VNIVERSITAT DE VALÈNCIA

Course Guide
44777 Processing of medical images

COURSE DATA

Data Subject	
Code	44777
Name	Processing of medical images
Cycle	Master's degree
ECTS Credits	4.5
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2231 - M.D. in Biomedical Engineering	Faculty of Medicine and Odontology	0	Second term

Subject-matter

Degree	Subject-matter	Character
2231 - M.D. in Biomedical Engineering	15 - Bridging courses	Optional

Coordination

Name	Department
DOMINGO ESTEVE, JUAN DE MATA	240 - Computer Science
DURA MARTINEZ, ESTHER	240 - Computer Science

SUMMARY

This course studies the use of digital image processing and computer vision techniques for the analysis and interpretation of different medical imaging modalities. In this sense a review is made of them, indicating what particularities of them it is necessary to take into account for the subsequent processing, and then explain those techniques related to image processing that are actually used with medical images. Therefore this course can be considered a particularization and in certain cases an extension of a course of digital image processing. The techniques are restricted to those used in this context. The examples and cases of study provided are related to medical images . In this sense, the course follows the organization of similar courses based on image processing or computer vision (low, medium and high levels) courses taught in universities of the United States and the United Kingdom follows the general organization of a) . However aspects such as color, reconstruction of 2-1 / 2 D, interpretation of scenes, etc. are less emphasized or even suppressed. This course highlights other aspects such as segmentation, volumetric reconstruction, visualization, etc.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

The requirement are specificed in the verification document of the Biomedical Engineering Master, point 4.2

OUTCOMES

LEARNING OUTCOMES

At the end of the course a student, even without previous knowledge, the student should be able to:

• Compare capture and storage systems as well as image processing systems for a particular application, including appropriate hardware and software. It must be able to meet the restrictions of computational capacity and economic cost, which implies paying special attention to the alternatives of free software that may exist.

• Know the basic tools for managing, storing and analyzing the image and choosing the optimal one for your environment.

• Extract and analyze information with the aim of generating useful and understandable reports for health professionals.

• Search, select and evaluate information, using both the relevant information available on the network and the traditional bibliography.

• Solve problems whose solution does not derive from the application of a standardized procedure.

• Obtain the right information to deal with new scientific problems that arise.

• Plan and conduct their own learning.

• Ease of communication of information, both orally and in writing.

• To work in groups aming to face different situations

DESCRIPTION OF CONTENTS

1. Introduction

This unit will briefly review the essential concepts of digital image processing that were taught previously in the courses: "Medical Instrumentation" and "Medical Signals". Specifically, we will remember the concepts of sampling, quantization, and related theorems to highltigth how they influence the quality of the image, as well as the need for compression and its types.

2. Acquisition

The acquisition modalities seen in the modules mentioned previously will be reviewed as well as the ones not seen there, indicating what characteristics of each one need to be taken into account for the subsequent processing step. Also, what information that can be obtained from each modality and what level of reliability presents this information, will be explained.

3. Preprocessing

In this unit the main operations performed at the low level of the vision process (from the iconic image to the raw primal sketch) will be explained. The main focuss will be on those techniques that are most useful in medical imaging, and showing examples of them .

4. Coregistration

This unit deals with the techniques used to align medical images, both in 2D and 3D, due to the special importance of this step in systems of image-assisted diagnosis, particularly regarding the comparison of image of the same patient taken in different instants or in different perspectives or to compare with a sample of images of other patients, either healthy or diseased.

5. Segmentation

This units begins assuming the the image has been preprocessed previously and shows some useful techniques to get to the segmented image step in which each element (pixel or voxel) of the image is associated with a symbolic label indicating its membership in a region. The aim of this is to intend to coincide with a useful semantic attribution (tissue type, normal or altered area, etc.). Nowdays this is probably the most important issue in medical applications because of its implications for assisted diagnosis.

6. Analysis and feature extraction

Once the significant regions are found, or at least separated from the rest, it is usually necessary to quantify parameters of the same, either geometric (areas, volumes, etc.) or physiological type (functional phenomena that have a correlate in the observed image). To do this, the analysis of images has a series of tools that will be mentioned in this course.

7. Visualization modes

This theme will show the techniques that make the image visible in a way that facilitates the analysis performed by the medical professionals by highlighting those characteristics in which the doctor can be most interested. Visualization in 2D, 3D or 4D (including temporal variation) combines the techniques of superimposing information (for example from other image modalities) and connection with virtual reality systems.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	45,00	100
Attendance at events and external activities	6,00	0
Development of group work	15,00	0
Development of individual work	15,00	0
Study and independent work	15,00	0
Readings supplementary material	10,00	0
Preparation of evaluation activities	10,00	0
Preparing lectures	4,00	0
Preparation of practical classes and problem	4,00	0
TOTAL	**124,00**	

TEACHING METHODOLOGY

The lecture class, the class of problems and the conferences / seminars will be combined.

