VNIVERSITAT DE VALÈNCIA

Course Guide
36421 Image processing

COURSE DATA

Data Subject	
Code	36421
Name	Image processing
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1406 - Degree in Data Science	School of Engineering	2	Second term

Subject-matter

Degree	Subject-matter	Character
1406 - Degree in Data Science	7 - Signals	Obligatory

Coordination

Name	Department
BENAVENT GARCIA, MARIA ROSER	240 - Computer Science

SUMMARY

Students on this course are introduced to the fundamentals of image processing from the point of view of data science, the concept of digital image, and the various ways of representing an image. They learn the basic methods of image preprocessing for contrast modification, noise elimination and edge enhancement as well as techniques for extracting the features of the image and for segmenting the image.

The lecture classes will be taught in Spanish. The language for the practical and laboratory classes will be stated in the course guidelines available on the website for this degree.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

Given the basic nature of this course and its position in the curriculum, the only prerequisites are those stipulated for admission to the degree.

OUTCOMES

1406 - Degree in Data Science

- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- (CG06) Ability to access and manage information in different formats for subsequent analysis in order to obtain knowledge from data.
- (CG07) Ability to autonomously make decisions and to properly and originally elaborate reasoned arguments, in order to obtain reasonable and contrastable hypotheses.
- (CT02) To be able to complete technical, scientific, social and human training in general, and to organise self-learning with a high degree of autonomy.
- (CE10) Ability to digitally process signals and extract information from them.

LEARNING OUTCOMES

Know the representation of the images. (CB1)

Know the Fourier transform of an image and its relation to 2D convolution. (CE10)

Know how to apply image pre-processing methods for contrast modification, noise elimination and edge enhancement. (CE10)

Know the image representation formats, with and without compression (with and without losses). (CG06)

Know how to apply techniques to extract features of an image (detection of corners, lines and circular aspects). (CE10).

Know what is involved in the segmentation of images and how to apply the basic methods for this task. (CE10).

DESCRIPTION OF CONTENTS

1. Fundamentals of the digital image

Introduction to computer vision, acquisition, geometry, topology, sampling, quantization, color.

2. Transformations of the image in the spatial and frequency domain.

Spatial processing: convolutions and correlation. Domain of frequency. Fourier transform. Arithmetic, logical and geometric operations. Binary mathematical morphology.

3. Image preprocessing

Contrast manipulation. Elimination of noise. Edge enhancement.

4. Image formats and image data compression

Image formats. Compression techniques with and without losses.

5. Feature extraction.

Low-level features extraction: color, shape and texture. Motion analysis.

6. Image segmentation and classification.

Image segmentation. Segmentation methods: thresholding, region-based, Watershed transform. Classification.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	20,00	100
Classroom practices	10,00	100
Attendance at events and external activities	5,00	0
Development of group work	10,00	0
Development of individual work	10,00	0
Study and independent work	15,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	10,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	15,00	0
Resolution of online questionnaires	10,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

MD1 - Theoretical activities.

The main concepts will be explained and illustrated with examples, sometimes using computer tools. Students will complete online questionnaires via the e-learning platform before attending the lecture sessions to encourage them to participate in these sessions and increase their understanding of the contents presented. (CG06, CB01, CB05, CT02, CE10).

MD2 - Practical activities.

Exercises during the course will be solved either by the students themselves or by the teacher. After each thematic unit, students will complete individual exercises (workshops) via the e-learning platform. These exercises will be corrected by the students themselves by comparing their own work with the solutions suggested by their lecturers, as well as viewing evaluable interactive videos. A mini-project will be proposed based on a topic of the subject. This work will be done in pairs/individually (CG07, CT02, CE10).

MD3 - Cross-disciplinary competences.

Attendance at all activities related to digital image processing will be encouraged. (CT02).

MD4 - Laboratory work and/or computer classroom.

At each laboratory session students will complete a practice activity on the contents viewed in the group theoretical classes. Students will then prepare a report on each practice session individually or in pairs in accordance with the work conducted in the laboratory. (CG06, CG07, CE10).

The University of Valencia's e-learning platform (*Aula Virtual*) will be used to communicate with students. Students will also have access to the learning materials used in class and the problems and exercises they need to solve via this platform.

EVALUATION

Evaluation will be continuous throughout the course and will comprise the following components:

SE1 - An objective test will consist of one or more exams comprising theoretical and practical issues and problems. At the first examination sitting, the score obtained on these exams will account for 40% of the final grade. Students will need to obtain a minimum score of 4,5 points out of 10 on this component to pass the course (CG06, CB01, CB05, CT02, CE10).

SE2 - Evaluation of practical activities will be based on the student's papers, reports, online tests and/or oral presentations. Attendance at these activities, which will be conducted in the computer laboratory, is compulsory unless absence is properly justified. The score students obtain on this component will account for 40% of their final grade. (CG06, CG07, CE10).

SE3 - Continuous assessment will be based on the student's participation and degree of involvement in the teaching-learning process, attendance at face-to-face activities, solution of issues and problems set periodically, and presentation and exposition of assignments. The score they obtain on this component will account for 20% of the final grade. (CG07, CT02).

The activities conducted for components SE2 and SE3 cannot be re-taken.

At the second examination sitting, an exam will account for 60% of the final grade. To pass the course, students will need to obtain a minimum of 4,5 points out of 10 on this exam. The grade students obtained during the academic year on component SE2 will account for the remaining 40%. If the student has not realized the SE2 activities during the school period, there will be a test/oral exam that assesses the specific knowledge of this block.

In all cases the evaluation system will be governed by the University of Valencia's regulations on grading and assessment for bachelor's degrees and master's degrees, which is available at:

https://webges.uv.es/uvTaeWeb/MuestraInformacionEdictoPublicoFrontAction.do?accion=inicio&idEdictoSeleccionado=5639

REFERENCES

Basic

- Richard Szeliski (2011c). Computer Vision: algorithms and Applications. SpringerLink eBooks. [Recurs electrònic].
- Alan C. Bovik (2009). The essential guide to image processing. [Recurs electrònic].
- Rafael C. González and Richard E. Woods (2008). Digital image processing. Prentice-Hall.
- Nixon, Mark S (2012). Feature extraction & image processing for computer vision. Elsevier Academic Press [Recurs electrònic].
- Stéfan Vander Walt; Schönberger, Johannes L; Nunez-Iglesias, Juan; Boulogne, François; Warner, Joshua D; et al. PeerJ; San Diego (Jun 19, 2014). Scikit-image: image processing in Python. DOI:10.7717/peerj.453 [Recurs electrònic]

Additional

- M. Sonka, V. Hlavac, R. Boyle. Image processing, Analysis and Machine Vision. Chapman and Hall, 1999
- Peters, James F. (2017) Foundations of Computer Vision: Computational Geometry, Visual Image Structures and Object Shape Detection. [Recurs electrònic].
- John C. Russ and F. Brent Neal (2016). The Image Processing Handbook. Boca Raton, FL : CRC Press, [2016].
- Sandipan Dey (2018). Hands-On Image Processing with Python: Expert techniques for advanced image analysis and effective interpretation of image data.

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

The teaching methodology of the course will follow the Teaching Model approved by the Data Science Academic Committee (https://go.uv.es/cienciadatos/ModelDocentGCD2Q). In the event that the facilities are closed for health reasons that affect all or part of the course sessions, these will be replaced by non-presential sessions following the established timetable. If the closure affects a presential assessment test for the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode through the computer tools supported by the University of Valencia. The percentages of each assessment test will remain unchanged, as established by this guide.