Speech, audio, image, and video processing applications

Academic Year: (2019 / 2020) **Review date: 03/12/2019 10:19:20**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: FERNANDEZ TORRES, MIGUEL ANGEL

Type: Electives ECTS Credits : 3.0

Year : 2 Semester : 1

OBJECTIVES

COMPETENCES

CB6.- Knowledge and understanding that provide a basis or opportunity for originality in developing and / or applying ideas, often in a research context.
CB9.- Students can communicate their conclusions and the underlying knowledge and rationale to specialist and non-specialist audiences clearly and unambiguously.
CB10.- Students have the learning skills that enable them to continue studying in a way that will be largely self-guided or autonomous.
CG9.- Adequate knowledge of physical problems and technologies and of the function of buildings so as to provide them with internal conditions of comfort and protection against the climate.
CG11.- Ability to communicate (oral and written) findings - and the underlying knowledge and rationale - to specialists and non-specialists in a clear and unambiguous manner.
CG12.- Capacity for continuous, self-guided and autonomous learning.

Regarding CB9 and CG12 competence, this course covers and evaluates only the part that has to do with specialized audiences.

LEARNING RESULTS

Similarly to other Master's elective courses, the student will acquire a greater specialization in different areas of Telecommunications technologies. Particularly, this course covers the following Signal Processing skills:

1.- General/Cross-curricular learning results
1.1. General basic knowledge
1.2. Analysis and synthesis abilities
1.3. Capability of applying the knowledge they have acquired
1.4. Problem-solving skills
1.5. Capability of integration of knowledge

2.- Specific learning results
(Knowledge-related learning results)
2.1. Mathematical basis of signal processing
2.2. General knowledge on potential image/video processing applications
2.3. Basic subsystems of image/video processing applications

(Instrumental learning results)
2.5. Use of image processing software
2.6. Mastering of basic processing tools
2.7. Solving image processing problems by using several basic tools

(Attitudinal learning results)
2.8. Individual- and team-work
2.9. Decision-making

2.10. Analysis and problem-solving capabilities

DESCRIPTION OF CONTENTS: PROGRAMME

The goal of this subject is to provide the student with an introduction to signal processing techniques with application to speech, audio, image and video. To that end, a Project-Based Learning Approach is followed. The emphasis is put on lab exercises, so that the student can be assessed according to her work on a mini project.

For shortening reasons, the subject focuses on image processing by means of a mini project.

1.- Course Presentation
2.- Fundamentals and Traditional Image Processing Techniques
    2.1. Digital image. Color spaces
    2.2. Point operations
    2.3. Filters. Edge detection
    2.4. Image segmentation
    2.5. Image classification
3.- Introduction to CNNs and their Applications in Computer Vision
    3.1. Neural Networks. Deep Neural Networks
    3.2. Convolutional Neural Networks
    3.3. Applications in Computer Vision

LEARNING ACTIVITIES AND METHODOLOGY

Two teaching activities are proposed: theoretical classes with examples and lab exercises.

THEORETICAL CLASSES WITH EXAMPLES (1 ECTS)

The theoretical class will be given in the blackboard, with slides or by any other means to illustrate the concepts of the lectures. In these classes the explanation will be completed with examples (AF1, MD1).

In these sessions the student will acquire the basic concepts of the course. It is important to highlight that these classes require the initiative and the personal and group involvement of the students (there will be concepts that the students should develop by themselves) (AF3, MD3).

LABORATORY EXERCISES (2 ECTS)

Some basic selected concepts learnt during the course are applied in the lab. The students should participate actively in the exercise implementation.

There will be two types of lab exercises:
- Guided lab exercises: getting used to image processing with MATLAB and Python (AF2, AF4, MD4).
- Project: image processing problem to be solved in groups (AF5, AF6, AF7, MD2, MD5).

ASSESSMENT SYSTEM

% end-of-term-examination/test:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

SE2.- Individually or in group works performed during the course.
The final project will account for the 100% of the final grade.

BASIC BIBLIOGRAPHY

- Aurélien Géron Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly Media, 2017

- Ian Goodfellow, Yoshua Bengio, Aaron Courville Deep Learning, MIT Press, 2016

- 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: Fundamental Techniques, Springer-Verlag, 2009

ADDITIONAL BIBLIOGRAPHY

- Gonzalez and Woods Digital Image Processing 4th Edition, Pearson, 2018

- Wilhelm Burger and Mark J. Burge Principles of Digital Image Processing: Core Techniques, Springer-Verlag, 2009