However, the master class should not be understood in the classic way of presenting a complete and detailed presentation of a topic by the teacher: it is a question of the content of this class, in the form of notes and / or book chapters, as well as the transparencies that are used, have been previously delivered to the students, or made available in the virtual classroom, and that they have read it as a prior preparation. In this way it suffices to briefly expose the subject, stopping only in the aspects of difficult comprehension or to attend the questions of the students.

With regard to the works, which will be carried out in groups of two people. It will be given preference to the work (starting from a relevant article) that faces a problem by looking in the bibliography that better addresses the problem as well as how different approaches cope with it. It will also be valuable aspects what criticisms can be made, and if possible, implementation of the method proposed. The work will be presented orally and the content will be especially valued and whether or not it has been implemented. The order and clarity of the exposition and the answers given by the students to the questions of the teachers and their colleagues will also be valuable aspects.

Lastly, conferences / seminars may be delivered by invited speakers with professional experience in the application of medical imaging techniques in medicine, or in general health, who succinctly explains their daily work, the type of problems that must be solved, and questions in the form of a subsequent colloquium with students and the usual lecturer.

EVALUATION

There will be four modes of evaluation:

-Correction of the works, in principle of the text, practices, etc. that the students deliver. The student may be called in tutor hours to explain the writing or verify their authorship of his/her work for a maxium of half an hour.

-Continuous assessment during the lecture. The lecturer may request to the students to hand in short exercises given during the lecture or that some of the students solve one of them on the board.

-Correction of the work indicated above on an article, using the criteria specified above.

-Exam to evaluate the acquisition of the knowledge and the individual performance of each student.

The overall rating will result from the weighted average of the results of these four modes.

It is considered that a student has assisted to all the compulsory sessions if he or she attends a minium of the 80% of the laboratory sessions. The student also has to justify why he/she could not attend as long as there is a major reason. Those students that are working and can not attend the practical sessions should contact the lecturer before the beginning of the first session. The results of these activities must be submitted to the lecturer in charge of the group during the course and in the terms established by the lecturer. Students are expected to do/prepare some of these activities at home.

The evaluation will be conducted in accordance Qualifications University of Valencia. At the time of writing this guide, the current legislation was the one approved by the Governing Council of the UVEG of January 27, 2004, adjusted as provided for that purpose by the Royal Decrees 1044/2003 and 1125 / 2003. It states basically that the marks will be numbered from 0 to 10 with a decimal expression with the following rating scale :

From 0 to 4,9: “Fail”(D,E, F)

From 5 to 6,9: “Pass” (C)

From 7 to 8,9: “Notable”(B)

From 9 to 10: “Excellent” (A, A+)

Any copy among students detected in the continuous assessment (C), in the final test (E) or in the laboratory assessment (P) involves loosing the matriculation of first and second call in the current course.

Regarding fraudulent activities:

-The lecturer may expel students form the classroom while they are doing an exam if:

1) They don’t guarantee the authencity and privacy of the exercise.

2) They borrow the identity of another student

3) They have the mobile phone or any other unauthorized electronic device or document

-The lecturer can stay with the evidence involved in incidents occurred as they are doing an exam and notify by a written stament to the head of studies of the center.

The lecturer can qualify with a “zero” mark an exam when:

1) There are indications of fraudulent performance in the exam or part of it.

2) They have the mobile phone or any other unauthorized electronic device or document

In addition to all these measures, the lecturer may initiate disciplinary proceedings against the student.

REFERENCES

Basic

- Referencia b1: Medical Image Processing: A Basic Course. Wolfang Birkfellner. CRC Press, ISBN 978-1-4398-2444-3
  Referencia b2: Digital Image Processing for Medical Applications. Geoff Dougherty. Cambridge University Press, ISBN 978-0-521-86085-7
  Referencia b3: Handbook of Biomedical Image Analysi. Volume I: Segmentation Models Part A . Edited by Jasjit S. Suri, David L. Wilson and Swamy Laxminarayan. Kluwer Academic / Plenum Publishers, ISBN 0-306-48550-8

Additional

- Referencia c1: Medical Image Anaysis. Atam P. Dhawan. IEEE Press, ISBN 978-0-470-622056
  Referencia c2: Mathematical Models for Registration and Applications to Medical Imaging. Otmar Scherzer, ed. Springer, ISBN-10 3-540-25029-8 S
  Referencia c3: Computed Tomography: From Photon Statistics to Modern Cone-Beam CT. Thorsten M. Buzug. Springer, ISBN 978-3-540-39407-5