MICRO-511 **Image processing I**

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Cursus	Sem.	Type
Computational and Quantitative Biology		Opt.
Computational science and Engineering	MA1, MA3	Opt.
Computational science and engineering minor	H	Opt.
Computer science	MA1, MA3	Opt.
Cybersecurity	MA1, MA3	Opt.
Data Science	MA1, MA3	Opt.
Digital Humanities	MA1, MA3	Opt.
Environmental Sciences and Engineering	MA1, MA3	Opt.
Life Sciences Engineering	MA1, MA3	Opt.
Microtechnics	MA1, MA3	Opt.
Minor in Imaging	H	Opt.
Minor in life sciences engineering	H	Opt.
Neuro-X minor	H	Opt.
Neuro-X	MA1, MA3	Opt.
Nuclear engineering	MA1	Opt.
Photonics minor	H	Opt.
Robotics, Control and Intelligent Systems		Opt.
Robotics	MA1, MA3	Opt.
SC master EPFL	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

Introduction to the basic techniques of image processing. Introduction to the development of image-processing software and to prototyping using Jupyter notebooks. Application to real-world examples in industrial vision and biomedical imaging.

Content

- **Introduction**. Image processing versus image analysis. Applications. System components.
- **Characterization of continuous images**. Image classes. 2D Fourier transform. Shift-invariant systems.
- **Image acquisition**. Sampling theory. Acquisition systems. Histogram and simple statistics. Max-Lloyd quantization (K-means).
- **Characterization of discrete images and linear filtering**. z-transform. Convolution. Separability. FIR and IIR filters.
- **Morphological operators**. Binary morphology (opening, closing, etc.). Gray-level morphology.
- **Image-processing tasks**. Preprocessing. Matching and detection. Feature extraction. Segmentation.
- **Convolutional neural networks**. Basic components. Operator-based formalism. CNN in practice: denoising and segmentation.

Learning Prerequisites

Required courses

Signals and Systems I & II (or equivalent)

Important concepts to start the course

1-D signal processing: convolution, Fourier transform, z-transform

Learning Outcomes

By the end of the course, the student must be able to:

- Exploit the multidimensional Fourier transform
- Select appropriately Hilbert spaces and inner-products
- Optimize 2-D sampling to avoid aliasing
- Formalize convolution and optical systems
- Design digital filters in 2-D
- Analyze multidimensional linear shift-invariant systems
- Apply image-analysis techniques
- Construct image-processing software
- Elaborate morphological filters
- Exploit the multidimensional Fourier transform
- Select appropriately Hilbert spaces and inner-products
- Optimize 2-D sampling to avoid aliasing
- Formalize convolution and optical systems
- Design digital filters in 2-D
- Analyze multidimensional linear shift-invariant systems
- Apply image-analysis techniques
- Construct image-processing software

Transversal skills

- Use a work methodology appropriate to the task.
- Manage priorities.
- Use both general and domain specific IT resources and tools

Assessment methods

- 70% final exam
- 30% IP labs during semester

Resources

Moodle Link

- https://go.epfl.ch/MICRO-511