INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Computer Vision		Field of study	Signal Processing	
Master in	Electrical and Computers Engineering		School	School of Technology and Management	
Academic Year	2023/2024	Year of study	1	Level	2-1	ECTS credits	6.0
Type	Semestral	Semester	2	Code	5070-792-1205-00-23	

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 images and some of its major techniques;
3. describe and apply techniques for image 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 computer vision;
5. identify, formulate and solve a specific problem in computer vision.

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.

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 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
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. Davis, E. R. (2018). Computer Vision Principles, Algorithms, Applications, Learning. 5th edition, Academic Press. ISBN 9780128092842
5. Szeliski, R. (2022). Computer Vision: Algorithms and Applications, 2nd edition. Springer. ISBN 9783030343712

Teaching and learning methods

Presentation of image analysis and classification methodologies. Lecture sessions are taught the curricula of Computer Vision using as background presentation materials and/or videos. The Problem-solving, project or laboratory sessions are held in computer lab, using Python and/or Matlab, and where applications are developed for analysis of industrial images.

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	João Paulo Ramos Teixeira	José Carlos Rufino Amaro
21-02-2024	27-02-2024	13-03-2024	16-03-2024