lelec2885
2024

Image processing and computer vision

5.00 credits	30.0 h + 30.0 h	Q1

Teacher(s)	De Vleeschouwer Christophe (coordinator) ;Jacques Laurent ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Main themes	This course is part of the ELEC/EPL program in "**information and signal processing**". The main objective of LELEC2885is to introduce all the concepts needed to understand the "image" signals, from their acquisition until their processing, through the important questions of signal representation and approximation occuring during data transmission or interpretation.
Learning outcomes	**At the end of this learning unit, the student is able to :** With respect to the AA referring system defined for the Master in Electrical Engineering, the course contributes to the deveeloopment, mastery and assessment of the following skills : • AA1.1, AA1.2 • AA3.1, AA3.3 • AA5.5, AA5.6 b. **At the end of this course, the student will be able to:** 1. Handle techniques of representation and approximation of images in order to extract their meaningful components with respect to a particular application, for example, in the fields of data transmission or interpretation; 2. Apply linear and non-linear filtering operations (e.g., morphological) to isolate certain frequency components or to cancel particular noises; 3. Detect structures of interest in an image, such as contours, key features, etc.. 4. Segment an image into regions of homogeneous characteristics, targeting a semantic interpretation of the image content; 5. Restore images corrupted a noise or a blurring; 6. Understand the basic principles of inverse problem solving in imaging and in compressed sensing; 7. Manage image databases using detection tools or classification; 8. Detect and track one or more object(s) of interest in video streams, in biomedical applications or for 3-D scene interpretation; 9. Compress image signals considering their visual perception and their accessability in the compressed signal representation; 10. Provide a solution to complex problems involving image processing, such as quality control, visiosurveillance, multimodal human-machine interfaces, and image compression.
Evaluation methods	The evaluation includes two components : • An **oral examination** (in-session): Scheduled in January, this test evaluates individually the students on their understanding of the concepts and methods taught during the theoretical courses and the numerical practical sessions. • A **hackathon-type project** (off-session*), carried out by teams of two or three students, with the aim of solving a concrete problem in intelligent vision. The final mark for the project will be based on a written report and a submission of Python code. Particular attention will be paid to assessing the proposed method. These three components will be weighted at 70% and 30% respectively. The mark obtained for the assessment of the project is acquired for all the sessions of the academic year. *: The project will result in a single overall mark for out-of-session assessment. Failure to comply with the methodological guidelines set out on moodle, particularly with regard to the use of online resources or collaboration between students, will result in an overall mark of 0 for the out-of-session assessment.

Teaching methods	The course is organized around a series of lectures, each dealing with a specific problem commonly encountered in the field of image processing. Each lesson introduces a selection of the main solutions found in the literature and/or the industry to solve the problem of interest, and a list of references is provided for each covered topic. In addition to the theoretical classes, • numerical exercise sessions under Python are organized in a computer room. Students are asked to program different algorithms associated with a consistent sub-selection of the techniques taught. They use existing Python libraries for this purpose. Learning is provided by problem solving, based on real or synthetic images/ signals, sometimes associated with external databases. • a problem-based learning system is used: groups of 2 to 3 students are given a practical challenge in the field of intelligent vision. The solution devised and implemented is carefully validated and assessed by means of a written report and the submission of codes. The course is given in the classroom exclusively.
Content	• Image representation: Pixels, Fourier and Multiscale Transforms. • The wavelet transform. • The sparsity principle and applications: from orthonormal bases to redundant systems. • Human visual system and salient image features. • Image classification and deep learning introduction. • Basic tools of image analysis: mathematical morphology and relatives. • Image segmentation, (spectral) clustering, watershed and level sets • An introduction to computational imaging • Detection-based (multi-) object tracking: detect-before-track • Recursive visual object tracking: track-before-detect • Principles of stereo vision • From entropy coding to image compression • Video compression, and sparse approximation coding
Inline resources	Moodle https://moodle.uclouvain.be/course/view.php?id=982
Bibliography	Support de cours : Transparents, articles tutoriaux et parties de code Python. Les documents du cours sont disponibles sur Moodle ------------------ Course materials: Slides, tutorials and parts of Python code. Course documents are available on Moodle
Other infos	This course assumes that the basics of signal processing, such as taught in the course "signals and systems" (**LFSAB1106**) or "digital signal processing" (**LELEC2900**), are known.
Faculty or entity in charge	ELEC

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Biomedical Engineering	GBIO2M	5		🔍
Master [120] in Electrical Engineering	ELEC2M	5		🔍
Master [120] in Computer Science and Engineering	INFO2M	5		🔍
Master [120] in Computer Science	SINF2M	5		🔍
Master [120] in Mathematical Engineering	MAP2M	5		🔍
Master [120] in Data Science Engineering	DATE2M	5		🔍
Master [120] in Data Science: Information Technology	DATI2M	5		🔍