Universidad Zaragoza

Academic Year/course: 2024/25

69719 - Medical image analysis

Syllabus Information

Academic year: 2024/25
Subject: 69719 - Medical image analysis
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 633 - Master's Degree in Biomedical Engineering
ECTS: 3.0
Year: 1
Semester: Second semester
Subject type: Optional
Module:

1. General information

The general objective of the subject is to introduce the student to the discipline of quantitative analysis of medical images. For this purpose, we propose the study of two of the major problems in the analysis of medical images with a great potential for applications, both in the clinical and research fields: image registration or alignment and medical image segmentation. As an application of both problems, the statistical analysis of geometric information, known as computational anatomy, is also addressed.

2. Learning results

- To be able to apply methodologies of automatic segmentation of anatomical structures, as well as to select a priori information for such segmentation task.
- To be able to design and propose a design of the registration procedure (alignment) of medical images in a specific application, such as morphometry analysis, construction of an image atlas, correction of motion artifacts during acquisition, etc. To have solid criteria to choose the type of spatial transformation or the type of regularizer in different applications of medical image registration (alignment).
- To be able to construct a statistical model of the shape of one or more anatomical structures when provided with a set of instances.
- To be able to apply statistical techniques, both from group and individual studies, to different types of anatomical features: coordinates of anatomical minutiae, medial representations of organs, parameters of global and nonlinear spatial transformations.

3. Syllabus

1. Basic concepts of medical imaging. Image modalities. Representation and visualization. Image formats: DICOM, Analyze, NIFTI.
2. Medical image segmentation and thresholding. Morphological filtering. Segmentation by probabilistic models. ITK-SNAP tool.
3. Registration of medical images. Rigid and non-rigid register. Deformation models: parametric and non-parametric. FAIR Toolbox. Cerebral perfusion analysis in MRI-DSC images and motion artifact correction.
4. Statistical analysis of shapes. Shape descriptors. Statistical inference. Multiple comparisons and spatial correlation.

4. Academic activities

The subject has a markedly applied orientation, so that the image analysis techniques studied will be exemplified at all times with specific real cases. Sometimes the same application example will serve to develop different techniques, with an increasing order of complexity. The subject is designed on the basis of three projects or case studies, which will cover the following domains:

- Segmentation of medical images of brain tumours in multimodality MRI imaging.
- Medical image registration: computational anatomy and brain morphometry; correction of motion artifacts in temporal imaging sequences and cerebral perfusion.
- Statistical analysis of images and geometric shapes for the diagnosis of individuals and for group inference in clinical trials with or without therapy.

The following training activities are proposed:

- Participative master class (28 hours): presentation by the teacher of the main contents of the subject. The computer will be extensively used in explanations and examples.
- Practical application or research work. Each student will individually carry out three practical works or projects, one for

each block of the subject, which may include an oral defence in front of the teacher, and in some cases, in front of the rest of the classmates.

- Tutoring. Personalized attention to students in order to review and discuss the materials and topics presented in the theoretical and practical classes.
- Assessment Set of theoretical-practical written tests and presentation of reports or papers used in the evaluation of the student's progress. Details can be found in the section corresponding to the assessment activities.

This course is English Language Friendly, which means that: the course syllabus is also available in English; the study and class materials are in English; the faculty is willing to conduct office hours in English; and students are allowed to take their assessments in English

5. Assessment system

There are two evaluation procedures to choose from:

a. **Mixed evaluation**, which is the recommended procedure, given the practical focus of the subject. It consists of two distinct parts:

- Projects of the subject (40%): for each of the three projects, all three of which are mandatory, a brief report with the most relevant results and conclusions will be submitted. There may be an oral presentation. These assignments will be carried out continuously throughout the weeks of the subject with previously established and announced deadlines. The evaluation will assess aspects of originality in the proposed solutions, efficiency of the applied methods, presentation of the report and eventual oral presentation. It will be necessary to present the three projects, with a minimum grade of 4 points in each of the projects.
- Final exam (60%) Written test, graded from 0 to 10 points. This test will be written, and the computer may be eventually used for some of its parts. The student must obtain a minimum total grade of 4 points out of 10 in the final exam.

b. **Simple evaluation**, which will consist of a single global test, to be carried out on the date of each of the two official calls. This global test will consist of a global written test, similar to the final exam previously described, and therefore will have a theoretical/conceptual part, and a practical part related to the tasks/projects carried out during the academic year. The practical part of the global test will be evaluated with the results delivered and potentially an oral defence before the teacher.

6. Sustainable Development Goals

8 - Decent Work and Economic Growth
9 - Industry, Innovation and Infrastructure