Course Unit	Artificial Vision			**Field of study**	Telecommunications and Signal Processing		
Master in	Industrial Engineering - Electrical Engineering			**School**	School of Technology and Management		
Academic Year	2022/2023	**Year of study**	1	**Level**	2-1	**ECTS credits**	6.0
Type	Semestral	**Semester**	2	**Code**	9572-355-1205-00-22		

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 fundamentals of digital image representation and the elements of an image processing system;
2. develop capabilities to apply this knowledge in practice, mastering appropriate tools of image processing;
3. describe and apply techniques to image enhancement;
4. understand the fundamentals of a computer vision system;
5. understand the concepts and problems of images with movement;
6. develop, implement and compare methods relevant to a specific industrial application.

Prerequisites

Before the course unit the learner is expected to be able to:
1. dominate the two-dimensional mathematical formalism;
2. know the fundamentals of signal processing;
3. programming in MATLAB.

Course contents

1 - Digital image: The human visual system, formation of an image, digital representation of an image, color, noise.
2 - Image processing: Point-to-point manipulation, spatial filters, extraction of geometric structures, segmentation.
3 - Video processing: Optical stream, video compression.
4 - Pattern recognition: Introduction, knowledge representation, statistical pattern recognition, machine learning.
5 - Applications.

Course contents (extended version)

1. Introduction
   - areas of interest;
   - representation of image and modeling;
   - image enhancement;
   - applications of image processing and computer vision.
2. System of digital image processing
   - elements of a system of digital image processing;
   - video cameras.
3. 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;
   - colour models.
4. The fundamentals of digital image
   - sampling and quantification;
   - basic relations between pixels;
   - geometry of images;
   - point, local and global operations;
   - mapping intensities. Histogram.
5. Filtering the image
   - image enhancement through manipulation of the histogram;
   - removal of noise;
   - image enhancement.
6. Detection of lines and contours
   - digital approximation of Gradient and Laplacian;
   - line detection;
   - classical detectors of contours;
   - detector of corners;
   - SIFT and SURF.
7. Segmentation and image representation
   - attributes;
   - methods for segmentation;
   - classification;
   - an approach to unsupervised image segmentation.
8. Recognition of objects
   - components of the system;
   - complexity of the recognition of objects;
   - representation of the object;
   - strategies for recognition;
   - verification.
9. Three-dimensional reconstruction
   - Definition of disparity between images;
   - mathematical models of three-dimensional reconstruction;
   - Definition of stereovision.
10. Dynamic vision
    - change detection;
    - segmentation using motion;
    - image matching;
    - tracking.
11. Pattern recognition
    - knowledge representation

Course contents (extended version)

- statistical pattern recognition
- machine 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. Forsyth, D. A. (2011). Computer Vision: A Modern Approach, 2nd edition, Pearson. ISBN 9780136085928.
4. Chen, C. H. (2016). Handbook of Pattern Recognition and Computer Vision, 5th edition, World Scientific. ISBN 9789814656528.

Teaching and learning methods

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)
    - Projects - 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	José Alexandre de Carvalho Gonçalves	José Carlos Rufino Amaro
23-02-2023	11-03-2023	12-03-2023	17-03-2023