# 230726 - CVDL - Computer Vision with Deep Learning

**Coordinating unit:** 230 - ETSETB - Barcelona School of Telecommunications Engineering  
**Teaching unit:** 739 - TSC - Department of Signal Theory and Communications  
**Academic year:** 2019  
**Degree:** MASTER’S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)  
MASTER’S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)  
**ECTS credits:** 5  
**Teaching languages:** English

## Teaching staff

**Coordinator:** JOSEP RAMON MORROS  
**Others:** JAVIER RUIZ, VERÓNICA VILAPLANA

## Prior skills

Important: You should have the following previous knowledge to follow the course:
- Image processing: pixels, color spaces, histograms, frequency domain representation  
- Digital signal processing: linear filters, convolution  
- Vector and matrix algebra  

Notions of python are useful, but these are easily obtained during the course.

## Degree competences to which the subject contributes

### Specific:
1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing to communication and audiovisual systems.  
2. Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as bioengineering, photovoltaic conversion, nanotechnology and telemedicine.

### Transversal:
3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.  
4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.  
5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

## Teaching methodology

- Lectures  
- Practical work  
- Group work (distance)  
- Individual work (distance)  
- Exercises  
- Extended answer test (Final Exam)
Learning objectives of the subject:

The aim of this course is to provide an overview of concepts and applications of computer vision. We will introduce low level techniques such as feature extraction and matching, edge detection, cameras and projection models and optical flow; mid-level topics such as video segmentation and feature tracking; high level methods such as object tracking. Then, examples of application will be shown, such as face and object recognition.

Learning results of the subject:

- Ability to understand and use techniques for image and video analysis: feature extraction, video segmentation, stereo, object detection.
- Ability to use computer vision algorithms to implement high-level applications.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>39h</th>
<th>31.20%</th>
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<tr>
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<td>Hours medium group:</td>
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<tr>
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<td>Hours small group:</td>
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<td>Guided activities:</td>
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<td>Self study:</td>
<td>86h</td>
<td>68.80%</td>
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<td>Content</td>
<td>Learning time:</td>
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<tr>
<td>1. Introduction</td>
<td>7h</td>
<td>- Motivation, types of problems in CV</td>
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<td></td>
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<td>- Image formation, perception, 3D sensors</td>
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<td></td>
<td>Theory classes: 3h</td>
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<td>Self study : 4h</td>
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<td>2. Image Structure</td>
<td>29h</td>
<td>- Color, texture, filtering and contours</td>
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<td>- Detection and representation of interesting points and 'blobs'</td>
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<td>- Modelling: RANSAC, Hough transform</td>
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<td>- Saliency maps</td>
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<td>Theory classes: 9h</td>
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<td>Guided activities: 4h</td>
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<td>Self study : 16h</td>
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<tr>
<td>3. Stereo and 3D applications</td>
<td>30h</td>
<td>- Single camera geometry, camera calibration</td>
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<td>- Epipolar geometry, homography</td>
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<td>Theory classes: 9h</td>
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<td>Guided activities: 4h</td>
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<td>Self study : 17h</td>
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<td>4. Video tracking</td>
<td>29h</td>
<td>- Optical flow: Lucas-Kanade, Shi-Tomasi</td>
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<td>- Bayesian tracking: Kalman, Particle filters</td>
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<td>Theory classes: 9h</td>
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<td>Guided activities: 4h</td>
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<td>Self study : 16h</td>
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### 5. Detection and recognition

#### Learning time: 30h
- Theory classes: 9h
- Guided activities: 4h
- Self study: 17h

#### Description:
- Specific object recognition: face detection and recognition
- Bag of Words models
- Part-based models

### Planning of activities

#### LABORATORY

**Description:**
- Detecting contours and modelling lines: Canny, Hough, Ransac
- Finding correspondences between images: Harris, SIFT
- Fundamental matrix estimation
- Application of homography: panorama creation
- Face detection & recognition

#### EXERCISES

**Description:**
Exercises to strengthen the theoretical knowledge.

#### EXTENDED ANSWER TEST

**Description:**
Mid-term examination.

**Hours:** 2h
- Theory classes: 2h

#### EXTENDED ANSWER TEST

**Description:**
Second term examination

**Hours:** 2h
- Theory classes: 2h
Qualification system

First term examination: 40%
Second term examination: 40%
Laboratory/Exercises assessments: 20%

Bibliography

Basic:


Complementary:

