

Course Unit	Medical Image Processing		Field of study	Instrumentation and Biomedical Signals	
Bachelor in	Biomedical Technology		School	School of Technology and Management	
Academic Year	2023/2024	Year of study	3	Level	1-3
Type	Semestral	Semester	2	ECTS credits	6.0
			Code	9600-752-3203-00-23	
Workload (hours)	162	Contact hours	T -	TP 30	PL 30
			TC -	S -	E -
			OT -	O -	

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) Fernando Jorge Coutinho Monteiro

### Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. understand the human visual perception system and the process of digital image formation;
2. understand the theoretical foundations of digital image processing, including its context in the acquisition and analysis of medical images and some of its major technicals;
3. describe and apply techniques for medical imaging enhancement;
4. develop capabilities to apply in practice the knowledge acquired by mastering appropriate tools for image processing, in particular, the Matlab toolbox of image processing and OpenCV from Python;
5. identify, formulate and solve a specific problem in medical image processing.

### Prerequisites

Before the course unit the learner is expected to be able to:

1. understand the basic two-dimensional mathematical formalism;
2. know the fundamentals of signal processing;
3. know the concepts of programming in Matlab or Python.

### Course contents

Introduction. The nature of biomedical images. Digital image processing system. Topics on the human visual system. Fundamentals of digital image. Removal of artifacts. Image enhancement. Detection of lines and edges. Detection of region of interest. Segmentation. Mathematical morphology. Pattern recognition. Introduction to deep learning.

### Course contents (extended version)

1. Introduction
  - Areas of interest;
  - The concept of digital image;
  - The steps of image processing;
  - Applications of image processing and vision.
2. The origin of biomedical images
3. System of digital image processing
  - Elements of a system of digital image processing;
  - Equipment acquisition of medical imaging.
4. Topics on the human visual system
  - Elements of the human visual system;
  - Structure of the human eye;
  - Adjustment of brightness and discrimination.
5. The fundamentals of digital image
  - Sampling and quantification;
  - The geometry of images;
  - Point, local and global operations;
  - Mapping intensities. Histogram.
6. Removal of artifacts
  - Linear and nonlinear filtering;
7. Image enhancement
  - Image enhancement through manipulation of the histogram;
  - Convolution mask operators;
  - Filtering for enhancement.
8. Detection of lines and contours
  - Digital approximation of gradient and laplacian;
  - Line detection;
  - Edge detection;
  - Corner detection;
  - SIFT and SURF.
9. Detection of regions of interest
  - Thresholding and binarization;
  - Basic methods of segmentation.
10. Morphological operations
11. Pattern Recognition
12. Introduction to deep learning

### Recommended reading

1. Gonzalez, R. and Woods R. E. (2017). Digital Image Processing, 4th edition, Pearson. ISBN 9789353062989
2. Russ, J. C. (2017). The Image Processing Handbook, 7th edition, CRC Press. ISBN 9781498740265
3. Chen, C. H. (2016). Handbook of Pattern Recognition and Computer Vision, 5th edition, World Scientific. ISBN 9789814656528
4. Bankman, I. N. (2009). Handbook of Medical Image Processing and Analysis, 2nd edition, Academic Press, ISBN 9780123739049
5. Zhou, S. K. and Greenspan, H. and Shen, D. (2017). Deep Learning for Medical Image Analysis, Academic Press. ISBN 9780128104088

### Teaching and learning methods

The course is organized in one theoretical and one practical session per week. In the theoretical sessions the fundamentals of medical image are given by using powerpoint presentations as material support. The practical sessions are conducted in the laboratory and where applications are developed for medical image processing.

Assessment methods

- Alternative 1 - (Regular, Student Worker) (Final, Supplementary, Special)

- Practical Work - 50%

- Final Written Exam - 50%

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation			
Fernando Jorge Coutinho Monteiro	José Luís Sousa de Magalhaes Lima	Joana Andrea Soares Amaral	José Carlos Rufino Amaro
15-02-2024	27-02-2024	15-03-2024	24-03-2024

This document is valid only if stamped in all pages.