Course guide
820028 - PIB - Biomedical Image Processig

Last modified: 14/06/2023

Unit in charge: Barcelona East School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Joan Francesc Alonso López

Others: Segon quadrimestre:
JOAN FRANCESC ALONSO LÓPEZ - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: M15
ALICIA CASALS GELPI - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: M15
CRISTIAN MATA MIQUEL - Grup: M13, Grup: M14, Grup: M15

PRIOR SKILLS

Basic skills in linear algebra.
Basic level programming (structures if, for, while).
Abstraction skills

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. Apply the techniques for analysing and interpreting biomedical signals and images.

Transversal:
1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

TEACHING METHODOLOGY

In theory sessions the professor will introduce, through explanations and illustrative examples, the concepts, methods and results of the subject. In problem-solving sessions, the professor guides the students in solving exercises and problems related to the subject. In the lab, students will practice the concepts and methods with the help of the profesor and work with actual biomedical images. Students, independently, should study to assimilate the concepts and solve exercises. Students should also develop a case study in group.

LEARNING OBJECTIVES OF THE SUBJECT

The aim of the course is to introduce students to different techniques of acquisition and processing of biomedical images, their characteristics and applications. Once students become familiar with biomedical images, the methods to achieve better image quality or contrast will be presented. The course will also include techniques for segmentation, registration, localization, motion analysis and compression.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	30.00
Hours small group	15,0	10.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Introduction

Description:
In the context of different image modalities the structure of an image processing system is explained as well as the application fields in the biomedical area.

Specific objectives:
Understanding the need, potential limitations of image processing as well as the structure of aone such system in the biomedical field.
Presentation of the course and its organization.

Related activities:
Oral presentation

Full-or-part-time: 2h
Theory classes: 2h

Image preprocessing

Description:
This lesson describes the preliminary stages of preprocessing and their purpose, either displaying (enrichment, contrast, enhancement) or as a step previous to a higher level processing. Histograms, binarization and filtering.

Specific objectives:
Understanding the need of preprocessing, its different types (transformation function and techniques) and the suitability of each one according to their aim.

Related activities:
Theoretical sessions, exercises on the topic and laboratory sessions.

Full-or-part-time: 16h
Theory classes: 10h
Laboratory classes: 6h

Features Extraction

Description:
Presentation of the theory in class of the different types of features in images and the techniques for their extraction from images. Study of the needs in different types of applications.

Specific objectives:
Understanding the need to extract relevant information from images as data for a later stage of image description or interpretation of the scene. Acquiring criteria for determining what information is relevant, features, in each image depending also of the final application. Learning the techniques for feature extraction.

Related activities:
Theoretical sessions, exercises on the topic and laboratory sessions.

Full-or-part-time: 6h 30m
Theory classes: 5h
Laboratory classes: 1h 30m

Image segmentation

Description:
The concept of segmentation. Description of the various segmentation techniques and study of image segmentation algorithms.

Specific objectives:
From the image typologies to work on and the needs of the application, determining the type of segmentation to use, or combination of techniques, and learn the different types of algorithms for its implementation.

Related activities:
Theoretical sessions, exercises on the topic and laboratory sessions.

Full-or-part-time: 3h 30m
Theory classes: 2h
Laboratory classes: 1h 30m

Pattern recognition

Description:
Description and learning the concept of recognition and the techniques to apply it.

Specific objectives:
Understand the concept of classification, techniques and algorithms for its implementation. Understanding the stages of learning and recognition.

Related activities:
Theoretical sessions, exercises on the topic and laboratory sessions.

Full-or-part-time: 3h 30m
Theory classes: 2h
Laboratory classes: 1h 30m

Image modalities

Description:
Review of the different types of imaging techniques and their characteristics.

Specific objectives:
Understanding the different kind of images pointing to their applications.

Related activities:
Theoretical session and examples.

Full-or-part-time: 2h 30m
Theory classes: 2h 30m

Image registration

Description:
Description of techniques, methods and applications.

Specific objectives:
Understanding the needs of biomedical registration and implementation techniques.

Related activities:
Theoretical session and exercises.

Full-or-part-time: 2h 30m
Theory classes: 2h 30m

Application fields

Description:
Description with examples on the application fields.

Specific objectives:
Acquire a global view of techniques and applications.

Related activities:
Theoretical sessions with examples.

Full-or-part-time: 5h
Practical classes: 5h

GRADING SYSTEM

The evaluation will consider the following activities:
- Laboratory sessions, including reports and the final project (LAB)
- Mid-term exam (MTE)
- End-of-term exam (ETE)

The grade for the course is obtained by the calculation 0.3*LAB + 0.3*MTE + 0.4*ETE

This course has a reassessment test, which students can undergo if they meet the requirements as per EEBE regulations: https://eebe.upc.edu/ca/estudis/avaluacio-i-permanencia

EXAMINATION RULES.

Exams administered individually, without any books nor class notes

BIBLIOGRAPHY

Basic:
- González, Rafael C.; Woods, Richard E. Digital image processing. Fourth edition, Global edition. New York, NY: Pearson Education Internacional, 2018. ISBN 9781292223049|.
- Webb, Andrew R. Introduction to biomedical imaging. Hoboken (N.J.): Wiley, cop. 2003. ISBN 0471237663.

Complementary:
- Bankman, Isaac N.. Handbook of medical imaging : processing and analysis. San Diego [etc.]: Academic Press, cop. 2000. ISBN 0120777908.
- Rangayyan, Rangaraj M. Biomedical image analysis. Boca Raton: CRC cop, cop. 2005. ISBN 0849396956.

RESOURCES

Computer material:
- Computer Vision on Line. http://homepages.inf.ed.ac.uk/rbf/CVonline/CVentry.htm

Other resources: