270623 - VAR - Virtual and Augmented Reality

Coordinating unit: 270 - FIB - Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science
Academic year: 2019
Degree: MASTER’S DEGREE IN INNOVATION AND RESEARCH IN INFORMATICS (Syllabus 2012). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: English

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.

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 assignments 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

Total learning time: 150h
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<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>27h</td>
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### Content

#### VR systems

**Degree competences to which the content contributes:**

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

#### VR hardware

**Degree competences to which the content contributes:**

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

#### Stereoscopic Vision

**Degree competences to which the content contributes:**

**Description:**

#### Haptic rendering

**Degree competences to which the content contributes:**

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

#### VR software development

**Degree competences to which the content contributes:**

**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

**Degree competences to which the content contributes:**
3D user interfaces

Degree competences to which the content contributes:

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

Presence

Degree competences to which the content contributes:

Description:
Presence: concept, definition, measurement and applications.
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| Planning of activities | Hours: 18h
Theory classes: 2h
Practical classes: 0h
Laboratory classes: 4h
Guided activities: 4h
Self study: 8h |
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<tr>
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<tbody>
<tr>
<td><strong>VR project</strong></td>
<td>Description: Development of a programing project using a game engine and google VR software to run it on a smarphone inside a head set.</td>
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<tr>
<td><strong>Project stereoscopy</strong></td>
<td>Description: Development of a project with stereoscopy</td>
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<tr>
<td><strong>AR Project</strong></td>
<td>Description: Development of a project for Augmented Reality applications using ARToolkit or Unity</td>
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</table>
| **Midterm exam**       | Hours: 21h
Theory classes: 2h
Practical classes: 0h
Laboratory classes: 0h
Guided activities: 0h
Self study: 19h |
### Description:
Midterm exam

### Specific objectives:
2

<table>
<thead>
<tr>
<th>Final exam</th>
<th>Hours: 27h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
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<tr>
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<td>Practical classes: 0h</td>
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<td>Laboratory classes: 0h</td>
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<td>Guided activities: 0h</td>
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<td>Self study: 25h</td>
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<td>Final exam</td>
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### Specific objectives:
2, 3

<table>
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<tr>
<th>Theory classes</th>
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<td>Practical classes: 0h</td>
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<td>Guided activities: 8h</td>
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<td>Self study: 0h</td>
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### Specific objectives:
2, 3

<table>
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<tr>
<th>Student presentation</th>
<th>Hours: 14h</th>
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<tbody>
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<td>Practical classes: 0h</td>
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<td>Guided activities: 0h</td>
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<td>Self study: 10h</td>
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<table>
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<th>Description:</th>
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<tr>
<td>Student presentation</td>
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Qualification system

The course assessment is based on three types of activities:

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

Grade = 0.15*P1 + 0.15*P2 + 0.15*P3 + 0.10*Pr + max(0.20*MT + 0.25*F, 0.45*F)

Bibliography

Basic:

Others resources:

Hyperlink
- http://www.hitl.washington.edu/artoolkit/