# Computer Vision

Code: 104423
ECTS Credits: 6

2025/2026

| Degree | Type | Year |
|---|---|---|
| Computational Mathematics and Data Analytics | OP | 4 |

## Contact

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## Teachers

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## Teaching groups languages

You can view this information at the end of this document.

## Prerequisites

There are no prerequisites. This course is fairly self-contained. However, in this course will touch topics related to mathematical calculations, probability and signal theory, on the other hand, problems and practices in many cases will be small programs, so it is necessary a good foundation in mathematics and in programming.

## Objectives and Contextualisation

The objectives of the subject can be summarized in:

Knowledge:

Know, understand and know how to model the acquisition with different sensors, especially with cameras.
Describe and relate the phases in which the solution is divided to a problem of analysis of signal processing.
Identify the advantages and disadvantages of image processing algorithms.
Solve real problems related to image processing techniques.
Understand the result and limitations of vision techniques in different case studies.
Know how to choose the most suitable image processing algorithm to solve a given task.
Knowing how to choose the most appropriate computer vision techniques to solve contextualized problems.

Skills:

Recognize situations in which the application of image processing algorithms may be adequate to solve a problem.

Analyze the problem to solve and design the optimal solution applying the techniques learned.
Write technical documents related to the analysis and solution of a problem.
Program the basic algorithms to solve the proposed problems.
Evaluate the results of the implemented solution and evaluate the possible improvements.
Defend and argue the decisions made in the solution of the proposed problems.

## Learning Outcomes

1. CM45 (Competence) Extract shape descriptors from objects present in a scene.
2. CM46 (Competence) Efficiently integrate heterogeneous data from various interconnected devices and systems.
3. SM45 (Skill) Apply basic image processing methods to specific problems.
4. SM46 (Skill) Develop computer vision applications to solve basic image and video analysis problems.

## Content

1. Introduction to signal, image and video processing
2. Image formation
3. Image processing
4. Linear (spatial) filtering
5. Frequency filtering
6. Non-linear filtering
7. Geometric transformations
8. Segmentation
9. Features
10. Classification
11. Miscellany (applications, movement)
12. Deep Learning

## Activities and Methodology

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Laboratori classes | 10 | 0.4 | CM45, CM46, SM45, SM46, CM45 |
| Master class | 20 | 0.8 | CM45, CM46, SM45, SM46, CM45 |
| Problem seminars | 11.5 | 0.46 | CM45, CM46, SM45, SM46, CM45 |
| Type: Supervised | | | |
| Analysis and design of the project | 12 | 0.48 | CM45, CM46, SM45, SM46, CM45 |
| Project documentation | 6 | 0.24 | CM45, CM46, SM45, SM46, CM45 |
| Type: Autonomous | | | |
| Individual study | 45 | 1.8 | CM45, CM46, SM45, SM46, CM45 |

| | | | |
|---|---|---|---|
| Oral presentation | 12 | 0.48 | CM45, CM46, SM45, SM46, CM45 |
| Project programming | 25 | 1 | CM45, CM46, SM45, SM46, CM45 |

The different activities that will be carried out in this course are organized as follows:

Master classes

The main concepts and algorithms of each theoretical subject will be exposed. These subjects represent the starting point in the work of the subject.

Problem seminars

They will be classes with small groups of students that facilitate the interaction. In these classes, practical cases will be considered that require the design of a solution in which the methods seen in the theory classes are used.

Laboratory practices

There will be a series of common practices that will allow you to acquire basic skills in terms of vision. First delivery to know the tools. Three thematic practices closely related to the theory that is being given at the same time or before. Finally a project chosen by the students themselves. In the second part of the semester they will have to analyze this problem, design and implement solutions based on different process and vision algorithms seen in class, analyze the results obtained in each one of the methods, defend their solution and make the results publicly available .

The work groups will be formed by groups of 1 to 3 students formed in the second week of the course. These work groups must be maintained until the end of the course and they must be self-managed: role play, work planning, assignment of tasks, management of available resources, conflicts, etc. Although the teacher will guide the learning process, his intervention in the management of the groups will be minimal.

In order to develop the project, the groups will work independently and the practice sessions will be devoted mainly to solving doubts with the teacher that will monitor the project status, indicate errors to correct, propose improvements, etc.

Some of the sessions will be marked as control sessions where a practice should be handed out. In these sessions the groups will have to explain the work done and the teacher will ask questions to all the members of the group to evaluate the work done. Attendance at these sessions is mandatory.

In the final delivery, the groups will present a presentation of the project explaining the project developed, the solution adopted and the results obtained. In this presentation each member of the group will have to do a part of the presentation.

The code of common practices will be developed in Matlab and Python language. The part of the project will be free to choose by the students.

Virtual teaching platform:

Caronte will be the platform that we will use for communication and delivery of tasks as well as storage of all teaching material.

