

CIVIL-510

Quantitative imaging for civil engineering

Andò Edward

Cursus	Sem.	Type
Civil Engineering	MA1, MA3	Opt.

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

Summary

This course will arm students with knowledge of different imaging techniques for practical use to make measurements in many different fields of civil engineering. Modalities will range from satellite and drone imaging all the way down to microscopy and x-ray tomography with practical sessions.

Content

This course will be given by a visiting Professor (Edward Andò) over 14 weeks. The material covered in the 14 weeks will be roughly as follows:

1. **Introductory lecture: Images and measurements**
2. **Image acquisition basics: sensors and optics**
3. **Image quality basics: noise, blur, contrast**
4. **Depth measurement: structured light, time of flight**
5. **Practical session 1: Building a 21st century sandbox, projecting height map onto sand**
6. **Basic image analysis: filters, thresholding, segmenting**
7. **(x-ray) Tomography: acquiring and analysing 3D volume images**
8. **Practical session 2: 3D evaluation of a concrete specimen on PIXE**
9. **Advanced image analysis: tracking movement with image correlation**
10. **Crack detection and characterisation**
11. **Measuring a 3D surface: Structure from motion**
12. **Practical session 3: 3D scanning in EPFL campus**
13. **Seeing from above: Capabilities of Satellite imaging**
14. **Written, short-answer, exam**

Keywords

quantitative imaging, satellite imaging, drone imaging, thermal imaging, photography, microscopy, x-ray tomography, crack identification, digital image/volume correlation, uncertainty quantification, structure from motion

Learning Prerequisites

Required courses

Physique générale : mécanique (PHYS-101) -- or equivalent
Analyse I (MATH-111) -- or equivalent
Géométrie (MATH-123(b)) -- or equivalent
Algèbre linéaire (MATH-111) -- or equivalent

Recommended courses

Mécanique des milieux continus (pour GC) (CIVIL-225)
Eléments de géomatique (ENV-140)

Important concepts to start the course

- Matrix manipulation
- Gaussian/Normal distributions
- 3D geometry

Learning Outcomes

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

- Analyze An image-based measurement system
- Interpret Quantitative image-based measurements
- Propose Suitable image-based measurement tool for different practical problems
- Quantify Measurement errors and their source

Transversal skills

- Access and evaluate appropriate sources of information.
- Collect data.
- Use both general and domain specific IT resources and tools

Teaching methods

The course is built around a number of lectures that will introduce concepts related to quantitative imaging, which is the concept of using images (photography, microscopy, x-ray imaging, hyperspectral imaging) in order to make a precise measurement (of dimensions, strain, structure).

There will be practical exercise classes, using examples from civil engineering, to cement the knowledge gained during the course.

Expected student activities

- Attendance at lectures/exercise sessions
- Attendance and active participation in practical sessions

Assessment methods

Important point: This course is unique for the Autumn term 2021-2022 and is being taught by an invited Professor (E. Andò from Université Grenoble Alpes).

The final mark will be a combination of the in-class exercises and a small single final exam in week 14, which will be written and closed-book.

This exam will have no numerical questions, and instead be composed of numerous questions with short answers, which

someone understanding the main points of the course should have no problem in passing.

Supervision

Office hours	Yes
Assistants	Yes
Forum	No