320114 - PDI - Digital Image Processing

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications
Academic year: 2019
Degree: BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Spanish

Teaching staff
Coordinator: Verónica Vilaplana

Degree competences to which the subject contributes

Specific:
1. AUD: Ability to build, exploit and manage telecommunication services and applications, understood as capture systems, analogue and digital manipulation, coding, transport, representation, processing, storage, reproduction, management and presentation of audiovisual services and multimedia information.
2. AUD: Ability to create, encode, manage, promote and distribute multimedia content, on the basis of the criteria of usability and accessibility of audiovisual services and interactive broadcasts.

Transversal:
3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
4. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.

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

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>45h</th>
<th>30.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</tbody>
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### TOPIC 1: IMAGES AND VISION

**Learning time:** 15h  
Theory classes: 3h  
Laboratory classes: 2h  
Self study: 10h

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

**Related activities:**  
- Pixel-level processing.

### TOPIC 2: LOW-LEVEL REPRESENTATION: PIXELS

**Learning time:** 31h  
Theory classes: 9h  
Laboratory classes: 4h  
Self study: 18h

**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.

### TOPIC 3: SPACE-FREQUENCY REPRESENTATION

**Learning time:** 31h  
Theory classes: 9h  
Laboratory classes: 4h  
Self study: 18h

**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.
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**TOPIC 4: GEOMETRIC IMAGE PROCESSING**

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

**Related activities:**
- Mathematical morphology

**Learning 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.

**Learning 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

**Learning time:** 15h
- Theory classes: 6h
- Laboratory classes: 1h
- Self study: 8h
Qualification 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.

Regulations for carrying out activities

- 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:


