale: Fail, Pass