Course guides
295106 - 295II022 - Computer Vision

Unit in charge: Barcelona East School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.
749 - MAT - Department of Mathematics.
717 - DEGD - Department of Engineering Graphics and Design.

Degree: MASTER’S DEGREE IN INTERDISCIPLINARY AND INNOVATIVE ENGINEERING (Syllabus 2019). (Compulsory subject).

Academic year: 2021  ECTS Credits: 6.0  Languages: English

LECTURER

Coordinating lecturer: José Rodellar

Others: Segon quadrimestre:
ANDREA MILENA ACEVEDO LIPES - T11, T12
FRANCISCO ALPISTE PENALBA - T11, T12
RAUL BENITEZ IGLESIAS - T11, T12
ANTONI GRAU SALDES - T11, T12
JOSE JULIAN RODELLAR BENEDE - T11, T12
JORDI TORNER RIBE - T11, T12

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.

Generical:
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.

TEACHING METHODOLOGY
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>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Self study</td>
<td>96,0</td>
<td>64.00</td>
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<tr>
<td>Hours large group</td>
<td>34,0</td>
<td>22.67</td>
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<tr>
<td>Hours small group</td>
<td>20,0</td>
<td>13.33</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

Image processing

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

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

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

Full-or-part-time: 12h
Theory classes: 8h
Laboratory classes: 4h
Pattern recognition in images

Description:
• Machine learning based on features: Linear discriminant analysis, Bayes classifier, principal component analysis, decision trees and support vector machines.
• Deep learning: blocks of deep neural networks, convolutional filters, training, forward and backward propagation, parameters and hyperparameters.
• Specialized architectures and codes for structured implementations.

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.

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

Full-or-part-time: 16h
Theory classes: 10h
Laboratory classes: 6h

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.

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.

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

Full-or-part-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

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

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

**Full-or-part-time:** 14h
- Theory classes: 12h
- Laboratory classes: 2h

**GRADING 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:**

**RESOURCES**

**Other resources:**
Contents and software uploaded to Atenea