Course guide
300265 - IMAGE - Applied Image Processing

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: MASTER'S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Optional subject).

Academic year: 2023  ECTS Credits: 3.0  Languages: English

LECTURER

Coordinating lecturer: Francesc Tarrés
Others: Francesc Tarrés

PRIOR SKILLS
Signals and Systems, Digital Signal Processing, Digital audiovisual communications fundamentals

REQUIREMENTS

Pre: No pre-requirements are identified in MASTEAM
Co: No co-requirements are identified in MASTEAM

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Generical:
03 DIS. (ENG) Diseñar aplicaciones de alto valor añadido basadas en las Tecnologías de la Información y las Comunicaciones (TIC), aplicadas a cualquier ámbito de la sociedad.

Transversal:
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.

Basic:
CB6. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
CB7. Students will be able to apply the acquired knowledge and their ability to solve problems in new or little explored environments in broader (or multidisciplinary) contexts related to their study area.

TEACHING METHODOLOGY

Teaching is based mainly on lectures and some case studies which are analyzed with some detail. Lectures introduce image processing concepts, mathematic tools, algorithms, methods and technologies which are involved in the design of practical image processing and computer vision systems. Lectures are based on a collection of slides and additional notes provided as accompanying hangouts to the lecture.

Every lesson is summarized with a collection of exercises or computer exercises that help the student to summarize the theoretical and practical concepts. Computer exercises are accompanied with practical study cases that the student has to analyze carefully and select the best solution to the problem. Solutions have to be developed in high level languages such as Python, OpenCV or Matlab and are presented as guided activities in class. Assessment is evaluated through test questions, exams and reports of case studies solutions.
LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student should be able to:

To know the technologies and characteristics of camera systems, capture and representation technologies in computer vision systems.

Be able to select between different algorithms for extraction the useful information in still images and video. Understand algorithms for image enhancement and segmentation based on local or global features.

Know, understand and be able to select possible alternatives for computer video analysis based on salient feature analysis and other low level descriptors such as color, color, motion and shape.

Understand and be able to used several deep learning architectures and learning algorithms for image classification and object detection.

Have a perspective of different software packages and hardware components for developing customer solutions using computer visions systems.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>3,0</td>
<td>4.05</td>
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<tr>
<td>Hours large group</td>
<td>23,0</td>
<td>31.08</td>
</tr>
<tr>
<td>Self study</td>
<td>48,0</td>
<td>64.86</td>
</tr>
</tbody>
</table>

Total learning time: 74 h

CONTENTS

Introduction to Digital Image Processing

Description:
Presentation of algorithms and strategies for image enhancement

Specific objectives:

Related activities:
Activity 1, 6, 7

Full-or-part-time: 11h
Theory classes: 4h
Self study: 7h
### Cameras, Optics and Acquisition Systems

**Description:**
This chapter introduces some basic principles of image formation and optics to help selection of optical parameters in computer vision applications. A perspective on cameras, illumination and acquisition devices is also provided.

**Specific objectives:**
- Fundamentals of optics. Selecting the optics in different computer vision applications.
- Types of cameras. Light and principles of lighting in computer vision applications.

**Related activities:**
Activity 2, 6, 7

**Full-or-part-time:** 8h
Theory classes: 3h
Self study: 5h

### Contour Detection and Segmentation

**Description:**
This chapter covers the classic algorithm for image segmentation based on contour or region analysis. It reviews the main techniques on image segmentation.

**Specific objectives:**
- Region representation using contours. Graph Based segmentation. GraphCut

**Related activities:**
Activity 3, 6, 7

**Full-or-part-time:** 5h
Theory classes: 2h
Self study: 3h
**Feature Extraction and Its Applications in Computer Vision**

**Description:**
This chapter presents different techniques for extracting automatic features of an image and discusses alternatives for using these features and their descriptors to object detection and recognition.

**Specific objectives:**
- Defining interest points, saliencies, corners, etc. Basic methods for corner extraction: Moravec, Harris, shi-tomasi, Nobles, Trigg, Broen.
- Detection of interest points: Kadir & Brady, SUSAN: edge and corner detection, FAST corner detector.
- Blob Detection. Laplacian of a Gaussian and Difference of Gaussians. MSER
- Scale Invariant Feature Detection (SIFT). SIFT Variants: SURF, GLOH, BRISK, ORB, etc.
- Face and person detection. Adaboost and Histogram of Gradients.

**Related activities:**
- Activity 4, Activity 7

**Full-or-part-time:** 24h
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 16h

**Convolutional Neural Networks and Applications to Image Classification and Object Detection**

**Description:**
Fundamentals of neural networks and deep learning are presented in the context of image recognition. The main architectures for image classification and object detection are covered. Examples are presented using Tensorflow or Pytorch developing environments.

**Specific objectives:**

**Related activities:**
- Activity 5, Activity 7

**Full-or-part-time:** 25h
- Theory classes: 6h
- Practical classes: 2h
- Self study: 17h

**GRADING SYSTEM**

Evaluation takes into account the following topics:

- 30 % Final Exam
- 20 % Control Exam
- 20 % Exercises and Computer Exercises Modules 1-2-3
- 20 % Exercises and Computer Exercises Modules 4-5
- 10 % Participation
EXAMINATION RULES.

Exams consist on short questions, problems and a True/False Quiz.

The exercises and computer exercises have to be presented individually in a report and answering the different questions.

BIBLIOGRAPHY

Basic: