Digital image processing

Academic Year: (2020 / 2021) **Review date: 09-07-2020**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: DIAZ DE MARIA, FERNANDO

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

OBJECTIVES

The goal of the course is to provide the student with an understanding of the fundamental Digital Image Processing concepts, some ability to use the basic tools to process static images and video sequences, and a general view of the main image processing applications.

At the end of the course, the student will know (PO a):
- The mathematical and statistical foundations of Digital Image Processing, emphasizing linear processing.
- The main sources of image degradation, and the possibilities of image restoration techniques.
- The basic components of image analysis and image understanding systems.
- Elementary strategies for image segmentation, feature extraction, morphological processing and object recognition.
- The basic tools for processing image sequences.

In relation to specific abilities, at the end of the course the student will be able to:
- Use a specific software environment to implement image processing algorithms. (PO b)
- Implement and use basic processing tools: linear and non-linear local processing, image transform, morphological operators, basic methods for feature extraction and segmentation. (PO b)
- Solve complex image processing problems through the combination of basic processing blocks. (PO e)
- Designing strategies and image processing algorithms for solving specific problems. (PO e)

Finally, the student will achieve (new) or enhance (existing) general capabilities to
- Analize problems and synthesize solutions.
- Apply knowledge to engineering practice.
- Decompose complex problems and tasks in a structured collection of simpler ones.
- Integrate multidisciplinary knowledge.
- Work autonomously and cooperatively.
- Make decision designs.
- Make oral presentations

DESCRIPTION OF CONTENTS: PROGRAMME

0. Introduction. Applications of Digital Image Processing
1. The digital image.
2. Basic Image Processing
   - 2.1 Pointwise transformations.
   - 2.2 Geometric transformations.
   - 2.3 Filtering
   - 2.4 Image Processing in the Frequency Domain
3. Edge detection
4. Image restoration
5. Segmentation
6. Morphological image processing
7. Image Descriptors
8. Classification methods
9. Introduction to CNNs and their applications in image processing

LEARNING ACTIVITIES AND METHODOLOGY

The course will be organized around two types of class sessions: theoretical and laboratory.

THEORY

The theoretical classes will consist of conventional oral sessions by the teacher, with the aim to present and discuss the fundamental concepts and tools for digital image processing, providing the students with the opportunity to ask and resolve whatever questions arise during learning. Slides, blackboard and software demonstrations will be used to support the session.

LAB SESSIONS

At least one lab session per week will take place, with the following objectives (1) to get some skills in the use of an Image Processing Software (in particular, Matlab + Image Processing Toolbox), (2) use the image processing tools to visualize the eficacy of the methods discussed during the theoretical sessions, (3) solve simple image processing problems, and (4) complete a final lab project oriented to solve a complex problem.

ASSESSMENT SYSTEM

The final student grade will be computed as a weighted sum of the grades of two mid-term exams and a quizz (15%, 15% and 5%, respectively), the final lab project (40 %) and the final exam (25 %). Additionally, a minimum score of 4/10 on the final exam is required to pass the course.

The mid-term exams will evaluate the knowledge acquisition of theoretical concepts (PO a).

The final lab project will be evaluated according to: the justification of the engineering decisions taken to solve the stated problems (PO e), the efficient use of the available softwar (PO k), the quality of the experimental results (PO e), and the critical analysis carried out by the students. In addition, the quality of the technical report, the software, and the oral presentations (PO g) is evaluated, as well as the fullfiment of the requirement to acknowledge external sources and to provide original contributions (PO f), that is taken into account to compute the final score.

The final exam will be used to evaluate the knowledge acquisition of the theoretical concepts (PO a), as well as the acquired skills to design strategies for solving complex image processing problems. The exam will combine test questions and several short questions.

% end-of-term-examination:	25
% of continuous assessment (assigments, laboratory, practicals…):	75

BASIC BIBLIOGRAPHY

- Rafael C. González and Richard E. Woods Digital Image Processing. Fourth Edition, Pearson, 2018
- Wilhelm Burger and Mark J. Burge Principles of Digital Image Processing: Fundamental Techniques, Springer-Verlag, 2009
- Wilhelm Burger and Mark J. Burge Principles of Digital Image Processing: Core Techniques, Springer-Verlag, 2009