Course guide
240IBI32 - 240IBI32 - Medical Images

Last modified: 16/05/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 723 - CS - Department of Computer Science.

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN NEUROENGINEERING AND REHABILITATION (Syllabus 2020). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: DANIELA TOST PARDELL

Others: Tost Pardell, Daniela

PRIOR SKILLS

Capacity of searching bibliography
Initiative to carry on projects
Skills in ICT
Hability to schedule and plan work

REQUIREMENTS

Skills in computer science, specifically programming (python)

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMEI16. Ability for the research management, development and technological innovation.
CEEAUT4. Apply vision techniques by computer, shape recognition and merging of multi-sensorial data in automated production systems.
CEEBIO3. Identify and extract information of interest in the biomedical signs.
CEEBIO4. Know how to apply the main methods which most of the treatment projects offer, analysis and visualization of medical images.

TEACHING METHODOLOGY

In this subject, a strong component of personal work is expected from students. In the theoretical sessions, the teacher will expose the needed concepts, give bibliographic references and present the corresponding works. In the lab sessions students will develop their requested work.

LEARNING OBJECTIVES OF THE SUBJECT

To introduce students into the representation, visualisation and analysis of 2D ans 3D biomedical images: images characteristics, representation models image file formats, visualisation through surface extraction and direct volume visualization, and image analysis and processing.

At the end of the curs, we expect students to be able to construct a volumetric model, to visualise it, to extract and visualise selected iso-surfaces and to apply analysis methodologies. Therefore, they have to learn images characteristics and file formats; the fundamentals of volume visualization including the ray-tracing method as well as to edit transfer functions in order to obtain illustrative images; methods for surface extraction as Marching Cubes and for visualising the corresponding surfaces.

Students are also expected to work with existing applications such as Slicer and/or Paraview and also to devise their own applications using VTK and ITK libraries.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	27,0	24.00
Self study	72,0	64.00
Hours small group	13,5	12.00

Total learning time: 112.5 h

CONTENTS

Introduction

Description:
1) Origins
2) Acquisition methods
3) Perspective
4) 2D images
5) 3D images
6) Data and applications

Full-or-part-time: 3h
Theory classes: 3h

Graphical interfaces

Description:
Introduction to graphical user interfaces. Graphic area, menu, panel.

Related activities:
Implementation of the project's'GUI

Full-or-part-time: 26h
Theory classes: 5h
Laboratory classes: 3h
Self study : 18h

Medical Images

Description:
Medical Image Representation
Creacion of a medical image
Reading of a medical image
Filtering
processing
Analysis
Segmentation

Specific objectives:
Learn to create a medical image, read it and know how to interpret its content
Know the basics of image processing and know how to apply filtering techniques using high-level libraries and applications
Know the basics of image analysis and know how to apply segmentation techniques using high-level libraries and applications

Full-or-part-time: 25h 30m
Theory classes: 5h
Laboratory classes: 3h 30m
Self study : 17h

Volume models

Description:
1) Voxel model
2) Alternative models

Full-or-part-time: 8h
Theory classes: 2h
Laboratory classes: 1h
Self study : 5h

Direct volume rendering (DVR)

Description:
1) Ray-tracing method
2) Shading and depth composition
3) Transfer functions

Full-or-part-time: 25h
Theory classes: 6h
Laboratory classes: 3h
Self study : 16h

Indirect volume rendering

Description:
1) Surface extraction and reconstruction
2) Methodologies/models: block-form/cuberile, beveled form/Marching Cubes
3) Triangle mesh representation. STL format
4) Surface processing

Full-or-part-time: 25h
Theory classes: 6h
Laboratory classes: 3h
Self study : 16h

GRADING SYSTEM

Throughout the course there will be 2 tests (T1 and T2) during a face-to-face session and 2 laboratory practices will be delivered (L1 and L2). The final grade of the course will be calculated as:

NF = max(NAC+NLab, NLab + NEF*0.4)

with:
NAC = Continuous assessment grade = T1*0.2 + T2*0.2 (value from 0 to 4)
NLab = Lab Grade = L1*0.30 + L3*0.30 (value from 0 to 6)
NEF = Final exam grade (value from 1 to 10)

BIBLIOGRAPHY

Complementary:
- Engel, Klaus. Real-time volume graphics [on line]. Wellesley, Mass.: A K Peters, cop. 2006 [Consultation: 31/05/2019]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1633501. ISBN 1568812663.
- Lichtenbelt, Barthold; Crane, Randy; Naqvi, S. Mahmood. Introduction to volume rendering. Upper Saddle River: Prentice Hall, cop. 1998. ISBN 0138616833.
- Schroeder, Will; Martin, Ken; Lorensen, Bill. The Visualization Toolkit : an object-oriented approach to 3D graphics. 4th ed. [S.l.]: Kitware, cop. 2006. ISBN 193093419X.
- González, Rafael C ; Woods, Richard E. Digital image processing [on line]. 4th ed. New York: Pearson, 2018 [Consultation: 19/10/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=5573669. ISBN 9781292223049.

RESOURCES

Audiovisual material:
- Nom recurs. Resource

Other resources:
Papers of the following jounals (to spacify):
- IEEE Transactions on Visualization and Computer Graphics
- ACM Computer Graphics
- Computer Graphics Forum
- Computers & Graphics

Computer applications:
- 3D Slicer: www.slicer.org/
- itk: www.itk.org
- vtk: www.vtk.org