Subject Biomedical Image Processing and its applications (BIP)
Code: 32430
Institution: Escuela Politécnica Superior
Degree: Master's program in Research and Innovation in Information and Communications Technologies (I^2-ICT)
Level: Master
Type: Elective [computational intelligence]
ECTS: 6

COURSE GUIDE: Biomedical Image Processing and its applications (BIP)

Academic year: 2017-2018

Program: Master's program in Research and Innovation in Information and Communications Technologies (I^2-ICT)
Center: Escuela Politécnica Superior
University: Universidad Autónoma de Madrid

Last modified: 2015/04/27
Status: Approved 2017/07/11

1. ASIGNATURA / COURSE (ID)

Procesamiento de imágenes biomédicas y sus aplicaciones
Biomedical Image Processing and its applications (BIP)

1.1. Programa / program

Máster Universitario en Investigación e Innovación en Tecnologías de la Información y las Comunicaciones (I^2-TIC)

Master in Research and Innovation in Information and Communications Technologies (I^2-ICT) [Officially certified]

1.2. Course code

32424

1.3. Course areas

Computer Science and Artificial Intelligence

1.4. Tipo de asignatura / Course type

Optativa [itinerario: Informática biomédica]
Elective [itinerary: Biomedical informatics]

1.5. Semester

Second semester

1.6. Credits

6 ETCS

1.7. Language of instruction

The lecture and lecture notes are in English.

1.8. Recommendations / Related subjects

Basic knowledge of image processing should be useful to follow the course.

Related subjects are:

- Procesamiento de señales biomédicas y sus aplicaciones [Biomedical signal processing and its applications]

1.9. Lecturers

Add @uam.es to all email addresses below.

Lectures and labs:

Dr. Roberto Marabini
Departamento de Ingeniería Informática
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Tel.: +34 914972247
e-mail: Roberto.marabini

1.10. Course objectives

This course introduces basic biomedical imaging methods that from a set of 2D images are able to produce a 3D reconstruction. We will explore computed tomography (CT), positron emission tomography (PET) and electron microscopy. Students will gain understanding in the basic physics of image acquisition and the algorithms required for image processing. Basic image enhancement, and image analysis will be presented in the context of tomographic imaging and microscopy.

After this course, the student should be able to:

UNIT BY UNIT SPECIFIC OBJECTIVES	
UNIT 1.- Introduction to biomedical digital imaging	
1.1.	Understand basic concepts in *image* sampling and *processing*
UNIT 2.- Tomography and 3D reconstruction	
2.1.	Understand interaction between matter and light
2.2.	Understand basic algorithm in 3D tomography
UNIT 3.- Positron Emission Tomography	

3.1.	Understand the physical principles, usages and limitations in positron emission tomography
3.2.	Perform basic imaging processing in positron emission tomography
UNIT 4.- Transmission Electron Microcopy	
4.1.	Understand the physical principles, usages and limitations in electron tomography.
4.2.	Perform basic imaging processing in transmission electron tomography

1.11. Course contents

UNIT I Introduction to the biomedical digital imaging (2D): 5 weeks

1. What is a signal?
2. Analog, Discrete and Digital systems
3. Sampling and quantization
4. Nyquist rate
5. Signal Processing for feature extraction
6. Fourier Transform
7. Discrete Fourier Transform
8. Image Filtering and deblurring
9. Edge detection and segmentation of Images
10. Registration of Images

UNIT II Theoretical Basis to tomography: 4 weeks

1. Principles of Computer tomography
2. Photon interaction with matter
3. The Fourier Slice Theorem
4. Concept of projection: Radon Transform
5. Image Reconstruction in real space: Filtered Back Projection, ART
6. Image Reconstruction in Fourier space: Fourier interpolation
7. Image Reconstruction using a statistical approach: Maximum Likelihood

UNIT III Positron Emission Tomography (PET) 3 week

1. Physical and Physiological principles of PET
2. PET Image Formation and Processing
3. Applicatiosn of PET

UNIT IV. Transmission Electron Microscopy (MET) 3 week

1. Physical and Physiological principles of MET
2. MET Image Formation and Processing
3. Applications of MET

1.12. Course bibliography

1. Prince &Links, Medical Imaging, Signals and Systems, Pearson Prentice Hall, 2006
2. Andrew Webb, Introduction to biomedical Imaging, IEEE Press, 2003
3. Gonzalez & Woods, Digital Image Processing, Prentice Hall, 2003
4. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1988

1.13. Coursework and evaluation

The course involves lectures, assignments and a seminar presentation.

In both the ordinary and the extraordinary exam period it is necessary to have a grade ≥ 5 or passed in each of the evaluation activities to pass the course.

In the ordinary exam period, the evaluation will be made according to the following scheme:

1. Project 50%.
2. Presentation of research paper. 25%.
3. Assignments 25%.

In case of a fail grade in the ordinary exam period, in the extraordinary exam period, the student has the opportunity to

1. Turn in the project 50%.
2. Turn in all the Assignments 25%.
3. Turn in a report on a research paper 25%.
4. Oral examination. Pass/Fail.