Universidad Zaragoza

Academic Year/course: 2021/22

69157 - Virtual Reality

Syllabus Information

Academic Year: 2021/22
Subject: 69157 - Virtual Reality
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 615 - Master's in Robotics, Graphics and Computer Vision/ Robótica, Gráficos y Visión por Computador
ECTS: 3.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

With a strong applied character, upon successful completion of the course, each student should have achieved the following objectives:

- Multidisciplinary understanding of the scientific basis of the area of virtual reality and its industrial and scientific applications. Knowledge of its evolution, state-of-the-art and open problems.
- Know how to transmit the knowledge acquired to an audience of any kind adapting himself to the peculiarities of that audience.
- Be able to work both in an autonomous manner and in team, taking responsibilities.
- Be able to carry out the projection, calculation and design of solutions to specific problems.
- Be able to plan and work out R+D+I projects.
- Know how to design hardware and software solutions.
- Have knowledge of tools and methodologies.
- Be able carry out the creation and exploitation of virtual reality environments

These approaches and objectives are aligned with some of the Sustainable Development Goals, SDG, of the 2030 Agenda (https://www.un.org/sustainabledevelopment/es/) and certain specific goals, in such a way that the acquisition of the Learning outcomes of the subject provides training and competence to the student to contribute to a certain extent to their achievement:

- Objective 9: Industry, innovation and infrastructure
    - Target 9.5 Increase scientific research and improve the technological capacity of industrial sectors in all countries, particularly developing countries, including by fostering innovation and significantly increasing, by 2030, the number of people working in research and development per million inhabitants and the spending of the public and private sectors in research and development

1.2. Context and importance of this course in the degree

The rationale for this course is to know the fundamentals of the field of virtual reality, its industrial, scientific and technological applications, as well as the open problems that exist nowadays.

1.3. Recommendations to take this course

There is no special requirement or recommendation to take this course.

2. Learning goals

2.1. Competences

Basic and general competences

- CB6 – To possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
- CB7 – Students are able to apply the knowledge acquired and their problem solving skills in new or unfamiliar environments with broader (or multidisciplinary) contexts related to their area of study.
- CB8 – Students are able to integrate knowledge and deal with the complexity of making judgements based on pieces of information which, while being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgement.
- CB9 – Students are able to communicate their conclusions and the underlying knowledge and ultimate reasons to specialist and non-specialist audiences in a clear and straightforward manner.
- CB10 – Students possess the learning skills to enable them to continue studying in a way which will be largely self-directed and autonomous.
- CG01 – Students will have acquired advanced knowledge and demonstrated, in a scientific and technological research or highly specialised context, a detailed and solid understanding of the theoretical and practical aspects and working methodology in the fields of Robotics, Graphics and/or Computer Vision, allowing them to be innovative in a context of research, development and innovation.
- CG02 - Ability to apply and integrate their knowledge and its understanding, their scientific basis and problem solving skills in new and undefined contexts, including highly specialised multidisciplinary research and professional contexts.
- CG03 – Ability to evaluate and select the appropriate scientific theory and precise methodology of their fields of study in order to make judges base don incomplete or limited information, including, when needed and relevant, a reflection on the social and ethical responsibility linked to the solution proposed in each case.
- CG05 – Ability to transmit in English, orally and in writing, in a clear and straightforward manner, to both specialised and non-specialised audiences, results from scientific and technological research or from the most advanced innovation spheres, as well as the most relevant foundations in which they are based.
- CG06 - To have developed sufficient autonomy to take part in research projects and research or technological collaborations within his topic, in interdisciplinary contexts and, where appropriate, with a significant share of knowledge transfer.
- CG08 – To possess the aptitudes, skills and method necessary to carry out a multidisciplinary research and/or development work in the fields of Robotics, Graphics and/or Computer Vision.
- CG09 – Ability to use Engineering techniques, skills and tools necessary for problema solving in the fields of Robotics, Graphics and/or Computer Vision.
- CG10 – Ability to understand, relate to the estate-of-the-art and critically evaluate scientific Publications in the fields of Robotics, Graphics and/or Computer Vision..
- CG11 – Ability to manage and use bibliography, documents, databases, software and hardware specific to the fields of Robotics, Graphics and/or Computer Vision.

Specific competences

- CE02 – Ability to design and develop new methods and algorithms applicable to autonomous or virtual and augmented reality systems.
- CE05 – Ability to devise, design and develop software, products and systems in the sphere of computer

graphics.
- CE09 – Ability to develop in an autonomous manner an initiation to research and/or development assignment in the field of robotics, Graphics or computer vision, in which the competences acquired in the degree are synthesized and integrated.

