Universitat Autònoma de Barcelona

2022/2023

Computer-Vision Systems

Code: 104368
ECTS Credits: 6

Degree	Type	Year	Semester
2503758 Data Engineering	OT	4	2

Contact

Name: Daniel Ponsa Mussarra
Email: daniel.ponsa@uab.cat

Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Prerequisites

The course has no prerequisites. However, its contents extend and complement those previously seen in the subjects of "Signal, image and video processing" and "Neural networks and deep learning", which must be mastered. Likewise, in the course different vision systems will be developed, for which it is necessary to have a good level of programming in Python.

Objectives and Contextualisation

The training objectives of the subject are:

- Depening the design of computer vision systems, given a specific problem to be solved.
- Identifying the necessary data that must be captured to develop a system, as well as the appropriate metrics to analyze its performance.
- Knowing the main open software libraries to develop both traditional vision systems and those based on deep learning.
- Acquiring practical experience in the application of state-of-the-art techniques for the extraction of knowledge from the data of a computer vision system.

Competences

- Conceive, design and implement smart systems for autonomous leaning and predictive capacity systems.
- Conceive, design and implement the most appropriate data acquisition system for the specific problem to be solved.
- Demonstrate sensitivity towards ethical, social and environmental topics.
- Prevent and solve problems, adapt to unforeseen situations and take decisions.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.

Learning Outcomes

1. Choose and interpret the most suitable predictive models for environmental management in Smart Cities.
2. Demonstrate sensitivity towards ethical, social and environmental topics.
3. Design the most efficient data acquisition system for a system to support autonomous driving.
4. Prevent and solve problems, adapt to unforeseen situations and take decisions.
5. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
6. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.

Content

- Introduction to Computer Vision systems
- Cameras
- Optics
- Ilumination
- Monocular systems
- Stereo systems and range sensors
- Multiview systems
- Robust estimators
- Super-resolution
- Image fusion: Pan-sharpening

Methodology

The different activities that will be carried out in the subject are organized as follows:

Theory sessions: The basic concepts of the subject are exposed and indications are given on how to complete and deepen this content. Activities are carried out in the classroom, some of which must be previously prepared in autonomous work.

Problem sessions: The topics seen in the theory sessions are extended in a practical way. Problems are solved and case studies are discussed. With the proposed activities, autonomous and cooperative work is promoted, the capacity for analysis and synthesis, critical reasoning, and the student is trained in problem solving.

Practices: During the course practical work is carried out in groups of 2 people (exceptionally 1 or 3). Challenge-projects are proposed where the group applies techniques worked on in theory and problems sessions, as well as other state-of-the-art proposals that the group selects and tests.

General considerations
The 'Campus virtual' platform will be used to disseminate information to students. The dates of continuous evaluation and delivery of works will be published through this medium, and may be subject to possible programming changes for reasons of adaptation to possible incidents. 'Campus virtual' will be used to inform about these possible changes, since this is the platform for the exchange of information between the teaching staff and the students.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			

Assessment Test	4	0.16	2, 6, 5
Practical work sessions	12	0.48	2, 3, 1, 4
Problem sessions	12	0.48	4, 6
Theory Sessions	22	0.88	6, 5
Type: Supervised			
Preparation of practical work projects	36	1.44	2, 3, 1, 4
Problem solving outside the classroom	12	0.48	4, 6
Type: Autonomous			
Study	50	2	6, 5
Tutoring and consultation	2	0.08	6

Assessment

a) Programmed evaluation process and activities

The evaluation of the subject will be carried out continuously from the learning evidences collected in the following processes:

- [E1]. Written tests (exams).
- [E2]. Resolution and delivery of questionnaires and exercises proposed in the theory and problem sessions.
- [E3]. Carrying out projects (practice) evaluated from different activities and deliveries.

The course consists of the following assessment activities, each assessed with a grade between 0 and 10 (both inclusive):

- [E1]-ExP1, midterm exam 1, 25% on the final grade.
- [E1]-ExP2, midterm exam 2, 25% on the final grade.
- [E2]-Prob, resolution of exercises proposed in the theory and problem sessions, 10% on the final grade.
- [E3]-Prac1, practical activities related to block 1, 20% on the final grade.
- [E3]-Prac2, practical activities related to block 2, 20% on the final grade.

In order to pass the course through continuous assessment, you will have to get a grade equal to or greater than 5 in the following 2 expressions.

