Course guide
270623 - VAR - Virtual and Augmented Reality

Last modified: 13/07/2022

Unit in charge: Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science.

Degree: MASTER'S DEGREE IN INNOVATION AND RESEARCH IN INFORMATICS (Syllabus 2012). (Optional subject).

Academic year: 2022 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: NURIA PELECHANO GOMEZ

Others: Primer quadrimestre:
CARLOS ANTONIO ANDUJAR GRAN - 10
MARTA FAIREN GONZALEZ - 10
NURIA PELECHANO GOMEZ - 10

PRIOR SKILLS

The course assumes advanced C++ and or C# programming skills, as well as computer graphics knowledge (OpenGL and GLSL knowledge required).
Also convenient to be familiar with Unity.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEE1.2. Capability to understand and know how to apply current and future technologies for the evaluation, implementation and operation of virtual and / or increased reality environments, and 3D user interfaces based on devices for natural interaction.

Generical:
CG1. Capability to apply the scientific method to study and analyse of phenomena and systems in any area of Computer Science, and in the conception, design and implementation of innovative and original solutions.

Transversal:
CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study. Capacity for abstraction: the capability to create and use models that reflect real situations. Capability to design and implement simple experiments, and analyze and interpret their results. Capacity for analysis, synthesis and evaluation.

TEACHING METHODOLOGY

The course is based on weekly theory classes explaining the course concepts, techniques and algorithms.

The students will have to complete weekly assignments. The assigments require the student to read and analyse a few papers about the course topics and to answer questions or solve problems on the subject.

The students will have to complete a programming project involving the development of a moderate-complexity VR or AR application.

The course assumes advanced knowledge of the C++ language and OpenGL and GLSL APIs.

LEARNING OBJECTIVES OF THE SUBJECT

2.Understand the elements, architecture, input and output devices of virtual and augmented reality systems.
3.Be able to develop and evaluate 3D interactive applications involving stereoscopic output, virtual reality hardware and 3D user interfaces.

STUDY LOAD

Type	Hours	Percentage
Self study	96,0	64.00
Hours large group	27,0	18.00
Hours small group	27,0	18.00

Total learning time: 150 h

CONTENTS

VR systems

Description:
VR as a discipline. Basic features of VR systems. Architecture of VR systems.

VR hardware

Description:
VR input hardware: tracking systems, motion capture systems, data gloves. VR output hardware: visual displays.

Stereoscopic Vision

Description:
Fundamentals of the human visual system. Depth cues. Stereopsis. Retinal disparity and parallax. Synthesis of stereo pairs. Pipeline for stereo images.

Haptic rendering

Description:
Haptic sense. Haptic devices. Algorithms for haptic rendering

VR software development

Description:
Challenges in VR software development. Windowing, viewing, input/output and networking issues. Master/slave and Client/server architectures. Cluster rendering. VR Juggler and XVR. Game Engines and available sdk to develop VR applications for different hardware (HTC VIVE, Oculus, Google VR).

AR software development

Description:
AR software. Camera parameters and camera calibration. Marker-based augmented reality. Pattern recognition. AR Toolkit

3D user interfaces

Description:
Why 3D user interfaces. Major user tasks in VE. Interaction techniques for selection, manipulation and navigation. 3DUI evaluation.

Presence

Description:
Presence: concept, definition, measurement and applications.

ACTIVITIES

VR project

Description:
Development of a programing project using a game engine and google VR software to run it on a smarphone inside a head set.

Specific objectives:
3

Related competencies :
CG1. Capability to apply the scientific method to study and analyse of phenomena and systems in any area of Computer Science, and in the conception, design and implementation of innovative and original solutions.
CEE1.2. Capability to understand and know how to apply current and future technologies for the evaluation, implementation and operation of virtual and / or increased reality environments, and 3D user interfaces based on devices for natural interaction.
CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study. Capacity for abstraction: the capability to create and use models that reflect real situations. Capability to design and implement simple experiments, and analyze and interpret their results. Capacity for analysis, synthesis and evaluation.

