2015/2016

Introduction to Human and Computer Vision

Code: 43085

Credits: 6

Type: OB/OT/TFM Course: 1 Semester: 1

Contact

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Lecturers

Philippe Salembier (Module coordinator)
Ramon Morros (Project coordinator)
David Kane
Marcelo Bertalmío
Javier Ruiz
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Use of languages

Principal working language: English

Prerequisites

Degree in Engineering, Maths, Physics or similar

Objectives and contextualisation

The aim of this module is introduce the students to computer vision including basics of human visual system and image perception, acquisition and processing. In terms of processing, the module deals with low-level pixel-based transforms, linear, nonlinear and morphological filtering, Fourier analysis, multiscale representations, extraction of simple features and image descriptions. Furthermore, elementary grouping, segmentation and classification strategies will be discussed as well as quality and assessment methodologies for image processing algorithms. To put into practice the algorithms and techniques, the students will work on a concrete project along the course. The aim is to provide an applied knowledge of a broad variety of Computer Vision techniques applied to solve a real-world vision problem. The project goal is to detect specific objects in images, in our case traffic signals, using basic CV techniques such as linear and non-linear filtering segmentation, grouping, template matching, modeling, etc. The knowledge obtained can be used in a wide variety of applications, for instance, quality control, generic object detection, security applications, etc.

Skills and learning outcomes

E01 - Identify concepts and apply the most appropriate fundamental techniques for solving basic problems in computer vision.

01 - Relate the basic techniques in computer vision to the processing that takes place in the human visual system human.

02 - Identify and suitably apply the low-level techniques of vision systems, namely the extraction and grouping of characteristics.

E02 - Conceptualise alternatives to complex solutions for vision problems and create prototypes to show the validity of the system proposed.

03 - Identify the best definable representations for extracting and grouping characteristics in specific projects.

E03 - Choose the most suitable software tools and training sets for developing solutions to problems in computer vision.

04 - Choose low-level techniques for detecting and grouping characteristics and train them to resolve a specific project.

E04 - Plan, develop, evaluate and manage solutions for projects in the different areas of computer vision.

05 - Use low-level processing techniques to plan, develop, evaluate and manage a solution to a particular problem.

B06 - Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.

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B07 - Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.

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B10 - Continue the learning process, to a large extent autonomously

08 - Continue the learning process, to a large extent autonomously.

T02 - Understand, analyse and synthesise advanced knowledge in the area, and put forward innovative ideas.

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T03 - Accept responsibilities for information and knowledge management.

10 - Accept responsibilities for information and knowledge management.

T04 - Work in multidisciplinary teams.

11 - Work in multidisciplinary teams.

Content

1. Human visual system and perception
2. Image processing assessment and pixel-based processing
3. Morphological and nonlinear filtering
4. Image formation and color representation
5. Space-frequency representation, Fourier transform and linear filtering (I)
6. Space-frequency representation, Fourier transform and linear filtering (II)
7. Scale-space theory adn multi-scales image processing
8. Feature extraction

Methodology

Supervised sessions:

- **Lecture Sessions**, where the lecturers will explain general contents about the topics. Some of them will be used to solve the problems.

Directed sessions:

- **Project Sessions**, where the problems and goals of the projects will be presented and discussed, students will interact with the project coordinator about problems and ideas on solving the project (approx. 1 hour/week)
- **Presentation Session**, where the students give an oral presentation about how they have solved the project and a demo of the results.
- **Exam Session**, where the students are evaluated individually. Knowledge achievements and problem-solving skills

Autonomous work:

- Student will autonomously study and work with the materials derived from the lectures.
- Student will work in **groups** to solve the problems of the projects with deliverables:
    - Code
    - Reports
    - Oral presentations

Activities

TYPE	ACTIVITY	HOURS	LEARNING OUTCOMES
Supervised			
	Project, Presentation and Exam Sessions	10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Directed			

Lecture Sessions	20	1, 2, 3

Autonomous

Homework	120	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Evaluation

The **final marks** for this module will be computed with the **following formula**:

Final Mark = 0.4 x **Exam** + 0.55 x **Project**+ 0.05 x **Attendance**

where,

Exam: is the mark obtained in the Module Exam (must be >= 3)
Attendance: is the mark derived from the control of attendance at lectures (minimum 70%)
Projects: is the mark provided by the project coordinator based on the weekly follow-up of the project and deliverables. All accordingly with specific criteria such as:

- Participation in discussion sessions and in team work (inter-member evaluations)
- Delivery of mandatory and optional exercises.
- Code development (style, comments, etc.)
- Report (justification of the decisions in your project development)
- Presentation (Talk and demonstrations on your project)

Evaluation activities

TITLE	HOURS	WEIGHTING	LEARNING OUTCOMES
Exam	3	0,4	1, 2, 3, 6, 7, 8, 9, 10
Project	7	0,55	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Bibliography

Books:

1. Rafael C. Gonzalez, Richard E. Woods, *"Digital Image Processing", 3rd Edition.*
2. David Marr, "*Vision: A Computational Investigation into the Human Representation and Processing of Visual Information"*, Freeman, 1982.
3. Richard Szeliski, "*Computer Vision: Algorithms and Applications"*, Springer-Verlag New York, Inc. New York, USA 2010.