Universidad Zaragoza

**Year : 2020/21**

# 29847 - Computer Vision

## Syllabus Information

**Academic Year:** 2020/21
**Subject:** 29847 - Computer Vision
**Faculty / School:** 110 - Escuela de Ingeniería y Arquitectura
326 - Escuela Universitaria Politécnica de Teruel
**Degree:** 440 - Bachelor's Degree in Electronic and Automatic Engineering
444 - Bachelor's Degree in Electronic and Automatic Engineering
**ECTS:** 6.0
**Year:** 4
**Semester:** 440 - Second semester
444 - Second semester
**Subject Type:** Optional
**Module:** ---

# 1.General information

## 1.1.Aims of the course

This Computer Vision course aims to provide the student with an overview of the digital image processing process. It begins with the description of the image acquisition theory, stopping briefly in the formation of images in human beings, to analyze in more detail the operation of optical systems and the digitization process. Students must understand the main parameters in this acquisition process, as well as the physical magnitudes associated with an image.

Next, we work on the tasks of segmentation or extraction of information from the image. For this, it is important to remember the different transformation algorithms both in the spatial domain and in the transformed domain. In addition to edge and region detection tasks, simple image enhancement and smoothing algorithms will be introduced to increase image quality before tackling the segmentation process.

From the information obtained in the segmentation process, the appropriate descriptors for a set of generic applications will be described, specifically the case of recognition of 3-D objects will be analyzed.

The methodology to be used seeks the acquisition and evaluation of competences on a continuous basis. To do this, students will work on real images acquired by them on which to apply the processes of quality improvement, segmentation and obtaining descriptors at the same time as the algorithms are explained in the lectures.

## 1.2.Context and importance of this course in the degree

It is a 6 ECTS optional course that is taught in the second semester of the fourth year.

The course is oriented to equip the student with the basic competences that allow him to extract information from digital images. These can be used in the design and development of electronic and control systems in industrial work environments, a key competence of the Degree of Electronic and Automatic Engineering. Furthermore, the competences associated with this subject can be applied to other fields such as medicine or security that may be of interest to new graduates.

## 1.3.Recommendations to take this course

This Computer Vision course requires basic knowledge of mathematics, statistics, computer programming and signal processing (bachelor level).

Active attendance at theory and laboratory sessions is strongly recommended, as well as a continuous study of the theoretical and practical contents of the subject. It is also very important to handle with ease the computer tools that will be used for the digital processing of the images, in order to understand and visualize the different image transformations and to do the different tasks that are necessary for the evaluation process.

Continued work is essential to get the most out of this subject. When doubts arise, it is important to resolve them as soon as possible to guarantee correct progress in this matter. To help them solve their doubts, the student has the advice of the teacher, both during classes and in the tutoring hours specially designed for it.

# 2.Learning goals

## 2.1.Competences

BASIC SKILLS:

1. That the students know how to apply their knowledge to their work or vocation in a professional manner and acquire the

competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.

2. That students can transmit information, ideas, problems and solutions to both specialized and non-specialized audiences.

3. That students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

TRANSVERSAL COMPETENCES:

1. Ability to solve problems and make decisions with initiative, creativity and critical reasoning.

2. Ability to use the engineering techniques, skills and tools that are necessary in practical engineering tasks.

3. Ability to apply information and communication technologies in engineering tasks.

SPECIFIC COMPETENCES

1. Knowledge and capacity for modeling and simulating systems.

2. Applied knowledge of industrial computing and communications.

### 2.2.Learning goals

Knows and interprets the main parameters that describe the information in an image, its acquisition and storage.
Knows and applies digital image processing techniques.
Applies pattern recognition and classification methods and uses such information to control a system.
She/he is capable of recovering three-dimensional information from two-dimensional images and of using such information to control a system.
Uses basic digital image analysis and processing software.

### 2.3.Importance of learning goals

The learning results of the course are important for those students who want to specialize in digital image processing, whose main objectives are to improve the quality of images for human perception or to process and extract relevant information from these images for automatic machine perception.

## 3.Assessment (1st and 2nd call)

### 3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

**ZARAGOZA CAMPUS:**

In accordance with the regulations of the University of Zaragoza, the student may choose between continuous and global evaluation of their learning process. The course is passed with an overall rating of 5 points over 10.

Continuous assessment.

Oral presentations of practical laboratory sessions 1, 2, 4 and 5 will be made in the session immediately after each one. The weighting of this part of the evaluation will be 10% of the global mark.

Oral presentations of 2 course assignments will be made, which will be a continuation of the work in laboratory sessions 3 and 6. These course assignments will weigh 90% of the final grade (45% each).

Overall evaluation.

Oral presentations of 2 course assignments will be made, which will be a continuation of the work in laboratory sessions 3 and 6. These course assignments will weigh 90% of the final grade (50% each).

**TERUEL CAMPUS:**

1. Regular evaluation.

The summative evaluation will be continuous and will have three contributions:

Throughout the semester a series of individual activities will be carried out, one for each of the subjects of the course, which will lead to a series of assignments in different formats that the student must complete within the indicated deadlines. Part of these works corresponds to the resolution of tasks in the classroom. This work represents 20% of the grade.

There will be 7 laboratory sessions in which the students must demonstrate that they have acquired the different course skills and are able to apply them in similar assignments. This work represents 20% in the final grade of the subject.

