820028 - PIB - Biomedical Image Processing

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control
Academic year: 2018
Degree: BACHELOR’S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan

Teaching staff
Coordinator: Alicia Casals
Others: Joan Francesc Alonso
Raul Benitez

Opening hours
Timetable: Under previous agreement

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 professor 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

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 45h</th>
<th>30.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h</td>
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<tr>
<td></td>
<td>Hours small group: 15h</td>
<td>10.00%</td>
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<td>Guided activities: 0h</td>
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<td>Self study: 90h</td>
<td>60.00%</td>
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## 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.

**Related activities:**
Oral presentation

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

<table>
<thead>
<tr>
<th><strong>Learning time:</strong> 2h</th>
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<tbody>
<tr>
<td>Theory classes: 2h</td>
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## Image pre-processing

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

**Related activities:**
Theoretical presentation, exercises and practices in the lab.

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

<table>
<thead>
<tr>
<th><strong>Learning time:</strong> 16h</th>
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<tbody>
<tr>
<td>Theory classes: 10h</td>
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<tr>
<td>Laboratory classes: 6h</td>
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## Features Extraction

**Learning time:** 6h 30m  
Theory classes: 5h  
Laboratory classes: 1h 30m

**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.

**Related activities:**  
Presentation of the theory, exercises on the theme and practices in the laboratory.

**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.

## Image segmentation

**Learning time:** 3h 30m  
Theory classes: 2h  
Laboratory classes: 1h 30m

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

**Related activities:**  
Presentation of the theory, exercises on the theme and practices in the laboratory.

**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.

## Pattern recognition

**Learning time:** 3h 30m  
Theory classes: 2h  
Laboratory classes: 1h 30m

**Description:**  
Description and concept of training and recognition and learning the techniques to do so.

**Related activities:**  
Presentation of the theory, exercises on the theme and practices in the laboratory.

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

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

**Related activities:**
Class of theory and examples.

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

<table>
<thead>
<tr>
<th>Learning time: 2h 30m</th>
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<tbody>
<tr>
<td>Theory classes: 2h 30m</td>
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### Image registration

**Description:**
Description of techniques, methods and applications.

**Related activities:**
Class of theory and exercises.

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

<table>
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<tr>
<th>Learning time: 2h 30m</th>
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<tbody>
<tr>
<td>Theory classes: 2h 30m</td>
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### Application fields.

**Description:**
Description with examples of the application fields.

**Related activities:**
Class of theory with examples.

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

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<th>Learning time: 5h</th>
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<tr>
<td>Practical classes: 5h</td>
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Qualification system

The evaluation will consider the following activities:
· A partial exam (The score of this test is NEP)
· Practical Laboratory reports (The score of this activity is NPL).
· A final exam (The score of this exam is NEF).
There will be reevaluation exam.

The final grade for the course, NF, is calculated using the following expression:

\[ NF = 0.4 \times NEF + 0.3 \times NPL + 0.3 \times NEP \]

Regulations for carrying out activities

Exams without books nor notes
Bibliography

Basic:


Complementary:


Others resources:

http://ieeexplore.ieee.org/Xplore/DynWel (from computers in UPC UPC)
http://www.elsevier.com/wps/find/P05.cws_home/main (from computers in UPC) go to Journals and Medical Imaging
  · http://www.springerlink.com (from computers in UPC) go to book series: Lecture Notes in Computer Science

Audiovisual material

Series llibres Springer
  Resource

Computer material

Xplore IEEE
  Collection of IEEE publications

Revistes Elsevier
  Resource

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