Master in Computer Vision
Aim of the Master in Computer Vision

• To give to the students updated knowledge about Computer Vision
  • from basic techniques to state-of-art algorithms

• that is an emerging technology whose development and applicability to different fields have exponentially grown in the last decade.
  • new jobs, start-up opportunities, PhD studentships

• By joining 4 groups of experts in the field which are living in Barcelona
  • a big concentration of expertise in a singular place
Inter-university research master

Universitat Autònoma de Barcelona (coordination) (25%)

Universitat Oberta de Catalunya (25%)

Universitat Politècnica de Catalunya (25%)

Universitat Pompeu Fabra (25%)
Suggested profiles and workload

- Suggested profiles of access:
  - Engineers
  - Mathematics
  - Physics

MCV is 1 year Master of 60 ECTS

1 ECTS = 25 Hours of student work

- MCV workload distribution

<table>
<thead>
<tr>
<th>On-site modules (M1 to M6)</th>
<th>On-lines modules (M7, M8)</th>
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<tbody>
<tr>
<td>5 h. on-site (20% approx.)</td>
<td>100 % homework</td>
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<tr>
<td>20 h. homework (80% approx.)</td>
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<td>Modules</td>
<td>ECTS</td>
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<tr>
<td>M1 Introduction to human and CV</td>
<td>6</td>
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<tr>
<td>M2 Optimization and Inference techniques for CV</td>
<td>6</td>
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<tr>
<td>M3 Machine Learning techniques for CV</td>
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<td>M4 Video Analysis</td>
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<td>M5 Visual Recognition</td>
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<td>M6 3D Vision</td>
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<td>M7 Introduction to Research Dissemination</td>
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<tr>
<td>M8 Research and Technology Transfer Management</td>
<td>6</td>
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<tr>
<td>M9 Master Dissertation</td>
<td>12</td>
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**Total:** 60
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<tr>
<th>Modules</th>
<th>ECTS</th>
<th>Univ.</th>
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<td>M1</td>
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<td>M2</td>
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<td>M3</td>
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<td>M6</td>
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<td>UPF</td>
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<td>M7</td>
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<td>UOC</td>
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<tr>
<td>M8</td>
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<td>UOC</td>
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<td>M9</td>
<td>12</td>
<td>ALL</td>
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<tr>
<td>October</td>
<td>November</td>
<td>December</td>
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<tr>
<td>October</td>
<td>November</td>
<td>December</td>
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| 2nd YEAR: |  |
|---|---|---|---|---|---|---|---|
| October | November | December | February | March | April | May | July (September) |
| M2. Optimization and Inference techniques for CV | M4. Video Analysis | M6. 3D Vision | | | | | |
| M9. Master Dissertation |
Supervised Sessions on-site

- **Lecture Sessions**, where the lecturers will explain general contents about the topics. Some of them will be used to solve the problems.

- **Project Sessions**, where the problems and goals of the projects will be presented and discussed, students will interact with the project coordinator about problems and ideas on solving the project (approx. 1 hour/week)

- **Presentation Session**, where the students give an oral presentation about how they have solved the project and a demo of the results.

- **Exam Session**, where the students are evaluated individually. Knowledge achievements and problem-solving skills

**Homework**, student will work in **groups** to solve the problems of the projects with deliverables:
- Code
- Reports
- Oral presentations
M1: Introduction to human and CV

- Image formation and color representation
- Image processing assessment and pixel-based processing
- Morphological and nonlinear filtering
- Space-frequency representation, Fourier transform and linear filtering
- Scale-space theory and multi-scale image processing
- Feature extraction
- Grouping, segmentation and classification
- Human visual system and perception

**Project 1:** Traffic sign detection and recognition
M2: Optimization and variational techniques for CV

- Introduction to energy minimization and variational formulation.
- Segmentation with geodesic active contours.
- Segmentation with variational models with statistics.
- Numerical techniques for solving variational problems.
- Overview of graphical models. Bayesian Networks.
- Markov Random Fields. Belief Propagation
- Inpainting. Graph Cuts

Project 2: Removing Objects in Natural and Urban Scenes

[Images of objects being removed from natural and urban scenes]
M3: Machine learning techniques for CV

- Local Image Descriptors (HOG, LBP, EOH)
- Bayesian decision theory. Overview of statistical learning
- SVM for classification
- Ensemble methods. Multiclass methods
- Random forests. Kernel methods
- Dimensionality reduction
- Deep learning

- **Project 3.** Traffic sign detection and recognition (II)
M4. Video analysis

- Introduction to video analysis and tracking. Data and applications
- Motion segmentation. Background subtraction
- Motion estimation. Optical flow
- Bayesian tracking
- Model-based tracking
- Gesture and action recognition
- Video retrieval

Project 4. Road Traffic Monitoring
M5. Visual Recognition

- The Bag of Words framework. Extensions
- Image descriptors
- Color Image Descriptors
- Binary Image Descriptors
- Image Retrieval
- Augmenting Image Retrieval Efficiency
- Structured Object Recognition

- **Project 5.** Searching for objects in large Image datasets
M6. 3D Vision

- 2D projective geometry. Planar transformations.
- 3D projective geometry and transformations.
- Camera calibration. Radial distortion.
- Epipolar geometry. Image rectification.
- Triangulation methods. Depth computation.
- Bundle adjustment. 3D model generation. New view synthesis.
- 3D reconstruction from Kinect sensors.

