**Academic Year/course: 2024/25**

# 69151 - Computer Vision

## Syllabus Information

**Academic year:** 2024/25
**Subject:** 69151 - Computer Vision
**Faculty / School:** 110 - Escuela de Ingeniería y Arquitectura
**Degree:** 615 - Máster Universitario en Robótica, Gráficos y Visión por Computador / Robotics, Graphics and Computer Vision
**ECTS:** 6.0
**Year:** 1
**Semester:** First semester
**Subject type:** Compulsory
**Module:**

## 1. General information

The objective is the computational processing of images or digital video sequences for the inference of geometric properties, both for the observed 3D scene and for the trajectory that the camera follows during the filming of the images.

The methodology is based on a first understanding of the fundamentals through their mathematical, probabilistic, and algorithmic modelling. In a second stage, the design and implementation of algorithms in standard programming environments are addressed. The performance is evaluated by the processing of real images.

## 2. Learning results

1. Knowing the parametrization and the mathematical models of the image formation with 3D projective cameras, both in their geometric and photometric aspects.
2. Knowing the algorithms of image processing and image feature detection.
3. Knowing the formulation of multi-view geometry and the estimation of 3D information from projective images.
4. Knowing the formulation of stereo correspondences and optical flow.
5. Knowing specific models and algorithms for omnidirectional vision.
6. Designing and developing systems that make inferences about the 3D structure of the scene from images.
7. Evaluating the performance of computer vision systems in operation.
8. Proposing new algorithms that address unresolved aspects of the operation of a 3D vision system and the evaluation of its performance.
9. Development of software that processes real images using the most popular libraries of computer vision, mathematical operations and non-linear optimization.

## 3. Syllabus

Lectures

1. Image formation and image processing.
2. Local feature detection and matching.
3. Geometric camera model and calibration.
4. Two-view geometry.
5. Structure from motion and bundle adjustment.
6. Omnidirectinal vision.
7. Photometric camera model.
8. Dense motion estimation. Optical flow and stereo correspondence.
9. Multiview stereo and NeRF.
10. Photometric bundle adjustment.

Laboratory practices

1. 2D and 3D geometry.
2. H and F from camera motion. Two view SfM.
3. Robust F and H. Guided Matching.
4. Bundle Adjustment and multiview geometry.
5. Omnidirectional vision.
6. Optical Flow.

## 4. Academic activities

A01 Lectures (38 hours) Theoretical sessions devoted to concepts and foundations.

A02 Practice sessions (4 hours) Basic drills on the concepts of the course.

A03 Laboratory practices (18 hours) Exercises of medium complexity combining theoretical concepts with standard computer vision libraries, producing software able to process real image sequences.

A07 Autonomous work (83 hours) The autonomous work of the student.

A08 Assessment (7 hours). Assessment activities to present the outcome of the assignments.

## 5. Assessment system

A continuous assessment system is applied. It is composed of the following assessment activities programmed throughout the course:

E01 -Laboratory tests/interviews, in which each practice session is assessed (30%). The understanding of the theoretical foundations, the ability to produce an efficient implementation and experimental validation will be considered.

E02 -Course assignment, a project which globally combines the contents of the course (70%). - The student faces a new problem, the assessment criteria are:

1. Ability to tackle new situations using the course theoretical contents and algorithms.
2. Implementation efficiency.
3. Experimental validation.
4. Presentation of the results in an oral talk and/or a written report.

Students will also be able to pass the course through a global assessment carried out on the day designated by the school, passing the same activities above mentioned in the continuous assessment.

## 6. Sustainable Development Goals

9 - Industry, Innovation and Infrastructure