Last update: 06-05-2019

230561 - IMPROCES - Image Processing in Biophotonics

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 731 - OO - Department of Optics and Optometry

Academic year: 2019

Degree: MASTER'S DEGREE IN PHOTONICS (Syllabus 2013). (Teaching unit Optional)
ERASMUS MUNDUS MASTER'S DEGREE IN PHOTONICS ENGINEERING, NANOPHOTONICS AND BIOPHOTONICS (Syllabus 2010). (Teaching unit Optional)

ECTS credits: 3 Teaching languages: English

Teaching staff

Coordinator: Artur Carnicer, UB.

Requirements

Students are expected to be familiar with Python (or Matlab)

Degree competences to which the subject contributes

Basic:

CB7. (ENG) Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

CB8. (ENG) Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicio.

CB6. (ENG) Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CB10. (ENG) Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

Specific:

CE3. (ENG) Màster en Fotònica:
Conocer los fundamentos de la física del láser, los tipos de láser y sus principales aplicaciones

CE4. (ENG) Màster en Fotònica:
Demostrar que conoce los fundamentos de la formación de imagen, de la propagación de la luz a través de los diferentes medios y de la Óptica de Fourier.

CE6. (ENG) Màster en Fotònica:
Haber realizado un conjunto de prácticas de laboratorio de nivel avanzado, similar al de futuros trabajos experimentales de investigación

CE9. (ENG) Màster en Fotònica:
Capacidad para sintetizar y exponer los resultados de investigación en fótonica según los procedimientos y convenciones de las presentaciones científicas en inglés.

Generical:

CG1. (ENG) Màster en Fotònica:
Capacidad para proyectar, diseñar e implantar productos, procesos, servicios e instalaciones en algunos ámbitos de la fotónica como los relacionados con la ingeniería fotónica, la nanofotónica, la óptica cuántica, las telecomunicaciones y la biofotónica

CG2. (ENG) Màster en Fotònica:
Capacidad para la modelización, cálculo, simulación, desarrollo e implantación en centros de investigación, centros tecnológicos y empresas, particularmente en tareas de investigación, desarrollo e innovación en todos los ámbitos relacionados con la Fotónica.

CG4. (ENG) Màster en Fotònica:

Last update: 06-05-2019

230561 - IMPROCES - Image Processing in Biophotonics

Capacidad para entender el carácter generalista y multidisciplinario de la fótonica viendo su aplicación por ejemplo a la medicina, biología, energía, comunicaciones o la industria

Transversal:

1. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
2. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.
3. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.
4. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.
5. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Teaching methodology

Project-based learning

Learning objectives of the subject

This subject overviews several topics on digital image processing focusing on biophotonics applications. This is a hands-on course that provides an in-depth treatment of image processing techniques, emphasizing software principles and practical implementation. Despite no previous knowledge on digital image processing is required, those students willing to attend this course should be familiar with Python or Matlab computing environments. No background on basic programing techniques will be provided.

Study load

Total learning time: 75h	Hours large group:	24h	32.00%
	Self study:	51h	68.00%

Last update: 06-05-2019

230561 - IMPROCES - Image Processing in Biophotonics

Content

Lab #1

Learning time: 1h 30m
Guided activities: 1h 30m

Description:
Python concepts for image processing

Related activities:
Installation of the The Anaconda Python distribution
Basic procedures in Python

Lab #2

Learning time: 3h
Guided activities: 3h

Description:
Basic image manipulation: channel processing, colormaps and cameras

Related activities:
Channel extraction
Luminance, colormaps and false color
Gamma and log contrast
Image adquisition using opencvr

Lab #3

Learning time: 3h
Guided activities: 3h

Description:
Image binarization

Related activities:
Adaptive thresholding
Error diffusion binarization (dithering)
Color dithering. The HSV color model

230561 - IMPROCES - Image Processing in Biophotonics

Lab #4	Learning time: 3h Guided activities: 3h

Description:
More on color and channel transformations.

Related activities:
RGB coordinates from spectrum data. The CIE 1931 XYZ color model.
Histogram equalization
Image entropy
Least-significant bits steganography
Visual encryption

Lab #5	Learning time: 3h Guided activities: 3h

Description:
Fourier transforms and spatial filtering.

Related activities:
Basic operations
Fourier series and filtering of spatial frequencies
Relative importance of amplitude and phase of the Fourier Transform
Spatial filtering: Sharp cut-off low-pass filters, Laplacian filters, Gaussian filters, Butterworth filters, Quasi-periodic noise filtering
Spatial filtering in the image domain: Linear convolution kernels, the Kirsch compass kernel, Salt and Pepper noise and Roberts, Sobel and Prewitt filters

Lab #6	Learning time: 3h Guided activities: 3h

Description:
Axial computer tomography

Related activities:
Radom Transforms
The Projection-Slide Theorem
The Filtered Back-Propagation Algorithm.

Last update: 06-05-2019

230561 - IMPROCES - Image Processing in Biophotonics

Lab #7	Learning time: 3h Guided activities: 3h

Description:
Remote sensing image-segmentation using classification techniques

Related activities:
Spectral sensing
The k-nearest neighbors algorithm (kNN)

Lab #8	Learning time: 3h Guided activities: 3h

Description:
Spherical aberration and out-of-focus images. Image restoration filters.

Related activities:
Calculation of the PSF of an optical system with spherical aberration
Image reconstruction: inverse and least squares filters
Out-of-focus images

Planning of activities

If possible, a visit to a image processing unit will be scheduled	Hours: 2h Theory classes: 2h

Qualification system

Exam. Students have to solve a practical problem based on the topics developed of the syllabus. Students can use documentation, notes and code discussed during the course. The use of their own computer is encouraged and access to the internet will be granted during the exam.
A remedial activity will be scheduled for those students that fail the test.

Last update: 06-05-2019

230561 - IMPROCES - Image Processing in Biophotonics

Bibliography

Basic:

González, R.C.; Woods, R.E. Digital image processing. 4th ed., global ed. New York, NY: Pearson, 2018. ISBN 9781292223049.

Others resources:

Hyperlink

http://scikit-image.org/

The skimage library

http://docs.scipy.org/doc

Scipy documentation

https://docs.opencv.org/3.4.1/d6/d00/tutorial_py_root.html

OpenCV-Python Tutorials