COURSE PROGRAM

Academic year: 2021-2022

<table>
<tr><td colspan="5">Identification and characteristics of the course</td></tr>
<tr><td>Code</td><td>401915</td><td></td><td>ECTS credits</td><td>6</td></tr>
<tr><td>Course name (English)</td><td colspan="4">Computer Vision</td></tr>
<tr><td>Course name (Spanish)</td><td colspan="4">Visión por Computador</td></tr>
<tr><td>Degree programs</td><td colspan="4">Master on Simulation in Science and Engineering</td></tr>
<tr><td>Faculty/School</td><td colspan="4">Industrial Engineering School</td></tr>
<tr><td>Semester</td><td>1</td><td>Type of course</td><td colspan="2">Optional</td></tr>
<tr><td>Module</td><td colspan="4">Optional</td></tr>
<tr><td>Matter</td><td colspan="4">Simulation tools</td></tr>
<tr><td colspan="5">Lecturer/s</td></tr>
<tr><td>Name</td><td>Office</td><td>E-mail</td><td colspan="2">Web page</td></tr>
<tr><td>Juan Álvaro Fernández Muñoz [1]</td><td>D.1.18 E.II.II. (Badajoz)</td><td>jalvarof@unex.es</td><td colspan="2">https://www.unex.es/conoce-la-uex/centros/eii/centro/profesores/info/profesor?id_pro=jalvarof</td></tr>
<tr><td>Antonio García Manso [2]</td><td>T.16 E.P. (Cáceres)</td><td>agmanso@unex.es</td><td colspan="2">https://www.unex.es/conoce-la-uex/centros/eii/centro/profesores/info/profesor?id_pro=agmanso</td></tr>
<tr><td>Subject area</td><td colspan="4">[1] Electronic technology, [2] Electronics</td></tr>
<tr><td>Department</td><td colspan="4">Electrical, Electronic and Automatic Engineering</td></tr>
<tr><td>Coordinating Lecturer (if more than one)</td><td colspan="4">Juan Álvaro Fernández Muñoz</td></tr>
<tr><td colspan="5">Competencies (see table at https://goo.gl/BJxjVH)</td></tr>
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Basic Competencies	Check with an "X"	General Competencies	Check with an "X"	Transversal Competencies	Check with an "X"	Specific Competencies	Check with an "X"	Specific Competencies Optional	Check with an "X"
CB6	X	CG1	X	CT1	X	CE1		CEO1	
CB7	X	CG2	X	CT2	X	CE2		CEO2	X
CB8	X	CG3	X	CT3	X	CE3		CEO3	X
CB9	X	CG4	X	CT4	X	CE4		CEO4	X
CB10	X	CG5	X	CT5	X	CE5		CEO5	
		CG6	X	CT6	X	CE6		CEO6	
		CG7	X	CT7	X	CE7		CEO7	
				CT8	X	CE8		CEO8	
				CT9				CEO9	
				CT10					

Contents

Course outline

Image acquisition and processing systems. Basic image processing techniques. Feature extraction. Segmentation. Scene interpretation. Industrial applications.

Course syllabus

Unit 1: Introduction to Computer Vision (3 hours)

Contents:

- Theory (1 hour):
  - Digital image representation.
  - Elements of a Computer Vision System.

- Computer practice (2 hours):
  - Basic digital image manipulation (MATLAB/Octave).

Unit 2: Basic image operations (8 hours)

Contents:

- Theory (4 hours):
  - Arithmetic operations.
  - Binary logic operations.
  - Color models.

- Computer practice (4 hours):
  - Basic image operations (MATLAB/Octave).

Unit 3: Intensity transforms (8 hours)

Contents:

- Theory (4 hours):
  - Image normalization.
  - Histogram equalization.
  - Automatic thresholding.

- Computer practice (4 hours):
  - Histogram-based image processing (MATLAB/Octave).

Unit 4: Digital filters (10 hours)

Contents:

- Theory (5 hours):
  - Linear and nonlinear digital image filtering.
  - Morphologic filters for binary regions (blobs).