- (0,5*Nota[E1]-ExP1) + (0,5*Nota[E1]-ExP2) + (0,1*Nota[E2]-Prob)
- (0,25*Nota[E1]-ExP1) + (0,25*Nota[E1]-ExP2) + (0,1*Nota[E2]-Prob) + (0,2*Nota[E3]-Prac1) + (0,2*Nota[E3]-Prac2)

Keep in mind that:

- if the first condition to pass is not passed, the result of its expression will be assigned as the final grade for the subject.
- the exercises that make up the activity [E2]-Prob must be delivered within an established period, and will be evaluated with a mark between 0 and 10 (both inclusive). Exercises not delivered within their deadline will be evaluated with a grade of 0 and cannot be recovered.
- activities [E3]-Prac1 and [E3]-Prac2 will be evaluated based on different proposed sub-activities, which will have an established deadline for completion and delivery. Each subactivity willbeevaluated with a score between 0 and 10 (both inclusive). Sub-activities not carried out or delivered after their deadline will be evaluated with a score of 0 and cannot be recovered.

In case of irregularities in the evaluation activities, what is detailed in section f) will be applied.

It is important to bear in mind that evaluation activities will not be carried out on a date or time other than that established, except for justified reasons, duly informed in advance to the teaching staff.

b) Programming of evaluation activities

The calendar of the different evaluation activities is detailed in the 'Campus Virtual' platform, in the Moodle classroom of l'assignatura. The dates of completion of the written tests (activitats [E1]-ExP1 and [E1]-ExP2) will also be made public on the website of the School of Engineering, in the exams section.

c) Recovery process

The only recoverable evaluation activities are the written tests [E1]-ExP1 and [E1]-ExP2.

The student has the option to improve the grades of these tests (one of them, or both) provided he/she has been evaluated in a set of activities that represent a minimum of two thirds of the total grade of the subject.

In order to compute the final grade of the subject, the mark obtained in the recovery exam will replace the one of the corresponding exam carried out in the continuous assessment.

In accordance with the coordination of the Degree and the direction of the School of Engineering, the following activities cannot be recovered:

- [E2]-Prob, 10% on the final grade.
- [E3]-Prac1, 20% on the final grade.
- [E3]-Prac2, 20% on the final grade.

d) Procedure for the review of qualifications

For assessment activities based on written tests ([E1]-ExP1 and [E1]-ExP2), a procedure for booking a revision date ant time will be established in which the student will be able to review the activity with the teaching staff. In this context, claims can be made about the activity grade, which will be evaluated by the teachers responsible for the subject. Likewise, it is possible to arrange with the teaching staff the review of the rest of the assessment activities up to two weeks before the recovery exams.

e) Special qualifications

If the student has not performed any of the tests [E1] -ExP1 and [E1] -ExP2 the "Non-assessable" grade will be assigned. It must be remarked that according to current regulations "Non-assessable" qualifications also exhaust convocation.

As many honors registrations will be assigned as the current regulations allow, as long as the grade is higher than 9.0. The assignment of the registrations will be done following the order of grades. In the event of a tie, the results of the partial tests will be taken into account and, if necessary, supplementary activities will be proposed to determine who is awarded the honor roll.

f) Irregularities by the student, copy and plagiarism.

Notwithstanding other disciplinary measures deemed appropriate, assessment activities will receive a zero whenever a student commits academic irregularities that may alter such assessment. Therefore, copying, plagiarizing, cheating, ... in any of the assessment activities will imply suspending it with a zero.

g) Evaluation of repeater students
From the second enrollment, repeater students may request to validate the evaluation of the activities [E3]-Prac1 and [E3]-Prac2, taking the grade obtained the first time the student has enrolled in the subject. In order to be able to opt for this differentiated evaluation, repeater students must ask the faculty through an email.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
[E1]-ExP1: Partial Exam 1	25%	0	0	2, 6, 5
[E1]-ExP2: Partial Exam 2	25%	0	0	2, 6, 5
[E2]-Prob: Delivered activities	10%	0	0	4, 6
[E3]-Prac1: Practical work block 1	20%	0	0	2, 3, 1, 4
[E3]-Prac2: Practical work block 2	20%	0	0	2, 3, 1, 4

Bibliography

- Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition. Springer (Texts in computer Science) 2021. (http://szeliski.org/Book/)
- Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016. (http://www.deeplearningbook.org)
- Adrian Kaehler, Gary Bradsky, Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library, O'Reilly, 2016.
- Aurélien Géron, Hands-On Machine Learning with Scikit-Learn & TensorFlow, O'Reilly, 2017.
- Eli Stevens, Luca Antiga, Thomas Viehmann, Deep learning with Pytorch, Manning Publications, 2020 (https://pytorch.org/assets/deep-learning/Deep-Learning-with-PyTorch.pdf)
- François Chollet, Deep learning with Python, Manning Publications, 2021 (https://github.com/fchollet/deep-learning-with-python-notebooks)

Software

To develop different computer vision systems, both in practice and in problems sessions, the Python programming language will be used, working with Jupyter Notebooks.