Guía docente
300265 - IMAGE - Procesado de Imagen y Sus Aplicaciones

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Unidad responsable: Escuela de Ingeniería de Telecomunicación y Aeroespacial de Castelldefels
Unidad que imparte: 739 - TSC - Departamento de Teoría de la Señal y Comunicaciones.

Titulación: MÁSTER UNIVERSITARIO EN APLICACIONES Y GESTIÓN DE LA INGENIERÍA DE TELECOMUNICACIÓN (MASTEAM) (Plan 2015). (Asignatura optativa).

Curso: 2023 **Créditos ECTS:** 3.0 **Idiomas:** Inglés

PROFESORADO

Profesorado responsable: Francesc Tarrés

Otros: Francesc Tarrés

COMPETENCIAS DE LA TITULACIÓN A LAS QUE CONTRIBUYE LA ASIGNATURA

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

Transversales:
03 TLG. TERCERA LENGUA: Conocer una tercera lengua, que será preferentemente inglés, con un nivel adecuado de forma oral y por escrito y en consonancia con las necesidades que tendrán las tituladas y los titulados en cada enseñanza.

Básicas:
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. 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.

METODOLOGÍAS DOCENTES

OBJETIVOS DE APRENDIZAJE DE LA ASIGNATURA

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 enhacement 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 algoruthms for image classification and object detection.

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

HORAS TOTALES DE DEDICACIÓN DEL ESTUDIANTADO

Tipo	Horas	Porcentaje
Horas grupo pequeño	3,0	4.05
Horas aprendizaje autónomo	48,0	64.86
Horas grupo grande	23,0	31.08

Dedicación total: 74 h

CONTENIDOS

Introduction to Digital Image Processing

Descripción:
Presentation of algorithms and strategies for image enhancement

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

Actividades vinculadas:
Activity 1, 6, 7

Dedicación: 11h
Grupo grande/Teoría: 4h
Aprendizaje autónomo: 7h

Cameras, Optics and Acquisition Systems

Descripción:
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, ilumination and acquisition devises is also provided

Objetivos específicos:
Fundamentals of optics. Selecting the optics in different computer vision aplications. Types of cameras. Light and principles of lighting in computer vision applications. Types of lighting. Capturing images and video: frame grabbers, digital interfaces.

Actividades vinculadas:
Activity 2, 6, 7

Dedicación: 8h
Grupo grande/Teoría: 3h
Aprendizaje autónomo: 5h

Contour Detection and Segmentation

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

Objetivos específicos:
Canny method for contour detection. Hough Transform. Region Segmentation Techniques: Split & Merge, Region Growing, Watersheds. Region representation using contours. Graph Based segmentation. GraphCut

Actividades vinculadas:
Activity 3, 6, 7

Dedicación: 5h
Grupo grande/Teoría: 2h
Aprendizaje autónomo: 3h

Feature Extraction and Its Applications in Computer Vision

Descripción:
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

Objetivos específicos:
Defiining 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.

Actividades vinculadas:
Activity 4, Activity 7

Dedicación: 24h
Grupo grande/Teoría: 6h
Grupo pequeño/Laboratorio: 2h
Aprendizaje autónomo: 16h

Convolutional Neural Networks and Applications to Image Classification and Object Detection

Descripción:
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

Objetivos específicos:
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.

Actividades vinculadas:
Activity 5, Activity 7

Dedicación: 25h
Grupo grande/Teoría: 6h
Grupo mediano/Prácticas: 2h
Aprendizaje autónomo: 17h

ACTIVIDADES

Activity 1. Computer exercise: Image Enhancement and basic analysis techniques

Descripción:
This activity is a computer exercise. The student have the option of developing the exercise using Python with the library scikit images or Matlab. The activity covers different algorithm already covered in class: equalization, automatic binarization, labelling, non-linear filtering, etc.

Objetivos específicos:
The main objective is to emphasize and consolidate the knowledge on image enhancement techniques that are studied in the first chapter

Material:
Document describing the activity, software to be used and questions to solve

Entregable:
Report of the activity

Competencias relacionadas:
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03 TLG. TERCERA LENGUA: Conocer una tercera lengua, que será preferentemente inglés, con un nivel adecuado de forma oral y por escrito y en consonancia con las necesidades que tendrán las tituladas y los titulados en cada enseñanza.
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Dedicación: 2h
Aprendizaje autónomo: 2h

Activity 2. Exercises for cameras, optics and acquisition system

Descripción:
This exercise is a questionaire with different problems including concepts of cameras, geometric optics and acquisition systems

Objetivos específicos:
Emphasize and improve the knowledge on optics, cameras and acquisition systems

Material:
Documentation including the problems, questions and systems that the student has to obtain further information

Entregable:
The student has to deliver a report with her answers to the questionnaire

Dedicación: 2h
Aprendizaje autónomo: 2h

Activity 3. Computer Exercise. Contour Detection and Segmentation

Descripción:
The activity consist in implementing a series of contour detection and sigmentation algorithm in practical cases using Python and the OpenCV library

Objetivos específicos:
The objective is to consolidate through a series of computer exercises the methods studied in module 3

Material:
Documentation including the different computer exercises to perform and a series of images to analyze

Entregable:
The student has to deliver a report with the activity performed

Dedicación: 2h
Aprendizaje autónomo: 2h

Activity 4. Computer Exercise. Feature Extraction.

Descripción:
This activity proposes a series of computer exercises to analyze the performance of different algorithm for automatic feature extraction. The computer exercise is proposed in Matlab but students may implement it in any other language if they feel more comfortable

Objetivos específicos:
The objective is to consolidate through a series of computer exercises the methods studied in module 4

Material:
Documentation including the different computer exercises to perform and a series of images to analyze

Entregable:
The student has to deliver a report with the activity performed

Dedicación: 2h
Aprendizaje autónomo: 2h

Activity 5. Computer Exercise. Artificial Neural Networks for Image Classification

Descripción:
The student has to program different architectures of artificial neural networks for recognizing different types of images. The first part of the exercise proposes to classify the MNIST handwritten digit database using 3 different approaches that cover a linear classifier a multilayer perceptron and a convolutional neural network. A second part of the exercise proposes to train and test a CNN to classify fruits.

Objetivos específicos:
The objective is to consolidate through a series of computer exercises the methods studied in module 5

Material:
Documentation including the different computer exercises and databases to perform and a series of images to analyze

Entregable:
The student has to deliver a report with the activity performed

Dedicación: 2h
Aprendizaje autónomo: 2h

Activity 6. Control Exam

Descripción:
This exercise is an exam with questions about modules 1-2-3

Objetivos específicos:
Verify assessment of the first 3 modules

Material:
Question Sheet

Entregable:
After finishing the 90 min session

Dedicación: 1h 30m
Grupo mediano/Prácticas: 1h 30m

Activity 7. Final Exam

Descripción:
This exercise is an exam with questions about all the course

Objetivos específicos:
Verify assessment of the course contents

Material:
Question Sheet

Entregable:
After finishing the exam

Dedicación: 2h
Grupo mediano/Prácticas: 2h

SISTEMA DE CALIFICACIÓN

BIBLIOGRAFÍA

Básica:
- 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 [en línea]. Sebastopol, CA: O'Reilly Media, Inc, [2017] [Consulta: 26/07/2022]. Disponible a: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=4822582. ISBN 9781491962299.