Attendance:

Theory: recommended, Problems: recommended, Practices: mandatory, Project monitoring: recommended, Project controls: mandatory, Project presentation: mandatory.

Transversal competences:

T02.01 - Work autonomously.
T02.03 - Manage time and resources available. Work in an organized way.
T03.01 - Work cooperatively.
T04.01 - Communicate efficiently, orally and / or written, knowledge, results and abilities, both in professional environments and in non-expert public.

The Transversal Competences linked to T02 are evaluated in theory and problems classes. There is no specific part of the mark for autonomous work and time management because it is implicit in how to work. Both the theory and the problems, such as Lab0, are the parts of the subject that the student has to do individually (T02.01) and the problems and the Lab0 have associated goals and delivery dates that would be in the Line marked at (T02.03). Those linked to T03 and T04 work and are evaluated in the practical part. A part of the final project note reflects how the student is expressed in public when transmitting the results of his work (T04.01), another part of the note in this final project evaluates the writing of the project support material (T04.01). The Lab1, Lab2, Lab3 and Project are grouped and reinforce the cooperative work competencies (T3.01).

Use of AI (permitted): In this course, the use of Artificial Intelligence (AI) technologies is permitted as an integral part of the assignment, provided that the final result reflects a significant contribution by the student in the analysis and personal reflection. Students must clearly identify which parts were generated with this technology, specify the tools used, and include a critical reflection on how they influenced the process and the final result of the assignment. Lack of transparency in the use of AI will be considered a breach of academic honesty and may result in a penalty on the assignment grade, or greater sanctions in serious cases.

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.

## Assessment

## Continous Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|---|---|---|---|---|
| Group evaluation | 10 | 0.25 | 0.01 | CM45, CM46, SM45, SM46 |
| Labs | 20 | 2 | 0.08 | CM45, CM46, SM45, SM46 |
| Project presentation | 10 | 0.25 | 0.01 | CM45, CM46, SM45, SM46 |
| Pruebas teóricas individuales | 60 | 6 | 0.24 | CM45, CM46, SM45, SM46 |

Activities and evaluation instruments:

CONTINOUS ASSESSMENT.

The student sees at all times his evolution to the subject and how to reach the different objectives of practices, problems and theory.

There are two different blocks: Block 1 is related to Signal and Image Processing (assessed with an exam) and Block 2 is related to Computer Vision (assessed with ABP [Project-Based Learning])

Additionally, there are optional elements to raise a grade: tests, challenges, lab3

BLOCK1

- Theoretical knowledge

The final theory grade will be calculated from the score of one test: Theory grade Block1

These tests aim at an individualized evaluation of the student with his abilities to solve problems using the techniques explained in class as well as to evaluate the level of conceptualization that the student has made of the techniques seen.

Recovery (theory). If the student wants to upload a grade or recover, he/she can take the final exam.

Optional (theory). Weekly tests of between 5 and 15 test questions

- Problems

The problems are 3 or 4 exercises that will be evaluated along with the theory tests since the problems complement the theory: Problem grade Block 1

Recovery (problems). If the student wants to upload a grade or recover, he/she can take the final exam divided into two blocks.

Optional (problems). Weekly challenges consist of a longer problem to hand in as a mini report.

- Practices

The practical part is a series of small projects. The evaluation of this part will include:

Individual evaluationof Lab0 thatintroduces the work tools that will be used in the practices. Also, the exhibition parts of the final project are evaluated individually.
Joint evaluation of the practices: single marks for all members of the working group that will assess the results obtained and the quality of the code.
Evaluation of the project that will assess, the objectives achieved both by the group and individually, the results obtained and the presentation.

The grade of this part will be calculated according to the formula:

Practices grade = 0.2 Lab0 + 0.4 Lab1 + 0.4 Lab2

Recovery (practices). The recovery of this part will consist of the delivery of the material not delivered before but with a multiplying factor of 0.8.

Optional (practices). Lab3

BLOCK 2

Project in groups of 3 people that will be the central axis of the second half of the course. PBL (project-based learning) will be applied. A part of the note will be given by the rest of the group members and by the rest of the class.

Recovery. If the student wants to recover, he/she can take a special final exam on this part.

Final Grade (continuous assessment)

The Final Grade of the subject is obtained by combining the evaluation of these activities in the following way:

Final grade = 0.5 ( 0.25 Theory grade Block 1 + 0.35 Problems grade Block 1+ 0.4 Practice grade) + 0.5 Block 2

UNIQUE ASSESSMENT.

In the event that you wish to opt for the Unique Assessment, the material related to the laboratories must be presented in person before the final exams, or on the same day of the exam. The theory and problems grades will come out of the exams.

There will also be an option to get extra marks only for the problem challenges.

Those who wish to opt for this type of assessment must request it in advance, at least one week before the final exam (2nd midterm).

