# 295106 - 295II022 - Computer Vision

- **Coordinating unit:** 295 - EEBE - Barcelona East School of Engineering
- **Teaching unit:**
  - 749 - MAT - Department of Mathematics
  - 707 - ESAII - Department of Automatic Control
  - 717 - EGE - Department of Engineering Presentation
- **Academic year:** 2019
- **Degree:** MASTER'S DEGREE IN INTERDISCIPLINARY AND INNOVATIVE ENGINEERING (Syllabus 2019).
  (Teaching unit Compulsory)
- **ECTS credits:** 6

**Teaching staff**

- **Coordinator:** José Rodellar
- **Others:** Raul Benitez, Jordi Torner, Francesc Alpiste, Santiago Alférez, Antoni Grau

**Prior skills**

Programming. Basic statistics.

## Degree competences to which the subject contributes

### Specific:

CEMUEII-10. Design and implement image analysis systems for the advanced characterization of complex systems in engineering.

### General:

CGMUEII-01. Participate in technological innovation projects in multidisciplinary problems, applying mathematical, analytical, scientific, instrumental, technological and management knowledge.

### Transversal:

- **05 TEQ. TEAMWORK.** Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
- **06 URI. EFFECTIVE USE OF INFORMATION RESOURCES.** Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
- **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.

## Learning objectives of the subject

- Recognize different image modalities and their applications.
- Perform advanced manipulations of digital images stored in different file formats.
- Perform automatic segmentation and extraction of descriptors.
- Develop and implement algorithms for the automatic recognition of special patterns in images based on machine and deep learning methods.
- Getting an overview to VR development with Unity and introducing VR elements and user input.
- Introducing to different VR technologies and building an application.
- Publishing apps in Unity and exporting to mobile devices.
• Design and implement appropriate pipelines for specific real problems, including input datasets, decision on the most appropriate techniques and interpretation of the results.
• Generate high level reports including developments, evaluations and conclusions.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>34h</th>
<th>22.67%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td></td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>20h</td>
<td></td>
<td>13.33%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td></td>
<td>0.00%</td>
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<tr>
<td>Self study:</td>
<td>96h</td>
<td></td>
<td>64.00%</td>
</tr>
</tbody>
</table>
# Computer Vision

## Content

| **Image processing** | **Learning time:** 12h  
Theory classes: 8h  
Laboratory classes: 4h |
|----------------------|--------------------------|

### Description:
- Image preprocessing: intensity transformations, spatial and statistical filters, filtering in the frequency domain
- Image segmentation: Otsu, watershed, morphological operations
- Feature extraction: geometrical descriptors, color spaces, texture analysis

### Related activities:
- Laboratory session 1: Image preprocessing
- Laboratory session 2: Segmentation and features

### Specific objectives:
Understand the essential steps from an original image to its final representation by means of quantitative descriptors.

| **Pattern recognition in images** | **Learning time:** 16h  
Theory classes: 10h  
Laboratory classes: 6h |
|------------------------------|--------------------------|

### Description:
- Machine learning based on features: Linear discriminant analysis, Bayes classifier, principal component analysis, decision trees and support vector machines.
- Specialized architectures and codes for structured implementations.

### Related activities:
- Laboratory session 3: Machine learning
- Laboratory session 4: Convolutional neural networks 1
- Laboratory session 5: Convolutional neural networks 2

### Specific objectives:
Understand the theoretical background, formulate problems in biomedical and other application areas, develop and implement computer codes and be able to decide which algorithms perform better for each problem.
## Virtual reality

**Description:**
- Overview of virtual reality (VR) hardware and software to learn different ways to get started with this technology.
- Practical cases of current applications ongoing in the biomedical sector.

**Related activities:**
- Laboratory session 6:
- Laboratory session 7:
- Laboratory session 8:
- Laboratory session 9:

**Specific objectives:**
- Develop and publish VR apps using Unity 3D platform. Presenting biomedical applications practical cases: Rehabilitation, surgical planning, 3D reconstruction, cognitive training, and others.

### Learning time: 12h
- Theory classes: 4h
- Laboratory classes: 8h

## Applications

**Description:**
- Applications of the methodologies to practical problems in areas like:
  - Robotics
  - Medical images
  - Satellite images
  - Virtual reality

**Related activities:**
- Laboratory session 10: Application.

**Specific objectives:**
- Understand and solve specific problems using real data.

### Learning time: 14h
- Theory classes: 12h
- Laboratory classes: 2h
Qualification system

Partial exam 30%
Final exam  30%
Projects 40%

The subject has a reevaluation test. The students will be able to access the re-assessment test that meets the requirements set by the EEBE in its Assessment and Permanence Regulations (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf)

Bibliography

Basic:

Others resources:
- Contents and software uploaded to Atenea