# 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:** 2015 - 2016
**Degree:** Master's Degree in Photonics
Erasmus Mundus Master's Degree in Photonics Engineering, Nanophotonics and Biophotonics
**ECTS credits:** 3 **Teaching languages:** English

## Academic staff

**Coordinator:** María S. Millán (UPC) millan@oo.upc.edu

## Degree competences to which the subject contributes

**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. 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.
3. 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.
4. 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

**Lectures**
**Activities:**

- Students will be asked to implement one of the algorithms analyzed in the course, providing examples of how it would be used in practice. Alternatively, a work task on a particular application of their choice must be done. The latter should include: problem statement, constraint definition, possible approaches and solutions, case/s of application, references (paper/s with examples of such application) Written reports will be delivered in any case.
- Seminars and visits. The organization of complementary activities may vary depending on the number of students, timetable and availability of external collaborators and facilities.

## Objectives and short description of the course

This subject overviews several topics on digital image processing with emphasis in biophotonics applications. The course provides an in---depth treatment of image processing techniques, with special attention to the optical issues, algorithm principles, and practical implementations, among the many aspects involved.

The content of the course covers a variety of topics, from the fundamentals to the applications. Some sessions are intended to analyze general concepts and provide the basis for digital image processing. Some selected applications of image processing in biophotonics will be introduced and explained in more detail.

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## Study load

| | | | |
|---|---|---|---|
| Total learning time: 75h | Hours large group: | 22.5h | 30% |
| | Hours medium group: | 0h | 0% |
| | Hours small group: | 0h | 0% |
| | Guided activity: | 2.25h | 3% |
| | Self study: | 50.25h | 67% |

## Course index

**1. Fundamentals**

1.1 Introduction and overview of basic concepts in image processing.
- Stages of image processing algorithms.

1.2 Image/Video capture. Image chain. Illumination compensation.

1.3 Noise and denoise. Intensity transformation and Spatial Filtering

1.4 Frequency (Fourier) domain processing.

1.5 Common operations (Registration, Segmentation, Region growing, others).

1.6 Practical case: Review of fundamentals MATLAB Image Processing Toolbox.
*Application: Identity authentication based on biometric signal encryption.*

**2. Colour Image Processing**

2.1 Dealing with colour in images.

2.2 Channel transformations.

*2.3* Strategies for B/W and colour image sharpening. *Example: Natural and medical images display.*

*2.4 Practical case*
*Application: Feature extraction of standard grading colour images used in clinical practice. Looking for the underlying grading model.*
*Application: Segmentation of the optic nerve head in colour eye fundus images.*

**3. Image Restoration**

3.1 Imaging process, PSF analysis and image restoration in optical microscopy.

3.2 Deconvolution algorithm. Blind deconvolution. Spatial variant PSF.

3.3 Activity: Paper analysis and discussion.
*Application: Retinal image restoration by blind deconvolution for monitoring assistance.*

## Qualification system

Exam (~60%)
Practical task, homework (~30%)
Attending seminars and visits, class attendance and participation (~10%)

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## Bibliography

- R. C. González, S. L. Eddins, R. E. Woods, *Digital Image Processing Using Matlab*, Pearson-Prentice Hall (2004)
- J. Semmlow, *Biosignal and Biomedical Image Processing*, Marcel Dekker (2004)
- R. Rangayyan, B. Acha, C. Serrano, *Color Image Processing with Biomedical Applications*, SPIE Press (2011)