240AR052 - Advanced Topics in Computer Vision

Learning objectives of the subject

The computer vision goal is to extract data from digital images. It is supposed that students have learned the fundamentals of the design of computer vision techniques and their applications in the compulsory subject of "Computer Vision".

This subject will complement the acquired theoretical and practical knowledge on Computer Vision with topics that can be considered out-standard or cutting-edge applications.

The subject is divided in two main parts:

First with emphasis on segmentation, description and recognition methods, in order to get symbolic data from images.

Second focusing on extracting geometric data from images.

Students will apply some of presented techniques in a short project consisting in programming a solution to a given problem, where they will prove their acquired skills.

Learning Outcomes
- Compare different techniques of image processing and computer vision procedures.
- Combine and integrate different techniques and procedures.
- Select the correct tools in function to the problem to be solved.
- Propose new methods or variations on existing ones.
- Take conscience about difficulty of application of computer vision generalized solutions. Identify solutions that are not...
applicable to a generalized set of applications.

Mandatory Contents
- Image Transformations.
- Image segmentation by texture and color.
- Robust description of regions and images.
- Stereo vision
- 3D extraction and reconstruction.

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours large group:</th>
<th>Hours small group:</th>
<th>Self study:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong> 112h 30m</td>
<td>27h</td>
<td>13h 30m</td>
<td>72h</td>
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<td>24.00%</td>
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## 240AR052 - Advanced Topics in Computer Vision

### Content

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<tr>
<th>1. Introduction</th>
<th>Learning time: 4h</th>
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<tr>
<td><strong>Description:</strong> This topic will deal with:</td>
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<tr>
<td>· What is advanced in Computer Vision?</td>
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<tr>
<td>· Course contents, objectives and organization</td>
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<tr>
<td><strong>Related activities:</strong></td>
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<tr>
<td>Master class</td>
<td></td>
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<tr>
<td><strong>Specific objectives:</strong></td>
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<tr>
<td>CB1, CB2, CB3, CB4, CB5, CG1, CG3, CG8, CT2, CT3, CT4, CT5, CT7, CE7, CE9, CE13</td>
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<thead>
<tr>
<th>2. Image Transforms</th>
<th>Learning time: 8h</th>
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<tr>
<td><strong>Description:</strong> This topic deals with:</td>
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<tr>
<td>· Fourier, DCT, Hadamard, Haar, Slant</td>
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<td>· Wavelets</td>
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<td>· Bilateral Filtering</td>
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<td>· Application to image description and image compression</td>
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<tr>
<td><strong>Related activities:</strong></td>
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<tr>
<td>Master class, problem solving and independent learning through exercises</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
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<tr>
<td>CB1, CB2, CB3, CB4, CB5, CG1, CG3, CG8, CT2, CT3, CT4, CT5, CT7, CE7, CE9, CE13</td>
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</table>
### 3. Texture Analysis

**Learning time:** 8h
- Theory classes: 3h
- Practical classes: 1h
- Self study: 4h

**Description:**
- This topic deals with:
  - Texture descriptors
  - Methods: Statistical, structural and syntactic
  - Application to image segmentation

**Related activities:**
- Master class, problem solving and independent learning through exercises

**Specific objectives:**
- CB1, CB2, CB3, CB4, CB5, CG1, CG3, CG8, CT2, CT3, CT4, CT5, CT7, CE7, CE9, CE13

### 4. Color Analysis

**Learning time:** 8h
- Theory classes: 3h
- Practical classes: 1h
- Self study: 4h

**Description:**
- This topic deals with:
  - Color Spaces
  - Color Constancy
  - Descriptors for color invariance
  - Application to image segmentation

**Related activities:**
- Master class, problem solving and independent learning through exercises

**Specific objectives:**
- CB1, CB2, CB3, CB4, CB5, CG1, CG3, CG8, CT2, CT3, CT4, CT5, CT7, CE7, CE9, CE13
### 5. Descriptors and recognition methods

**Learning time:** 8h  
- Theory classes: 3h  
- Practical classes: 1h  
- Self study: 4h

**Description:**  
This topic deals with:  
- Descriptors: PCASIFT, SURF, GLOH, DASY, BRIEF  
- Object Recognition: Bag of words, Constellations

**Related activities:**  
Master class, problem solving and independent learning through exercises

**Specific objectives:**  
CB1, CB2, CB3, CB4, CB5, CG1, CG3, CG8, CT2, CT3, CT4, CT5, CT7, CE7, CE9, CE13

### 6. Stereo Correspondence

**Learning time:** 8h  
- Theory classes: 3h  
- Practical classes: 1h  
- Self study: 4h

**Description:**  
This topic deals with:  
- Epipolar Geometry  
- Correspondence problem: Sparse and dense approaches  
- Local methods: Distance measures. Shirai Algorithm.  
- Global optimization: SSSD, Relaxation, Dynamic programming.

**Related activities:**  
Master class, problem solving and independent learning through exercises

**Specific objectives:**  
CB1, CB2, CB3, CB4, CB5, CG1, CG3, CG8, CT2, CT3, CT4, CT5, CT7, CE7, CE9, CE13
7. 3D reconstruction

**Description:**
This topic deals with:
- Shape from X: photometry, shading, focus, texture.
- Structure from motion. Factorization.
- Multiview reconstruction: Voxel Coloring, Space Carving, shape from silhouettes.
- Active methods: laser planes, dot sets, ToF cameras, kinect, ...

**Related activities:**
Master class, problem solving and independent learning through exercises

**Specific objectives:**
CB1, CB2, CB3, CB4, CB5, CG1, CG3, CG8, CT2, CT3, CT4, CT5, CT7, CE7, CE9, CE13

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8. Monocular 3D Detection

**Description:**
This topic deals with:
- Camera geometry review
- Pose estimation
- Robust detectors
- Non-Rigid 3D detection

**Related activities:**
Master class, problem solving and independent learning through exercises

**Specific objectives:**
CB1, CB2, CB3, CB4, CB5, CG1, CG3, CG8, CT2, CT3, CT4, CT5, CT7, CE7, CE9, CE13
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Planning of activities

1. SHORT COMPUTER VISION PROJECT

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<tr>
<td>Theory classes: 2h</td>
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<tr>
<td>Self study: 2h</td>
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Support materials:
Computers and software tools

Descriptions of the assignments due and their relation to the assessment:
Public presentation of the developed method and results.

Specific objectives:
To implement computer vision solution for a specific problem where the student has to show the knowledge and skills acquired through the course. The project will be implemented in a programming language.

This project will represent the 40% of the final score.

Qualification system

The evaluation system will consist on the following elements:

- Evaluation of the exercises: (30% of the course score)
- Evaluation of a final exam: (30% of the course score)
- Evaluation of the short project: (40% of the course score)

Regulations for carrying out activities

TO BE DEFINED
Bibliography

Basic:


Complementary:

