300265 - IMAGE - Applied Image Processing

**Coordinating unit:** 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering

**Teaching unit:** 739 - TSC - Department of Signal Theory and Communications

**Academic year:** 2019

**Degree:** MASTER’S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Teaching unit Optional)

**ECTS credits:** 3  
**Teaching languages:** English

**Teaching staff**

**Coordinator:** Francesc Tarrés

**Others:** Francesc Tarrés

**Opening hours**

**Timetable:**
- Monday 16:00 - 19:00
- Tuesday 16:00 - 18:00
- Thursday 14:30 - 15:30

**Prior skills**

Signals and Systems, Digital Signal Processing, Digital audiovisual communications fundamentals

**Requirements**

Pre: No pre-requirements are identified in MASTEAM
Co: No co-requirements are identified in MASTEAM

**Degree competences to which the subject contributes**

**Basic:**
- CB6. (ENG) CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.
- CB7. (ENG) CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

**Generical:**
- 03 DIS. (ENG) Diseñar aplicaciones de alto valor añadido basadas en las Tecnologías de la Información y las Comunicaciones (TIC), aplicadas a cualquier ámbito de la sociedad.

**Transversal:**
- 03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
At the end of the course the student should be able to:

- To know the technologies and characteristics of camera systems, capture and representation technologies in computer vision systems
- Be able to select between different algorithms for extraction the useful information in still images and video. Understand algorithms for image enhancement and segmentation based on local or global features.
- Know, understand and be able to select possible alternatives for computer video analysis based on salient feature analysis and other low level descriptors such as color color, motion and shape.
- Understand and be able to used several deep learning architectures and learning algorithms for image classification and object detection.
- Have a perspective of different software packages and hardware components for developing customer solutions using computer visions systems
### Content

| **Introduction to Digital Image Processing** | **Learning time:** 11h  
| | Theory classes: 4h  
| | Self study: 7h |
| **Description:** | Presentation of algorithms and strategies for image enhancement |
| **Related activities:** | Activity 1, 6, 7 |

| **Cameras, Optics and Acquisition Systems** | **Learning time:** 8h  
| | Theory classes: 3h  
| | Self study: 5h |
| **Description:** | This chapter introduces some basic principles of image formation and optics to help selection of optical parameters in computer vision applications. A perspective on cameras, illumination and acquisition devices is also provided |
| **Related activities:** | Activity 2, 6, 7 |
| **Specific objectives:** | Fundamentals of optics. Selecting the optics in different computer vision applications. Types of cameras. Light and principles of lighting in computer vision applications. Types of lighting. Capturing images and video: frame grabbers, digital interfaces. |

| **Contour Detection and Segmentation** | **Learning time:** 5h  
| | Theory classes: 2h  
| | Self study: 3h |
| **Description:** | This chapter covers the classic algorithm for image segmentation based on contour or region analysis. It reviews the main techniques on image segmentation. |
| **Related activities:** | Activity 3, 6, 7 |
| **Specific objectives:** | Canny method for contour detection. Hough Transform. Region Segmentation Techniques: Split & Merge, Region Growing, Watersheds. Region representation using contours. Graph Based segmentation. GraphCut |
## Feature Extraction and Its Applications in Computer Vision

<table>
<thead>
<tr>
<th>Learning time: 24h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Self study: 16h</td>
</tr>
</tbody>
</table>

### Description:
This chapter presents different techniques for extracting automatic features of an image and discusses alternatives for using these features and their descriptors to object detection and recognition.

### Related activities:
Activity 4, Activity 7

### Specific objectives:
- Defining interest points, saliencies, corners, etc. Basic methods for corner extraction: Moravec, Harris, shi-tomasi, Nobles, Trigg, Broen.
- Detection of interest points: Kadir & Brady, SUSAN: edge and corner detection, FAST corner detector.
- Blob Detection. Laplacian of a Gaussian and Difference of Gaussians. MSER
- Scale Invariant Feature Detection (SIFT). SIFT Variants: SURF, GLOH, BRISK, ORB, etc.
- Face and person detection. Adaboost and Histogram of Gradients.

## Convolutional Neural Networks and Applications to Image Classification and Object Detection

<table>
<thead>
<tr>
<th>Learning time: 25h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Self study: 17h</td>
</tr>
</tbody>
</table>

### Description:
Fundamentals of neural networks and deep learning are presented in the context of image recognition. The main architectures for image classification and object detection are covered. Examples are presented using Tensorflow or Pytorch developing environments.

### Related activities:
Activity 5, Activity 7

### Specific objectives:
Evaluation takes into account the following topics

30 % Final Exam
20 % Control Exam
20 % Exercises and Computer Exercises Modules 1-2-3
20 % Exercises and Computer Exercises Modules 4-5
10 % Participation

Exams consist of short questions, problems, and a True/False Quiz.

The exercises and computer exercises have to be presented individually in a report and answering the different questions.

Basic:
