

CS-413

**Computational photography**

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Cursus	Sem.	Type
Computer science	MA2, MA4	Opt.
Cybersecurity	MA2, MA4	Opt.
Data Science	MA2, MA4	Opt.
Digital Humanities	MA2, MA4	Opt.
Electrical and Electronical Engineering	MA2, MA4	Opt.
Minor in Imaging	E	Opt.
SC master EPFL	MA2, MA4	Opt.

Language of teaching	English
Credits	6
Session	Summer
Semester	Spring
Exam	During the semester
Workload	180h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Lecture	2 weekly
Project	2 weekly
<b>Number of positions</b>	

**Summary**

The students will gain the theoretical knowledge in computational photography, which allows recording and processing a richer visual experience than traditional digital imaging. They will also execute practical group projects to develop their own computational photography application.

**Content**

Computational photography is the art, science, and engineering of creating a great (still or moving) image. Information is recorded in space, time, across visible and invisible radiation and from other sources, and then post-processed to produce the final - visually pleasing - result.

*Basics: Human vision system, Light and illumination, Geometric optics, Color science, Sensors, Digital camera systems.*

*Generalized illumination: Structured light, High dynamic range (HDR) imaging, Time-of-flight.*

*Generalized optics: Coded Image Sensing, Coded aperture, Focal stacks.*

*Generalized sensing: Low light imaging, Depth imaging, Plenoptic imaging, Light field cameras.*

*Generalized processing: Super-resolution, In-painting, Compositing, Photomontages, Panoramas, HDR imaging,*

*Multi-wavelength imaging, Dynamic imaging.*

*Generalized display: Stereoscopic displays, HDR displays, 3D displays, Mobile displays.*

*Deep Learning for image resoration and image enhancement.*

**Keywords**

Computational Photography, Coded Image Sensing, Non-classical image capture, Multi-Image & Sensor Fusion, Mobile Imaging, Machine Learning

**Learning Prerequisites****Required courses**

- A basic Signal Processing, Image Processing, and/or Computer Vision course.
- Linear Algebra.

**Recommended courses**

- Introduction to Computer Vision.
- Signal Processing for Communications.
- Machine Learning.

### Important concepts to start the course

- Basic signal/image processing.
- Basic computer vision.
- Basic programming (Python, iOS, Android).

### Learning Outcomes

- Identify the main components of a computational photography system.
- Contextualise the main trends in computational optics, sensing, processing, and displays.
- Create a computational photography application.
- Design a computational photography solution to solve a particular imaging task.
- Assess / Evaluate hardware and software combinations for their imaging performance.
- Formulate computational photography challenges that still need to be resolved.

### Transversal skills

- Evaluate one's own performance in the team, receive and respond appropriately to feedback.
- Continue to work through difficulties or initial failure to find optimal solutions.

### Teaching methods

The course consists of 2 hours of lectures per week that will cover the theoretical basics. An additional 2 hours per week are dedicated to a group project designing, developing, and programming a computational photography application on a mobile platform (iOS, Android).

### Expected student activities

The student is expected to attend the class and actively participate in the practical group project, which requires coding on either Android or iOS platform. The student is also required to read the assigned reading material (book chapters, scientific articles).

### Assessment methods

The theoretical part will be evaluated with an oral exam at the end of the semester, and the practical part based on the students' group projects

### Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

### Resources

#### Bibliography

- Selected book chapters
- Course notes (on moodle)
- Links to relevant scientific articles and on-line resources will be given on moodle.

### Moodle Link

- <https://go.epfl.ch/CS-413>