Course guide
320114 - PDI - Digital Image Processing

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: Verónica Vilaplana

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE21-ESAUD. Ability to build, operate, and manage telecommunications services and applications, understood as systems for capturing, analog and digital processing, encoding, transportation, representation, processing, storage, reproduction, management, and presentation of audiovisual services and multimedia information. (Specific Technology Module: Sound and Image)
CE25-ESAUD. Ability to create, encode, manage, disseminate, and distribute multimedia content, taking into account criteria of usability and accessibility of audiovisual, broadcasting, and interactive services. (Specific Technology Module: Sound and Image)

TEACHING METHODOLOGY

- Face-to-face sessions
a) Classroom sessions. The lecturer presents the theoretical content of the subject, performs demonstrations using a computer, assigns exercises and answers questions.
b) Laboratory sessions. Students carry out a series of practicals in a computer laboratory.
c) Assessment sessions. Individual tests on the material.

Take-home work.
d) Individual study and exercise completion.
e) Completion of practical assignments and exercises to be handed in.

LEARNING OBJECTIVES OF THE SUBJECT

This subject introduces the most commonly used techniques in image processing and relates them with the concepts covered in other subjects. The lecturer illustrates the use of these techniques in applications for improvement and restoration, computer vision, biomedical and industrial applications, etc.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours small group	15,0	10.00
Hours large group	45,0	30.00

Total learning time: 150 h

CONTENTS

TOPIC 1: IMAGES AND VISION

Description:
- Definition, types and properties of images.
- Applications of digital image processing.
- Formation of images. The human visual system
- Representation of colour. Attributes of colour. Models of colour.

Full-or-part-time: 15h
Theory classes: 3h
Laboratory classes: 2h
Self study : 10h

TOPIC 2: LOW-LEVEL REPRESENTATION: PIXELS

Description:
- Simple statistics and histograms.
- Point operations. Gray-level transformations; arithmetic and logical operations. Pseudo-colour.
- Histogram equalisation.
- Quantification: uniform, optimal. Colour quantification.

Related activities:
- Pixel-level processing.

Full-or-part-time: 31h
Theory classes: 9h
Laboratory classes: 4h
Self study : 18h

TOPIC 3: SPACE-FREQUENCY REPRESENTATION

Description:
- Linear and invariant systems. Convolution and correlation.
- FOURIER ANALYSIS. Discrete Fourier transform. Properties
- Sampling: sampling theorem. Aliasing.
- Linear filters. Applications: noise elimination, interpolation, simplification.

Related activities:
- Fourier transform, aliasing.
- Linear filters.

Full-or-part-time: 31h
Theory classes: 9h
Laboratory classes: 4h
Self study : 18h

TOPIC 4: GEOMETRIC IMAGE PROCESSING

Description:
- Geometric transformations
- Hough transform.
- Mathematical morphology:
Erosion, dilation, opening, closing.
filters.
Geodetic transformations.

Related activities:
- Mathematical morphology

Full-or-part-time: 29h
Theory classes: 9h
Laboratory classes: 2h
Self study : 18h

TOPIC 5: AN IMAGE AS A SET OF REGIONS

Description:
- Definition of segmentation.
- Transition-based techniques.
- Region-based techniques.
- Representation of shapes, contours and textures.

Related activities:
- Segmentation.

Full-or-part-time: 29h
Theory classes: 9h
Laboratory classes: 2h
Self study : 18h

TOPIC 6: INTRODUCTION TO VISUAL RECOGNITION

Description:
- Introduction: visual recognition, difficulties and applications
- Introduction to convolutional neuronal networks (CNN)
- Image recognition with CNN

Full-or-part-time: 15h
Theory classes: 6h
Laboratory classes: 1h
Self study : 8h

GRADING SYSTEM

- Partial examination: 35% (during the course schedule)
- Final examination: 40% (during the course schedule)
- Laboratory work: 15%
- Projects: 10%

Unsatisfactory results of the partial or final examination may be re-conducted by a written test to be carried out on the date scheduled for the subject in the calendar of final exams. All students with a mark lower than 5 in the partial examination can do this test. The test will consist of two parts, one for each examination. The grade obtained by applying this test (scored between 0 and 5) will replace the initial examination grades as long as it is higher.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

EXAMINATION RULES.

- Face-to-face lecture sessions.
- Face-to-face practical work sessions.
- Independent learning exercises
- Preparation and completion of group activities subject to assessment.

In the face-to-face lecture sessions, the lecturer will introduce the basic theory, concepts, methods and results for the subject and use examples to facilitate students' understanding.
Students will be expected to study in their own time to become familiar with the concepts, using their own notes taken in theory classes and the compulsory and recommended reading lists. It is especially important for students to complete the assignments set in class and those included in the set of problems for the subject.
Students are expected to complement in-class programming activities with independent learning activities outside of class in order to gain sufficient algorithm-coding practice in the appropriate programming language (MATLAB).

BIBLIOGRAPHY

Basic:
- Apunts de l'assignatura.

Complementary:
- González, Rafael C. Digital image processing. 3rd ed. Harlow: Pearson Prentice Hall, 2008. ISBN 9780131687288.
- González, Rafael C. Digital image processing using Matlab. Upper Saddle River: Prentice Hall, 2004. ISBN 0130085197.
- Russ, John C. The image processing handbook [on line]. 6th ed. Boca Raton: CRC Press, 2011 [Consultation: 07/10/2022]. Available on : https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=681303. ISBN 9781439840634.
- Jain, Anil K. Fundamentals of digital image processing. Uttar Pradesh: Pearson, 2015. ISBN 9789332551916.