Final Grade (unique assessment)

The Final Grade in the single assessment of the subject is obtained by combining the assessment of these activities as follows:

Final Grade = 0.15 Theory grade Block 1 + 0.15 Theory grade Block 2 + 0.15 Problems grade Block 1 + 0.15 Pro

Final evaluation

The final grade that will appear in the expedient file, except for specific cases of copying and plagiarism or "Not evaluable", will be the result of applying the formula Final grade, also for cases of failure.

Grad with honours(MH) will be given to the people with the best grade above 9, ordered in order of arrival to that mark and there will be as many as can be given by the enrollment ratio.

Students who do not participate in any of the different evaluable elements (tests, challenges, exams, practices) will receive a "Not Evaluable" grade.

Terms:

If the student presents a partial exam or if he/she presents himself/herself to a practice control session, he/she can no longer be evaluated as "Not evaluable" in case he/she does not attend the other evaluations, but the note will be calculated. final from those continuous evaluations to whichit has been submitted.

Clarifications:

4.9 is the minimum mark to pass.

In the case of repeating students, the practices of the previous year, if the theme is maintained, may be resubmitted. This means not a direct validation but they have to defend themselves in a single interview with the internship teacher. The rest of the evaluation activities (theory and problems) have to be re-evaluated in the established way.

The dates for continuous evaluation and submission of papers will be published on the web page of the subject

or in Catonte and may be subject to programming changes for reasons of adaptation to possible incidents; always be informed on the web page of the subject or Caront on these changes, since it is understood that the website of the subject or Caronte is the usual mechanisms of exchange of information between teacher and students.

For each evaluation activity, a place, date and time of revision in which the student can review the activity with the teacher will be indicated. In this context, claims may be made on the activity grade, which will be evaluated by the faculty responsible for the subject. If the student does not appear in this review, this activity will not be reviewed later.

Without prejudice to other disciplinary measures deemed appropriate, and in accordance with current academic regulations, irregularities committed by a student that may lead to a variation of the grade will be scored with a zero (0). The evaluation activities qualified in this way and by this procedure will not be recoverable. If it is necessary to pass any of these evaluation activities to pass the subject, this subject will be suspended directly, without the opportunity to recover it in the same course. These irregularities include, among others:
- the total or partial copy of a practice, report, or any other evaluation activity;
- let copy;
- present a group work not done entirely by the members of the group;
- presentation materials prepared by a third party, even if they are translations or adaptations, and in general works with non-original and exclusive elements of the student;
- have communication devices (such as mobile phones, smart watches, etc.) accessible during the theoretical evaluation-individual practices (exams).
The numerical note of the file will be the lower value between 3.0 and the weighted average of the marks in case the student has committed irregularities in an evaluation act (and therefore the approval by compensation will not be possible).
In summary: copying, leaving a copy or plagiarising in any of the evaluation activities is equivalent to a FAIL with a grade lower than 3.5.

## Bibliography

Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing (3rd Edition), Prentice Hall 2007.
Simon J.D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.(http://www.computervisionmodels.com/)
David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach (2nd Edition), Prentice Hall 2011.
Richard Szeliski, Computer Vision: Algorithms and Applications, Springer (Texts in computer Science) 2011. (http://szeliski.org/Book/)
Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016. (http://www.deeplearningbook.org)
Aurélien Géron, Hands-On Machine Learning with Scikit-Learn & TensorFlow, O'Reilly, 2017.

Similar and complementary online courses

Online course (MOOC Coursera): Image and video processing: From Mars to Hollywood with a stop at the hospital. (https://www.coursera.org/course/images)
Online course (MOOC Coursera): Detección de objetos (UAB). (https://www.coursera.org/learn/deteccion-objetos)
Online course (MOOC Coursera): Fundamentos del Procesamiento de Vídeo e Imagen Digital. (https://www.coursera.org/course/digital)
Online course (MOOC Coursera): Clasificación de imágenes: ¿cómo reconocer el contenido de una imagen? (UAB). (https://www.coursera.org/learn/clasificacion-imagenes)
Online course (MOOC Edx ): Introducción a la visión por computador: desarrollo de aplicaciones con OpenCV. (https://www.edx.org/course/introduccion-la-vision-por-computador-uc3mx-isa-1x)
Online course (MOOC Coursera): Machine Learning. (https://es.coursera.org/learn/machine-learning)

## Software

MatLab

Python

## Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

| Name | Group | Language | Semester | Turn |
|---|---|---|---|---|
| (PAUL) Classroom practices | 441 | Spanish | second semester | morning-mixed |
| (PAUL) Classroom practices | 442 | Spanish | second semester | morning-mixed |
| (PLAB) Practical laboratories | 441 | Catalan | second semester | morning-mixed |
| (PLAB) Practical laboratories | 442 | Catalan | second semester | morning-mixed |
| (PLAB) Practical laboratories | 443 | Catalan | second semester | morning-mixed |
| (PLAB) Practical laboratories | 444 | Catalan | second semester | morning-mixed |
| (TE) Theory | 440 | Spanish | second semester | morning-mixed |