

300265 - IMAGE - Applied Image Processing

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications
Academic year: 2019
Degree: MASTER'S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Teaching unit Optional)
ECTS credits: 3 Teaching languages: English

Teaching staff

Coordinator: Francesc Tarrés
Others: Francesc Tarrés

Opening hours

Timetable: Monday 16:00 - 19:00
Tuesday 16:00 -18:00
Thursday 14:30 - 15:30

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

Basic:

CB6. (ENG) CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.

CB7. (ENG) CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

Generic:

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.

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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, motion and shape.

Understand and be able to use 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 vision systems

Study load

Total learning time: 74h	Hours large group:	23h	31.08%
	Hours medium group:	0h	0.00%
	Hours small group:	3h	4.05%
	Guided activities:	0h	0.00%
	Self study:	48h	64.86%

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Content

<p>Introduction to Digital Image Processing</p>	<p>Learning time: 11h Theory classes: 4h Self study : 7h</p>
<p>Description: Presentation of algorithms and strategies for image enhancement</p> <p>Related activities: Activity 1, 6, 7</p> <p>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</p>	
<p>Cameras, Optics and Acquisition Systems</p>	<p>Learning time: 8h Theory classes: 3h Self study : 5h</p>
<p>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 devises is also provided</p> <p>Related activities: Activity 2, 6, 7</p> <p>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.</p>	
<p>Contour Detection and Segmentation</p>	<p>Learning time: 5h Theory classes: 2h Self study : 3h</p>
<p>Description: This chapter covers the classic algorithm for image segmentation based on contour or region analysis. It reviews the main techniques on image segmentation.</p> <p>Related activities: Activity 3, 6, 7</p> <p>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</p>	

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<p>Feature Extraction and Its Applications in Computer Vision</p>	<p>Learning time: 24h Theory classes: 6h Laboratory classes: 2h Self study : 16h</p>
<p>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</p> <p>Related activities: Activity 4, Activity 7</p> <p>Specific objectives: Defining interest points, saliencies, corners, etc. Basic methods for corner extraction: Moravec, Harris, shi-tomasi, Nobles, Trigg, Broen.</p> <p>Detection of interest points: Kadir & Brady, SUSAN: edge and corner detection, FAST corner detector.</p> <p>Blob Detection. Laplacian of a Gaussian and Difference of Gaussians. MSER</p> <p>Scale Invariant Feature Detection (SIFT). SIFT Variants: SURF, GLOH, BRISK, ORB, etc.</p> <p>Face and person detection. Adaboost and Histogram of Gradients.</p>	
<p>Convolutional Neural Networks and Applications to Image Classification and Object Detection</p>	<p>Learning time: 25h Theory classes: 6h Practical classes: 2h Self study : 17h</p>
<p>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</p> <p>Related activities: Activity 5, Activity 7</p> <p>Specific objectives: Introduction to Neural Networks and history. Neuron models. Elemental clasifiers. 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.</p>	

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Qualification 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

Regulations for carrying out activities

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: 03/10/2018]. Available on: <<https://proquest.safaribooksonline.com/9781491962282?uicode=politcat>>. ISBN 9781491962299.