- Computer practice (5 hours):
  - Noise reduction. Edge detection (MATLAB/Octave).
  - Binary region (blob) processing (MATLAB/Octave).

Unit 5: Feature extraction (14 hours)

Contents:

- Theory (7 hours):
  - Feature representation.
  - Convolutional features.
  - Unsupervised feature learning.
  - Feature coding.

- Computer practice (7 hours):
  - Feature extraction on natural images.

Unit 6: Segmentation and Scene interpretation (15 hours)

Contents:

- Theory (7 hours):
  - Intensity discontinuity-based segmentation methods.
  - Intensity similarity-based segmentation methods.
  - Segmentation algorithms: Watershed, K-means.
  - Motion-based segmentation.

- Computer practice (8 hours):
  - Motion detection.

Educational activities								
Student workload in hours per lesson		**Lectures**	**Practical activities**				**Monitoring activity**	**Homework**
Unit	Total	L	HI	LAB	COM	SEM	SGT	PS
1	5	1			2			2
2	14	4			4			6
3	14	4			4			6
4	20	5			5			10
5	28	7			7			14
6	31	7			8			16
Assessment	38	2						36
Total	**150**	**30**			**30**			**90**

L: Lectures (100 students)
HI: Hospital internships (7 students)
LAB: Lab sessions or field practice (15 students)
COM: Computer room or language laboratory practice (30 students)
SEM: Problem-solving classes, seminars or case studies (40 students)
SGT: Scheduled group tutorials (educational monitoring, ECTS type tutorials)
PS: Personal study, individual or group work and reading of bibliography

Note: this course (including Units 1 to 4) belongs to the internationalization program **PALEX Básico 2021**. Consequently, the course, taught in Spanish (Castilian), makes available to students, in English, the necessary material to the follow-up of the classes, as well as tutorials (on demand) and the possibility of carrying out course key tasks (practices and exams).

Teaching methodologies

Among the teaching methodologies included in the formative program, in this course the following are used:

Teaching methodologies	Used methodologies labelled with an "X"
1. Lectures. Explanation and discussion of theoretical contents.	X
2. Workshops with suitable methodology.	X
3. Problem solving in the class.	X
4. Practical work in environments with specialized equipment (labs, computer rooms, fieldwork).	X
5. Technical visits to installations.	
6. Elaboration and analysis (by groups or individually) of memoirs, exercises, case studies, on the skills and contents (theoretical and practical) related to the course.	X
7. Exams, defense of assignments, etc., oral or written, either individually or in groups.	X
8. Student study. Individual preparation and analysis of texts, cases, problems, etc.	X
9. Development of communication skills (oral, written, multimedia).	X
10. Out-of-class learning based on the link between academic education and professional or entrepreneurial experiences.	X

11. Tutored and supervised learning via student-tutor interaction, to detect potential problems in the education process, assess out-of-class learning outcomes, and program homework activities such as reports, the Master thesis and its academic presentation, etc.	

Learning outcomes

Ability to perform basic processes on digital images.
Ability to extract useful features from digital images.
Ability to apply suitable Digital Image Processing and Computer Vision techniques to real Engineering problems.

Assessment methods

Assessment criteria

CE1. Mastery of the theoretical contents of the course.
Related to competencies: CB6, CB7, CB8, CB10, CG1, CG4, CG5, CT1, CT4, CT7, CEO1.

CE2. Ability to apply the acquired theoretical knowledge to the solution of real problems.
Related to competencies: CB6, CB7, CB8, CG2, CG3, CG4, CG5, CG6, CG7, CT1, CT2, CT4, CT5, CT6, CT7, CT8, CEO2, CEO3, CEO4.

CE3. Mastery of the computational tools used in the course.
Related to competencies: CG2, CG3, CG6, CG7, CT5, CT6, CEO3, CEO4.

