INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Medical Image Processing			Field of study	Instrumentation and Biomedical Signals		
Bachelor in	Biomedical Technology			School	School of Technology and Management		
Academic Year	2022/2023	Year of study	3	Level	1-3	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9600-752-3203-00-22		

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;
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 C.

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. Features detection.

Course contents (extended version)

1. Introduction
   - Areas of interest;
   - The concept of digital image;
   - Representation of image and modeling;
   - The steps of image processing;
   - Image enhancement;
   - Restoration and reconstruction of image;
   - Applications of image processing and vision.
2. The nature of biomedical images
   - X-ray images;
   - Computed Tomography;
   - Magnetic Resonance Imaging;
   - Nuclear medicine imaging (PET and SPECT);
   - Ultrasound imaging.
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;
   - Image formation in the eye;
   - Adjustment of brightness and discrimination.
5. The fundamentals of digital image
   - Sampling and quantification;
   - Basic relations among pixels;
   - The geometry of images;
   - Point, local and global operations;
   - Mapping intensities. Histogram.
6. Removal of artifacts
   - Characterization 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 aproximation 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
   - Erosion and dilation;
   - Opening and closing;
   - Skeletons.

Recommended reading

1. Biomedical Image Analysis, R. M. Rangayyan, CRC Press, 2005.

Recommended reading

2. Digital Image Processing, R. C. Gonzalez and R. E. Woods, Prentice Hall, 2nd ed. , 2001.
3. Biomedical Signal and Image Processing, K. Najarian, R. Splinter, CRC Press, 2005.
4. Biosignal and Biomedical Image Processing: MATLAB-Based Applications, J. L. Semmlow, CRC Press, 2004.
5. The Image Processing Handbook, J. C. Russ, CRC Press, 6th ed. , 2011

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, using Matlab, 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

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23-02-2023	11-03-2023	12-03-2023	17-03-2023