



# Course guide

## 300265 - IMAGE - Applied Image Processing

Last modified: 09/06/2023

**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 handouts 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

---

Type	Hours	Percentage
Hours small group	3,0	4.05
Hours large group	23,0	31.08
Self study	48,0	64.86

**Total learning time:** 74 h

## CONTENTS

---

### Introduction to Digital Image Processing

**Description:**

Presentation of algorithms and strategies for image enhancement

**Specific objectives:**

Point transforms. Histogram and Image equalization. Automatic Binarization: k-means, Otsu Methods. Image Linear Filtering. Gradient estimation filters. Contour estimation using second derivatives: Marr-Hildreth. Non-linear filters. Basic morphological operations. Dilation, erosion, top-hat

**Related activities:**

Activity 1, 6, 7

**Full-or-part-time:** 11h

Theory classes: 4h

Self study : 7h



### Cameras, Optics and Acquisition Systems

**Description:**

content 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. Types of lighting. Capturing images and video: frame grabbers, digital interfaces.

**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:**

Canny method for contour detection. Hough Transform. Region Segmentation Techniques: Split & Merge, Region Growing, Watersheds. 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:

Introduction to Neural Networks and history. Neuron models. Elemental classifiers. Linear regression. Learning Models. Multilayer perceptrons. Backpropagation. Training, Test and Validation. Batches and Epochs. Loss functions. Regularization. Data augmentation. Convolutional Neural Networks and main architectures: AlexNet, ZF Net, VGG Net, Inception, Resnet. Object detection and segmentation: R-CNN, Fast R-CNN, Faster R-CNN, Yolo, SSD, Retina Net, Yolo V3.

### 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:

- Shapiro, Linda G; Stockman, George C. Computer vision. Upper Saddle River: Prentice Hall, cop. 2002. ISBN 0130307963.
- Parker, J. R. Algorithms for image processing and computer vision. 2nd ed. New York, [etc.]: John Wiley & Sons, cop. 2011. ISBN 9780470643853.
- Géron, Aurélien. Hands-on machine learning with scikit-learn & tensorflow : concepts, tools, and techniques to build intelligent systems [on line]. Sebastopol, CA: O'Reilly Media, Inc, [2017] [Consultation: 26/07/2022]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=4822582>. ISBN 9781491962299.