CE4. Ability to communicate knowledge using appropriate technical language, oral or written, within the field of Computer Vision.
Related to competencies: CB8, CB9, CG4, CG5, CT3, CT4, CT5, CT7, CT8.

Assessment activities

Among the assessment activities included in the formative program, in this course the following area used (with indicated weights in %):

	Range fixed	Ordinary call	Extraordinary call	Global assessment [*]
1. Final exam and/or partial examinations.	0%–40%[2]	20 %	20 %	20 %
2. Solution and submission of activities (cases, exercises, assignments, projects, etc.), individually and/or in groups.	40%–80%[2]	80 %	80 %	80 %
3. Attendance to face-to-face learning activities (lectures, practices, etc.)	0%–20%[1,2]			---
4. Presentation and defense of proposed projects and reports.	0%[1,2]			

[*] The student will communicate to the coordinating professor in writing the type of evaluation chosen in the first three weeks of each semester, and the coordinating professor will send the corresponding report to the Degree Quality Commission. If a student does not make this communication, it will be understood that he/she opts for continuous evaluation. Once the type of evaluation has been chosen, the student will not be able to change it in the ordinary call for that semester, and will abide by the evaluation regulations for the extraordinary call.

[1] Courses of the matter *Mathematical foundations* (*Numerical methods*, *Differential equations* and *Statistical data analysis*).

[2] Rest of courses.

Description of the assessment activities:

AE1. There will be a theoretical-practical exam at the end of the course to assess the knowledge acquired by the student during the course. It will represent **up to 20%** of the final grade for the course. This activity is mandatory and recoverable.

AE2.1. The student will develop computer programs in the practical sessions of the course. The listings and results of which will be presented in a Report whose delivery is mandatory. The evaluation of this compulsory report will suppose **up to 30%** of the final grade of the course. This activity is mandatory and recoverable.

AE2.2. The student will develop one or more computer programs, depending on their length and difficulty, to solve one or more additional practical cases, making use of the techniques studied in theory and in practical sessions. A Report will be presented with the developments and results obtained. The evaluation will represent **up to 50%** of the final grade for the course. This activity is optional and recoverable.

The **global assessment** will take place on the same day assigned to the final exam of each call by the Subdirectorate of Academic Organization of the E.II.II. It will consist of the following tests:
- Theoretical-practical exam. It will represent **up to 20%** of the global grade.
- The student must present a Report with the results obtained in solving several practical cases, similar to those carried out in the practical sessions. It will represent **up to 30%** of the grade.

- The student must also present a Report with the results obtained in solving one or more additional practical cases (depending on their difficulty and length), making use of the techniques studied in theory and in practical sessions. These practical cases will be similar to those proposed to the rest of the students throughout the course. It will represent **up to 50%** of the grade.

All the practical cases above will be personally entrusted to the student by the coordinating lecturer, in the event that this student expresses his/her desire to opt for the global assessment.

Bibliography (basic and complementary)

Basic bibliography

R. C. Gonzalez, R. E. Woods (2008): *Digital Image Processing*, 3rd ed., Prentice Hall, Upper Saddle River, NJ, USA.

R. Szeliski (2011): *Computer Vision: Algorithms and Applications*, Springer, London, UK.

Complementary bibliography

R. Fisher, S. Perkins, A. Walker, E. Wolfart (2004): *The Hypermedia Image Processing Reference*, University of Edinburgh, UK.

R. C. Gonzalez, R. E. Woods, S. L. Eddins (2009): *Digital Image Processing using MATLAB*, 2nd ed., Gatesmark, USA.

A. Coates (2012): *Demystifying Unsupervised Feature Learning*, PhD dissertation thesis. University of Stanford, USA.

E. Alegre, G. Pajares, A. de la Escalera (eds.) (2016): *Conceptos y Métodos en Visión por Computador*, Comité Español de Automática (CEA), Spain.

Other resources and complementary educational materials

Complementary materials of basic bibliography items:
http://www.imageprocessingplace.com/

Complementary materials at the official MATLAB website:
https://www.mathworks.com/products.html