

230560 - VISUAL - Visual Biophotonics and Multispectral Imaging

Coordinating unit:	230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit:	731 - OO - Department of Optics and Optometry
Academic year:	2014
Degree:	ERASMUS MUNDUS MASTER IN PHOTONICS ENGINEERING, NANOPHOTONICS AND BIOPHOTONICS (Syllabus 2010). (Teaching unit Optional) MASTER IN PHOTONICS (Syllabus 2013). (Teaching unit Optional)
ECTS credits:	3
Teaching languages:	English

Teaching staff

Coordinator: Meritxell Vilaseca, UPC.

Others: Jaume Pujol, UPC

Opening hours

Timetable: mvilasec@oo.upc.edu (coordinator)
pujol@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. 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.

Teaching methodology

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Learning objectives of the subject

A BRIEF DESCRIPTION

Visual Biophotonics is an innovative and multidisciplinary area that uses light-based technologies to image, examine and treat the eye and its visual performance, improving diagnosis, therapy, and follow-up care of certain diseases. Therefore, it plays a crucial role for a better health visual care. Examples include lasers being used routinely in laser-refractive surgery, clinical instruments developed to measure aberrations and retinal image quality, and advanced image techniques using adaptive optics, which can provide high resolution images of the ocular structures.

Multispectral imaging is a sophisticated and powerful technology that was developed to overcome the problems of conventional color (RGB) imaging systems, reaching a great spectral and spatial resolution. Its enormous potential opens

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a wide-field of applications including remote sensing, fine arts/museum analysis and archiving, Hi-Fi printing and displays, textiles, industrial inspection and quality control, medical imaging, and precise color measurement.

The course focuses on the main topics covered by Visual Biophotonics and Multispectral Imaging. The first part of course includes the new methods for ocular correction, such as intraocular lenses and refractive surgery, the evaluation of the ocular aberrations, retinal image quality and intraocular scatter, and concludes with the study of high resolution retinal images. The second part deals with the multispectral systems and the latest developments and applications in this exciting field. Program will focus on the most relevant applications and the student will have the possibility of performing measurements using experimental setups and commercial instruments.

TABLE OF CONTENTS

- The human eye: an overview. Schematic and advanced eye models. Simulation.
- Refractive anomalies and accommodation. Presbyopia. Means of correction: ophthalmic, contact, and intraocular lenses. Refractive surgery.
- Human eye aberrations and measurement techniques. Monochromatic and chromatic ocular aberrations. Evaluation of ocular aberrations. Wavefront sensors for the eye: Hartmann-Shack Wavefront sensor and Laser Ray tracing.
- Retinal image quality measurement. Double pass technique and intraocular scatter measurements.
- Measurement of optical properties of the cornea and lenses: Scheimpflug and Purkinje images.
- Adaptive Optics for vision and High Resolution Retinal Imaging. Scanning Laser Ophthalmoscope (SLO) and Optical Coherence Tomography (OCT)
- Multispectral Imaging. Limits of trichromatic colorimetry. Multispectral vs hyperspectral techniques. Components of multispectral systems. Spectral sampling techniques. Methods for spectral reconstruction. Applications.
- Spectral imaging of biological structures: Retinal imaging, sclera, iris, macular pigment and others.

BIBLIOGRAPHY

ATCHISON, D.A. & SMITH, G.: Optics of the Human Eye. Oxford: ButterworthHeinemann, 2000.

RABBETS, R.B. Clinical Visual Optics. 4 th ed. Elsevier/Butterworth-Heinemann 2007. PORTER, J., QUEENER, H., LIN, J., THORN, K, AWWAL, A.A.S.: Adaptive Optics for Vision Science: Principles, Practices, Design and Applications. New York: John Wiley & Sons, 2006.

BERNS R.S.: Principles of Color Technology. 3 ed. John Willey and Sons, Inc, 2000.

LEE H-C.: Introduction to color imaging science. Cambridge University Press. Reino Unido, 2005. Capítulos 19, 20.

KANG H. R.: Computacional color technology. Spie Press, 2006.

SCHANDA J.: Colorimetry. John Wiley and Sons, 2007.

MARTÍNEZ-VERDÚ F., CHORRO E., PERALES E., VILASECA M., PUJOL J.: Colour measurement.

Principles, advances and industrial applications. Camera based colour measurement. Woodhead Publishing Limited, 2010.

Study load

Total learning time: 75h	Hours large group:	22h 30m	30.00%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	2h 15m	3.00%
	Self study:	50h 15m	67.00%



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Qualification system

- Homework assessments (40%)
- Written exam (30%)
- Oral presentation of a scientific journal paper (15%)
- Attending seminars, lab visits, class attendance (15%)

Bibliography