UCLouvain

lelec2885

2020

Image processing and computer vision

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

5 credits	30.0 h + 30.0 h	Q1

Teacher(s)	De Vleeschouwer Christophe (coordinator) ;Jacques Laurent ;
Language :	English
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.
Aims	With respect to the AA referring system defined for the Master in Electrical Engineering, the course contributes to the develoopment, 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; 1 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. - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** The evaluation includes three components : • An **oral examination**: Scheduled in January, this test evaluates individually the students on their understanding of the concepts and methods taught during the theoretical courses. • **An evaluation of the Python numerical exercises**: students are evaluated on a computer (in session or out of session) based on problems similar to those presented during the year. • A **critical analysis of 3 scientific papers in the field**: This helps the student to develop his ability to analyze the advantages and the weaknesses of a scientific work, considering both its content and its general structure. Each student provides a report (1 page max per article) by December. These three components are weighted as 50%, 30% and 20% of the final grade, respectively. It is required to pass the oral exam. In case of exam failure, only the exam note will be taken into account.

Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** 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. To complement the lectures, the student is also asked to read and criticize a number of scientific publications. The goal is to allow him/her to deal with a subject in depth, but also and especially to draw his/her attention to the way a scientific paper is built. 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. The course is given in the classroom exclusively. However, in the context of health measures related to Covid-19, some lectures could be organized on a distance (or hybrid) basis, according to the terms and schedule displayed on the moodle page of the course.
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 http://moodleucl.uclouvain.be/course/view.php?id=7579
Bibliography	Support de cours : Transparents, articles tutoriaux et parties de code Python. Les documents du cours sont disponibles sur Moodle Lectures conseillées : Durant l'année, l'étudiant doit lire 3 articles sélectionnés dans une liste d'articles distribués sur le site Moodle du cours. ---------- Course materials: Slides, tutorials and parts of Python code. Course documents are available on Moodle Recommended reading: During the year, each student must read 3 articles selected from a list of articles distributed on the Moodle site of the course.
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

Force majeure

Teaching methods	The lectures are given in the form of videos that can be viewed remotely and the practical work is organized remotely via MS Teams.
Evaluation methods	The assessment will focus on the material covered during the lessons and exercises (whether they took place face-to-face or remote). Students will be assessed: - on the critical analysis of 3 scientific articles (as announced above in a context of standard evaluation); - by means of continuous evaluations associated with practical work, face-to-face if the health situation allows it, or remotely if the health situation requires it; - individually in oral examination, face-to-face if the health situation allows it, or remotely if the health situation requires it. The final mark (between the continuous evaluation, the 3 article reviews, and the oral examination) will follow the same weighting as announced in standard evaluation mode (in absence of pandemic).

Other infos	An oral exam will be offered to students who can assert before the exam an inability to participate in the exam organized on site, this impossibility attested by a quarantine certificate or a "return form" from the FPS Foreign Affairs. This oral exam will cover the same subject as the oral exam organized in person.

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Computer Science and Engineering	INFO2M	5		
Master [120] in Computer Science	SINF2M	5		
Master [120] in Electrical Engineering	ELEC2M	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		
Master [120] in Biomedical Engineering	GBIO2M	5		