

5.0 credits	30.0 h + 30.0 h	1q
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Teacher(s) :	Jacques Laurent ; De Vleeschouwer Christophe ;
Language :	Anglais
Place of the course	Louvain-la-Neuve
Inline resources:	Moodle > http://moodleucl.uclouvain.be/course/view.php?id=7579
Main themes :	This course is part of the ELEC/EPL program in "information and signal processing". The main objective of LELEC2885 is to introduce all the concepts needed to process "image" signals, from their acquisition to their rendering and /or analysis. It covers the signal representation and approximation issues raised by the transmission or the interpretation of (moving) images.
Aims :	<p>With respect to the AA referring system defined for the Master in Electrical Engineering, the course contributes to the development, mastery and assessment of the following skills :</p> <p>--</p> <p>AA1.1, AA1.2</p> <p>--</p> <p>AA3.1, AA3.3</p> <p>--</p> <p>AA5.5, AA5.6</p> <p>At the end of this course, the student will be able to:</p> <ol style="list-style-type: none"> 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 by 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 while preserving their visual perception and their access flexibility in the compressed domain; 10. Provide a solution to complex problems involving image processing, such as quality control, video surveillance, multimodal human-machine interfaces, and image compression. <p><i>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".</i></p>
Evaluation methods :	<p>The evaluation includes three components :</p> <p>--</p> <p>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.</p> <p>--</p> <p>A project (realized by a team of 2 or 3 students): The objective is to solve an actual problem in image processing and/or computer vision. Each group first prepares a brief midterm presentation (not rated); the objective is to evaluate the group progression in the project realization and to provide them advice on the selected approach and methodologies. The final project rating is based on a written report and on a final oral presentation made in December.</p> <p>--</p> <p>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.</p> <p>These three components are weighted as 40%, 40% and 20% of the final grade, respectively.</p>

Teaching methods :	<p>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.</p> <p>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.</p> <p>Besides the lectures, a learning procedure "by problems" is implemented: a practical challenge is addressed by group of 2 or 3 students, based on a software platform for image processing. The envisioned solution and its implementation are carefully validated and evaluated, before a final oral and written presentation.</p>
Content :	<p>--</p> <p>Image definition: pixels, resolutions and color systems</p> <p>--</p> <p>Image representation: from Fourier to wavelets.</p> <p>--</p> <p>Sparsity principles: from orthonormal bases to redundant systems</p> <p>--</p> <p>Tools for sparse decomposition: Matching Pursuit, greedy methods and Basis pursuit.</p> <p>--</p> <p>Sparsity and applications: denoising, deconvolution, compressed sensing, computational imaging.</p> <p>--</p> <p>Image perception, human visual system and application to watermarking.</p> <p>--</p> <p>Image and Video compression: JPEG, MPEG, and sparse approximation coding.</p> <p>--</p> <p>Basic tools of image analysis: filtering, thresholding, mathematical morphology.</p> <p>--</p> <p>Image Segmentation: clustering, watershed, graph cuts and Markov random fields.</p> <p>--</p> <p>Visual detection and recognition: point descriptors, image features, and classifiers.</p> <p>--</p> <p>Visual object tracking: Template matching, particle filters, graph-based formalisms</p>
Bibliography :	<p>Course support:</p> <p>Slides, tutorials and part of Matlab codes.</p> <p>These documents are available on Moodle</p> <p>Advised reading:</p> <p>During the semester, the student must read 3 articles selected in a list of 40 provided on Moodle</p>
Other infos :	<p>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.</p>
Faculty or entity in charge:	ELEC

Programmes / formations proposant cette unité d'enseignement (UE)				
Intitulé du programme	Sigle	Credits	Prerequis	Acquis d'apprentissage
Master [120] in Electrical Engineering	ELEC2M	5	-	
Master [120] in Computer Science and Engineering	INFO2M	5	-	
Master [120] in Mathematical Engineering	MAP2M	5	-	
Master [120] in Computer Science	SINF2M	5	-	
Master [120] in Biomedical Engineering	GBIO2M	5	-	