Full-or-part-time: 18h
Theory classes: 2h
Laboratory classes: 4h
Guided activities: 4h
Self study: 8h

Project sterescopy

Description:
Development of a project with sterescopy

Specific objectives:
2, 3

Related competencies :
CG1. Capability to apply the scientific method to study and analyse of phenomena and systems in any area of Computer Science, and in the conception, design and implementation of innovative and original solutions.
CEE1.2. Capability to understand and know how to apply current and future technologies for the evaluation, implementation and operation of virtual and / or increased reality environments, and 3D user interfaces based on devices for natural interaction.
CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study. Capacity for abstraction: the capability to create and use models that reflect real situations. Capability to design and implement simple experiments, and analyze and interpret their results. Capacity for analysis, synthesis and evaluation.

Full-or-part-time: 18h
Theory classes: 2h
Laboratory classes: 4h
Guided activities: 4h
Self study: 8h

AR Project

Description:
Development of a project for Augmented Reality applications using ARToolkit or Unity

Specific objectives:
2

Related competencies :
CEE1.2. Capability to understand and know how to apply current and future technologies for the evaluation, implementation and operation of virtual and / or increased reality environments, and 3D user interfaces based on devices for natural interaction.

Full-or-part-time: 18h
Theory classes: 2h
Laboratory classes: 4h
Guided activities: 4h
Self study: 8h

Midterm exam

Description:
Midterm exam

Specific objectives:
2

Related competencies :
CEE1.2. Capability to understand and know how to apply current and future technologies for the evaluation, implementation and operation of virtual and / or increased reality environments, and 3D user interfaces based on devices for natural interaction.

Full-or-part-time: 21h
Theory classes: 2h
Self study: 19h

Final exam

Description:
Final exam

Specific objectives:
2, 3

Related competencies :
CG1. Capability to apply the scientific method to study and analyse of phenomena and systems in any area of Computer Science, and in the conception, design and implementation of innovative and original solutions.
CEE1.2. Capability to understand and know how to apply current and future technologies for the evaluation, implementation and operation of virtual and / or increased reality environments, and 3D user interfaces based on devices for natural interaction.
CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study. Capacity for abstraction: the capability to create and use models that reflect real situations. Capability to design and implement simple experiments, and analyze and interpret their results. Capacity for analysis, synthesis and evaluation.

Full-or-part-time: 27h
Theory classes: 2h
Self study: 25h

Theory classes

Specific objectives:
2, 3

Related competencies :
CG1. Capability to apply the scientific method to study and analyse of phenomena and systems in any area of Computer Science, and in the conception, design and implementation of innovative and original solutions.
CEE1.2. Capability to understand and know how to apply current and future technologies for the evaluation, implementation and operation of virtual and / or increased reality environments, and 3D user interfaces based on devices for natural interaction.
CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study. Capacity for abstraction: the capability to create and use models that reflect real situations. Capability to design and implement simple experiments, and analyze and interpret their results. Capacity for analysis, synthesis and evaluation.

Full-or-part-time: 34h
Theory classes: 26h
Guided activities: 8h

Student presentation

Description:
Student presentation

Full-or-part-time: 14h
Theory classes: 4h
Self study: 10h

GRADING SYSTEM

The course assessment is based on three types of activities:

- 3 Programming project (P1, P2, P3)
- Final exam (F)
- Presentation (Pr)

Grade = 0.15*P1+ 0.15*P2 + 0.15*P3 + 0.10*Pr + 0.45*F

BIBLIOGRAPHY

Basic:
- LaViola, Joseph J. 3D user interfaces : theory and practice. 2nd ed. Boston: Addison-Wesley, 2017. ISBN 9780134034324.

RESOURCES

Hyperlink:
- http://www.hitl.washington.edu/artoolkit/- http://www.vrmedia.it/en/xvr.html