Medical Image processing

Academic Year: (2023 / 2024) **Review date: 19/01/2024 13:16:35**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: PASCAU GONZALEZ GARZON, JAVIER

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Introduction to bioengineering
- Systems and signals

LEARNING OUTCOMES

RA3: Be able to carry out conceptual designs for bioengineering applications according to their level of knowledge and understanding, working in a team. Design encompasses devices, processes, protocols, strategies, objects and specifications broader than strictly technical, including social awareness, health and safety, environmental and commercial considerations.
RA4: Be able to use appropriate methods to carry out studies and solve problems in the biomedical field, commensurate with their level of knowledge. Research involves conducting literature searches, designing and carrying out experimental practices, interpreting data, selecting the best approach and communicating knowledge, ideas and solutions within their field of study. May require consultation of databases, safety standards and procedures.
RA5: Acquire intermediate/advanced knowledge of engineering and biomedical sciences and demonstrate an understanding of the theoretical and practical aspects and methodology of work in their field of study.
CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3: Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4: Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5: Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2: Ability to design, draft and develop scientific-technical projects in the field of biomedical engineering.
CG4: Ability to solve problems with initiative, decision-making, creativity, and to communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the biomedical engineer's activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG7: Drafting, representing and interpreting scientific-technical documentation.
CG8: Ability to solve mathematical, physical, chemical and biochemical problems that may arise in biomedical engineering.
CG12: Ability to solve mathematically formulated problems applied to biology, physics and chemistry, using numerical algorithms and computational techniques.
CG19: Ability to apply different image analysis and processing techniques, as well as artificial vision to the resolution of problems of biological and medical interest. In particular, the problems of diagnosis by Medical Imaging stand out.
CG21: Ability to analyse complex and multidisciplinary problems from the global point of view of Biomedical Instrumentation.
ECRT33: Knowledge of the concepts of sampling, quantization and quality in digital imaging, as well as

the use of the most common image processing techniques such as contrast enhancement, filtering, segmentation and compression.
CT1: Ability to communicate knowledge orally and in writing to both specialised and non-specialised audiences.
CT2: Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3: Ability to organise and plan their work, making the right decisions based on the information available, gathering and interpreting relevant data in order to make judgements within their area of study.

OBJECTIVES

The course provides basic knowledge on digital image processing focused on medical image data. After completion of the course the student will understand concepts as sampling, quantization, noise, interpolation or segmentation in the field of 2D or 3D imaging, and specifically for every medical image modality. Students will acquire skills to process digital images in the spatial and frequency domain, and will be able to use some advanced techniques as morphological processing or segmentation.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Basic introduction to medical image processing. Visual Perception.
2. Image Sampling and Quantization.
3. Interpolation and geometrical transformations.
4. Image enhancement in the spatial domain: Point processing
5. Color. Image file formats.
6. Image enhancement in the spatial domain: Filtering
7. Image enhancement in the frequency domain
8. Image compression
9. Medical Image segmentation, morphological processing and quantification.
10. Medical Imaging Modalities: conventional radiology, CT, Nuclear imaging, MR, US.
11. Advanced methods and Artificial Intelligence applications in medical imaging

LEARNING ACTIVITIES AND METHODOLOGY

Teaching methodology will be mainly based on lectures, seminars and practical sessions.
Students are required to read assigned documentation before lectures and seminars. Lectures will be used by the teachers to stress and clarify some difficult or interesting points from the corresponding lesson, previously prepared by the student. Seminars will be mainly dedicated to interactive discussion with the students, present and evaluate homework.
Grading will be based on continuous evaluation (including short-exams, homework, group essays, practical sessions, and student participation in class and Aula Global) and a final exam covering the whole subject. Help sessions and tutorial classes will be held prior to the final exam.
Attendance to lectures, short-exams or submission of possible homework is not compulsory. However, failure to attend any exam or submit the exercises before the deadline will result in a grade of 0 in the corresponding exercise and will influence the final continuous evaluation score.
The practical sessions may consist on laboratory work or visits to research or clinical centers. A laboratory report will be required for each of them. Homework exercises will also be a very important contribution, since they will imply solving a specific problem, proposing an algorithm and implement it using computer tools. The attendance to 80% of practical sessions is mandatory. Failure to hand in the laboratory reports on time or unjustified lack of attendance will result in 0 marking for that practice session.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

Continuous evaluation: It accounts for up to 50% of the final score of the subject, and includes three components:
1) Short-exams: These exams will take place mostly during seminars, and will be announced at least one week in advance.
2) Practical sessions and homework exercises: They will be assessed through quizzes or exercises to be solved in groups or individually or a laboratory notebook or report in that will be handed in at the end of each practical session. Attendance to at least 80% of the practical sessions is mandatory; otherwise the score will be 0 in this item.
3) Student participation: It includes contribution to seminars, forum in Aula Global, attitude, or other

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

activities.

Final exam: The final exam will cover the whole subject and will account 50 % of the final score. The minimum score in the final exam to pass the subject is 4.0 over 10, notwithstanding the mark obtained in continuous evaluation.

Extraordinary exams: The mark for students attending any extraordinary examination will be the maximum between:
a) 100% exam
b) 50% exam and 50% continuous evaluation if it is available in the same course

Academic conduct: All exams will be closed-book, closed-notes, no PC or mobile phone, or anything else other than a writing implement and the exam itself. Plagiarism, cheating or other acts of academic dishonesty will not be tolerated. Any infractions whatsoever will result in a failing grade.

BASIC BIBLIOGRAPHY

- G. Dougherty Digital Image Processing for Medical Applications, Cambridge University Press, 2009

- R. C. Gonzalez, R. E. Woods Digital Image Processing, Pearson Education, 2008

ADDITIONAL BIBLIOGRAPHY

- H.C. Russ The Image Processing Handbook, CRC Press Inc, 2011

- P. Suetens Fundamentals of Medical Imaging, Cambridge University Press, 2009

BASIC ELECTRONIC RESOURCES

- . ImageJ Biomedical Image Processing Software: https://imagej.org