2.2. Learning goals

In order to pass this course, the student must demonstrate the following results:

1. Know and know how to apply advanced algorithms for analysis and generation of images.
2. Understand the relationship between efficiency and precision of the different applicable algorithms.
3. Conceptualize and design advanced applications based on techniques of the state of the art of Computer Graphics and Computer Vision.
4. Propose and design new areas of improvement on the state of the art in techniques of Computer Graphics and Computer Vision, including unresolved aspects or improvements on existing techniques and applications.
5. Know and evaluate bibliographic sources related to Computer Graphics and Computer Vision.
6. Write and present technical and scientific results effectively.

2.3. Importance of learning goals

Virtual Reality is a field of great technological strength and a strong growth in its applications of many different kinds. In this course the student will acquire the basics of this topic, which include:

a) the fundamentals and advances of the field;

b) existing tools;

c) industrial and scientific applications;

d) open problems and related lines of future work.

3. Assessment (1st and 2nd call)

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

The student must demonstrate the achievement of the intended learning outcomes through the following assessment activities:

- Written/oral deliverables on laboratory/practical work (30% - 50%) - Learning outcomes: 1, 2, 3, 6
- Project (30% - 50%) - Learning outcomes: 1, 2, 3, 4, 5, 6
- Oral presentations and discussions (10% - 20%) - Learning outcomes: 1, 2, 4, 5 6

Students who do not opt for the evaluation procedure described above, does not pass such tests during the teaching period or want to improve the mark/grade obtained, will be entitled to take a global exam.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process designed for this course is based on the following:

- Learning of concepts and techniques through master classes in which student participation will be encouraged.
- Personal study of the course by the student, and participation in the resolution of the exercises proposed in class.
- Accomplishment of practical assignments that develop the theoretical knowledge.

It should be noted that the course has both a theoretical and practical orientation

Teaching and learning activities are based on:

1. **Lectures.** Exposition of contents by means of presentation or explanation by a lecturer (possibly including demonstrations). Participation will be encouraged
2. **Practical classes**. Practical activities carried out with computers.
3. **Tutoring**. A period of instruction conducted by a tutor with the aim of reviewing and discussing the materials and topics presented in class.
4. **Evaluation**. Set of written, oral and practical tests, projects, assignments, etc. used in the evaluation of student progress.
5. **Tutorized assignements.** Projects which are larger than the practical classes, which will be handed in and presented
6. **Theoretical study.** Self-study of the contents presented, including any study activity which has not be computed in the previous section (studying exams, library work, complementary reading, doing problems and exercises, etc.)

4.2. Learning tasks

The course consists of 3 ECTS credits that correspond to 75 estimated hours of student work, distributed as follows:

- Lectures and practical sessions: 25h
- Practical assignments related to applications or research: 30h
- Personalized teacher-student tutoring: 5h
- Study: 10h
- Evaluation tests: 5h

4.3. Syllabus

The course syllabus will include at least the following topics and contents:

1. **Introduction to Virtual Reality (VR).** History. Evolution. Applications.
2. **Perception.** The human visual system. VR specific characteristics. Presence and immersion.
3. **Systems and tools for VR.** Sensors, displays, tracking.
4. **Content generation for VR.** Synthetic content and real content.
5. **Open VR problems and latest advances.**

4.4. Course planning and calendar

Teaching organization is planned as:

- Lectures and problem solving classes
- Practical sessions and assignments

The schedule of all lectures and dates of practical sessions will be announced well in advance on the center and course websites.

The calendar of lectures, practical sessions and presentations, as well as deadlines for practical assignments and projects, will be announced well in advance.

4.5. Bibliography and recommended resources

1. Akenine-Möller, Tomas. Real-time rendering / Tomas Akenine-Möller, Eric Haines, Naty Hoffman . 3rd ed. Boca Raton [etc.] : A K Peters, cop. 2008
2. LaValle, Steven. Virtual Reality. Cambridge University Press. 2016.
3. Sellers, Graham et al. OpenGL SuperBible. 7th Edition. Comprehensive Tutorial and Reference. Addison Wesley. 2015.
4. Frisby, John and Stone, James. Seeing: The computational approach to biological vision. 2nd Edition. MIT Press. 2010.

5. Marschner, S. and Shirley, P. Fundamentals of Computer Graphics. 4th Edition. CRC Press. 2016.