- **Project 6.**
  3D recovery of urban scenes
2014-2015 proposals from researchers

• Detection of anomalies in the electrocardiogram
• Advanced Algorithms for Magnetic Resonance Image Processing
• Brain Computer Interfaces for Video Retrieval
• Kidney stones classification
• Deep Learning Methods for Person Recognition
• On demand deep feature adaptation for identification problems
• Deep features for object localization
• White balance estimation using flash
• Advanced Numerical Schemes for Light Field Image Processing
• A comparison of perceptual image quality metrics
• What makes a great image?
• Visual Sentiment Concept Classification in Social Networks
• SAR remote sensing image analysis for ship monitoring
• Aerial imaging analysis
• …
2015-2016 proposals from researchers

• Deep features in robotics applications
• Deep color constancy
• Dense depth estimation from a single image by deep learning
• Deep learning methods for person annotation in video sequences
• Multitask deep facial emotion classification
• Virtual view generation using deep convolutional networks
• Driving scene understanding
• Personality estimation from shared images in social networks
• Learning attention for multiple activity recognition
• Multispectral photometric stereo
• Graph embedding models for structural indexing of document images
• Information extraction of historical documents
• Placenta localization in intrauterine MRI
• Computer vision for precision agriculture
• …
2014-2015 proposals from companies and institutions

• Recognition of weakly textured objects
• Contributions to segmentation in freesurfer for Alzheimer’s disease studies (Hosp. de Sant Pau)
• Automatic detection and enhancement of features
• Recognition of brands using an intelligent digital table in a restaurant context
• Age and gender recognition of people sitting around an intelligent table
• Deep features for semantic segmentation of fashion imagery
• Real-time UAV mapping
• Feature fusion for object recognition in RGB-D images
• …

…. that can become job opportunities or Ph.D thesis grants
2015-2016 proposals from companies and institutions

- Body and face shape calculator (Imersivo S.L.)
- Medium distance person counting using thermal sensors (Ctrl4 Enviro S.L.)
- Robust image alignment under illumination and material constraints (Océ Print Logic Technologies S.A.)
- BBVA Data - Interaction between physical documents and digital financial records (BBVA Data & Analytics – Barcelona Lab)
- Capture camera rig design for spherical stereoscopic video in audiovisual production (Antaviana Films)
- Real-time mapping of facial expressions to an Avatar (HealthApp)
- Quality check after manual mechaning operations (Alstom)
- …

…. that can become job opportunities or Ph.D thesis grants
Current numbers of the MCV students

- Number of registered students:
  - 15 in 2013-2014
  - 32 in 2014-2015
  - 30 in 2015-2016

- Students graduated in Sept. 2014
  - 92% have a job at this moment
    - 54,5% a PhD Studentship
    - 36,4% Software developers
    - 9,1% Videogame programmer
  - 8,58 is the mark given by the students about utility of MCV graduation

- Students graduated in Sept. 2015
  - 87,5% have a job at this moment
    - 52,4% PhD Student
    - 14,3% Engineer
    - 14,3% Software developer
    - 19,0% Other
  - 7,68 is the mark given by the students about utility of MCV for professional career
M1. Introduction to human and computer vision

The aim of this module is to introduce students to computer vision, including basics of human visual system and image perception, acquisition and processing. In terms of processing, the module deals with low-level pixel-based transforms, linear, nonlinear and morphological filtering, Fourier analysis, multiscale representations, extraction of simple features and image descriptions. Furthermore, elementary grouping, segmentation and classification strategies will be discussed as well as quality and assessment methods/image processing algorithms. To put into practice the algorithms and techniques, the students will work on a concrete project course. The aim is to provide an applied knowledge of a broad variety of Computer Vision techniques applied to solve a real-world problem. The project goal is to detect specific objects in images, in our case traffic signs, using basic CV techniques such as low-level filtering, segmentation, grouping, template matching, modeling, etc. The knowledge obtained can be used in a wide applications, for instance, quality control, generic object detection, security applications, etc.

Module lectures:

Project title: Traffic Sign Detection and Recognition (1)

Access to Moodle Room

Module Schedule

Link to the video

https://www.youtube.com/watch?v=zLkz6ljKtyw