270622 - FRR - Fast Realistic Rendering

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

Students are expected to know and OpenGL graphics have taken a course before this course.

Degree competences to which the subject contributes

Basic:
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CB7. Ability to integrate knowledge and handle the complexity of making judgments based on information which, being incomplete or limited, includes considerations on social and ethical responsibilities linked to the application of their knowledge and judgments.

Specific:
CEE1.1. Capability to understand and know how to apply current and future technologies for the design and evaluation of interactive graphic applications in three dimensions, either when prioritizing image quality or when prioritizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
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.
CEE1.3. Ability to integrate the technologies mentioned in CEE1.2 and CEE1.1 skills with other digital processing information technologies to build new applications as well as make significant contributions in multidisciplinary teams using computer graphics.
CEE3.1. Capability to identify computational barriers and to analyze the complexity of computational problems in different areas of science and technology as well as to represent high complexity problems in mathematical structures which can be treated effectively with algorithmic schemes.

Generical:
CG1. Capability to apply the scientific method to study and analyze of phenomena and systems in any area of Computer Science, and in the conception, design and implementation of innovative and original solutions.
CG3. Capacity for mathematical modeling, calculation and experimental designing in technology and companies engineering centers, particularly in research and innovation in all areas of Computer Science.

Transversal:
CTR4. INFORMATION LITERACY: Capability to manage the acquisition, structuring, analysis and visualization of data and information in the area of informatics engineering, and critically assess the results of this effort.
CTR5. APPROPRIATE ATTITUDE TOWARDS WORK: Capability to be motivated by professional achievement and to face new challenges, to have a broad vision of the possibilities of a career in the field of informatics engineering. Capability to be motivated by quality and continuous improvement, and to act strictly on professional development. Capability to adapt to technological or organizational changes. Capacity for working in absence of information and/or with time and/or resources constraints.
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Teaching methodology

For the realization of the course in the teacher provide theoretical lectures and materials as articles or manuals that students have read and presented in some cases.
During the lectures will introduce the most relevant concepts and give guidelines for the preparation of submissions of articles.
During the laboratory classes will be three events: developing small exercises GLSL to implement a small project to be presented at the end of the course and make presentations of papers in the literature.

Learning objectives of the subject

1. Get current graphics hardware and the development of GPU programming paradigms.
2. Understand the problems and limitations of developing graphical applications in real time.
3. Learn how to develop computer graphics applications for GPUs.
4. Learning the state of the art in algorithms to generate advanced shadows.
5. Learn techniques for accelerating scene rendering by geometry processing.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 36h 24.00%</th>
<th>Hours medium group: 6h 4.00%</th>
<th>Hours small group: 12h 8.00%</th>
<th>Guided activities: 0h 0.00%</th>
<th>Self study: 96h 64.00%</th>
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</thead>
</table>

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During the lectures will introduce the most relevant concepts and give guidelines for the preparation of submissions of articles.
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### Introduction to graphics hardware.

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

**Description:**
The aim of this section is to present the graphics software and its evolution over the years. We present the fixed pipeline of OpenGL programmable pipeline and analyzing the flow of information and data sources available. We also introduce generic algorithms accelerated by GPU computing.

### Introduction to GPU programming languages.

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

**Description:**
In this section we discuss Cg and GLSL, as well as introduced CUDA and OpenCL. GLSL and deepen all the different elements of the programming: types, data structures, control structures, subprograms and library definition.

### GPU-aided geometry processing.

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

**Description:**
The accurate real-time rendering acceleration painting process from the point of view of geometry and illumination. As the scenes of today are very complex algorithms needed to process them efficiently. In this section we discuss the geometry processing using different aspects of GPUs, such as the calculation of visibility, restructuring primitives and grouping of primitives.

### Shadow generation.

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

**Description:**
An important element in the perception of the realism of a scene is to display shadows. Over time, the algorithms have been refined display of shadows, moving shadows "hard" to shadows, to the generation of so-called ambient lighting. In this section we review the evolution and discuss the various methods of generating shadows using GPU.

### Accelerated rendering using images.

**Degree competences to which the content contributes:**
Description:
With the appearance of textures to the GPU, there have been many improvements in painting realistic attempting to use this element to improve the result. Initially, only to replace color, later, to simulate details of the geometry, and then for storing precomputed geometry and lighting. In this section we will review how to use textures to simulate various effects ranging from bump-mapping to storing the complete geometry of an object or a lot of texture memory using impostors.
### Planning of activities

| Lectures | **Hours:** 73h 36m  
Theory classes: 30h  
Practical classes: 0h  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 43h 36m |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Material will be presented in lectures along the term. You are expected to conduct complementary readings that will be assigned on occasion, to be presented at a later date.</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>1, 2, 3</td>
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| Implementation of the practical assignments. | **Hours:** 48h  
Theory classes: 0h  
Practical classes: 0h  
Laboratory classes: 12h  
Guided activities: 0h  
Self study: 36h |
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<tr>
<td><strong>Description:</strong></td>
<td>Some assignments will be proposed and the students must develop them, partially during the lab sessions.</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>1, 2, 3</td>
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| Articles presentation | **Hours:** 26h  
Theory classes: 0h  
Practical classes: 6h  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 20h |
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<tr>
<td><strong>Description:</strong></td>
<td>Papers will be assigned to the students and they will be presented and discussed by the students.</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>2, 3, 5</td>
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| Final exam | **Hours:** 2h 24m  
Guided activities: 2h 24m  
Self study: 0h |
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<tr>
<td><strong>Description:</strong></td>
<td>At the end of the term you will have a final exam, which may be a take-home.</td>
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Specific objectives:
1, 2, 3, 4, 5, 6

Qualification system

The evaluation method will have three parts: the presentation of papers and attendance, development of the project and a final exam. The presentation of papers and attendance will note (PRES) that depend on class attendance and participation, the rigor and quality of the presentation of the article that touches the student as well as the ability to answer questions from students and / or teacher about the article. Value will be questions that students make in the presentations of other students. The weight of this part (PRES) will be 30% of the final grade. The other part of the assessment (40%) will be the programming project (PROJ). The final exam (EF), which can be done at home, will have a weight of 30%. The final grade is then:
NF = PRES * 0.3 + PROJ * 0.4 + EF * 0.3

Bibliography

Basic:


Complementary:


Others resources:

Hyperlink

http://www.opengl.org


http://en.wikipedia.org/wiki/GLSL