By completing a final work in which most of the course contents will be applied, we will evaluate the application of fundamental computer vision concepts to a real case using a different tool than the one used in the lectures and laboratory sessions. This work represents the remaining 60% of the global grade.

All the proposed activities must be carried out and passed with a score of at least 4 out of 10 points to be able to qualify for the continuous evaluation process. The overall grade resulting from all completed tasks must be higher than 50% of the possible grade.

2. Evaluation by single test.

The students not choosing the continuous evaluation, not passing the course by this procedure or those who would like to improve his grade, will have the right for a global test, prevailing, in any case, the best of the grades obtained.

In this test the student must answer a series of theoretical questions associated with the basic concepts of the subject (1 hour).

Subsequently, the students must demonstrate in the laboratory that is able to complete the tasks of processing and extracting information from a digital image (3 hours). In addition, she/he must submit the final work proposed in the ordinary evaluation.

# 4.Methodology, learning tasks, syllabus and resources

## 4.1.Methodological overview

**The learning process designed so that students can pass the subject is based on the following tasks:**

- Classroom sessions where the lecturer explains the main theoretical concepts and will illustrate the application of this theoretical material via exercises and cases. Active students' participation is intended. So, they will continuously work with a computer applying the explained image processing functions and concepts to digital images.
- Laboratory sessions every two weeks. Students will carry out practical tasks related to their learning skills. They will work individually (one student-one computer) but they can exchange their views on the questions proposed so that they can discover knowledge collaboratively. The assessment of this activity will contribute to the final mark.
- Supervised projects. Students must solve a set of exercises or practical questions related to the concepts learned. They are used as formative and summative assessments.
- Student personal work essential to achieve significant learning and to have success with all the assessment activities proposed.

## 4.2.Learning tasks

**The course includes the following learning tasks:**

**ZARAGOZA CAMPUS:**

1.- Lectures (30 hours) The theoretical concepts and their application via exercises and cases are explained by the lecturer. Students are encouraged to take part actively in the resolution of practical questions. In this way, they will assimilate the learning concepts building their own knowledge. The concepts worked upon this in-face sessions are aligned to the thematic blocks described in ***5.3 Program***.

2. Laboratory sessions (6x3=18 hours) Students carry out experimental tasks following the information provided in the lab session instructions. It is very advisable to understand this information before attending to the laboratory room. Every student must produce a report on the activity after the end of the session.

3. Supervised projects (24 hours)

Lab exercise includes optional sections to be developed by the student after the sessions.

4. Personal work (75 hours)

It is very important for the student to work in a continuous and independent way on the understanding of the theoretical concepts, the resolution of exercises and cases and the writing of the lab and the project reports. Students must also learn how to use the software tools chosen to process digital images.

5. Tutorials

The lecturer allocates a tutorial timetable. All the students can solve doubts related to the subject at these specific hours.

6. Assessment (3 hours)

Written exam (2 hours). Oral talk for 1 hour.

**TERUEL CAMPUS**

1. Lectures (45 hours)

The theoretical concepts and their application via exercises and cases are explained by the lecturer. Students are encouraged to take part actively in the resolution of practical questions. In this way, they will assimilate the learning concepts building their own knowledge.

The concepts worked upon this in-face sessions are aligned to the thematic blocks described in ***4.3 Syllabus***.

2. Laboratory sessions (14 hours)

Students carry out experimental tasks following the information provided in the lab session instructions. It is very advisable to understand this information before attending to the laboratory session. Every student must produce a report on the activity after the end of the session.

With these activities, students will train the skills required to carry out the final project of the subject.

3. Supervised projects (60 hours)

The teacher proposes a set of practical exercises that students must solve individually providing a reasoned report with the achieved results.

These activities cover all the contents of the subject from image acquisition to characteristics extraction.

4. Personal work (30 hours)

It is very important for the student to work in a continuous and independent way on the understanding of the theoretical concepts, the resolution of exercises and cases and the writing of the lab and the project reports. Students must also learn how to use the software tools chosen to process digital images.

5. Tutorials

The lecturer allocates a tutorial timetable. All the students can solve doubts related to the subject at these specific hours.

6. Assessment (1 hour)

Students have to explain their final project to the teacher who could ask them different questions about the work. However, a continuous formative and summative assessment takes place during the whole semester by means of the laboratory sessions and the supervised projects. In this way, students can check their learning during the progress of the course.

## 4.3.Syllabus

**The course will address the following topics:**

**ZARAGOZA CAMPUS**

1. Acquisition and Image Processing.
2. Feature detection.
3. Segmentation.
4. 3D camera model.
5. Image alignment homography and epipolar geometry.
6. Structure from Motion. Bundle Adjustment.
7. Automatic learning. Basic concepts.
8. Visual recognition.

**Practice Sessions**

1. Open CV. Acquisition and Image Processing.
2. Interest point detection. Descriptors and putative matching.
3. Geometry estimation: homography and epipolar geometry.
4. Image segmentation.
5. Basic visual recognition.
6. Advanced visual recognition.

**TERUEL CAMPUS**

1. Introduction to computer vision.
2. Image. Basic concepts.
3. Image improvement. Preprocessing
4. Image segmentation. Edge detection and region extraction.
5. Description. Features and keypoints extraction.
6. Applications
7. Introduction to 3-D image

## 4.4.Course planning and calendar

The schedule of lectures, practice sessions and laboratory sessions is decided upon by the university centre and will be published before the beginning of the course.

Every teacher will inform about his/her tutorial timetable.

## 4.5.Bibliography and recommended resources