Course guide
270671 - A3DM - Advanced 3D Modeling

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: CARLOS ANTONIO ANDUJAR GRAN
Others: Segon quadrimestre: CARLOS ANTONIO ANDUJAR GRAN - 10

PRIOR SKILLS
The course requires a basic linear algebra and 2D/3D geometry background.

Background on Computer Graphics (rendering pipeline, shaders, OpenGL) is strongly recommended.

Lab exercises will be implemented in Python and C++ languages, so students should have at least C/C++ programming skills.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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.

General:
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:
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.
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 teaching methodology will be based on weekly theory classes and lab classes. Course concepts will be introduced in the theory classes. Exercises will be used to consolidate these concepts, which will be further developed in the lab sessions.

The lab sessions basically involve the teacher presenting the guidelines for the practical work (split by sessions) and the concepts bearing on the software to be used. Students will complete the design and programming of the various applications bearing on the course contents. The exercises will be carried out individually.
LEARNING OBJECTIVES OF THE SUBJECT

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>40.8</td>
<td>27.20</td>
</tr>
<tr>
<td>Hours small group</td>
<td>13.2</td>
<td>8.80</td>
</tr>
<tr>
<td>Self study</td>
<td>96.0</td>
<td>64.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

Foundations of 3D modeling

Description:
Elements of a geometric modeling system. Solid models. Closed, bounded and regular sets of points. Two-manifold surfaces. Abstraction levels in geometric modeling.

Boundary representation (BRep)

Description:

Subdivision surfaces

Description:

CSG models

Description:

Space decomposition models

Description:

Implicit modeling

Description:
Scalar fields. Surface reconstruction from scalar fields. Blobby molecules, metaballs and soft objects.
Data structures for triangle meshes

**Description:**
Euler equation for triangle meshes. Face-based, Vertex-based and edge-based representations. The half-edge data structure. APIs for geometry processing.

Geometric tests and queries

**Description:**

Procedural modeling

**Description:**

Geometry acquisition

**Description:**
Pipeline for the acquisition of 3D models. Technologies. Registration and merge.

**ACTIVITIES**

**Lectures**

**Description:**
Material will be presented in lectures along the term. You are expected to conduct complementary readings and exercises will also be assigned on occasion, to be presented at a later date or turned in.

**Full-or-part-time:** 95h
Theory classes: 39h
Guided activities: 4h
Self study: 52h

**Implementation of selected algorithms**

**Description:**
A selection of relevant algorithms will be assigned to implement in Lab sessions and on your own. You may be required to present your solution to the class. You must turn in fully functional source code that runs in the indicated platform. Usual languages are C++ and Python.

**Full-or-part-time:** 51h
Laboratory classes: 13h
Guided activities: 5h
Self study: 33h
Final exam

Description:
At the end of the term you will have a final exam, which may be a take-home.

Full-or-part-time: 2h
Guided activities: 2h

Partial exam

Description:
At the middle of the term you will have a partial exam, which may be a take-home.

Full-or-part-time: 2h
Guided activities: 2h

GRADING SYSTEM

Partial: mark based on the student's performance in the partial exam
Exam: mark based on the student's performance in the final exam
Lab: grade stem from the student's implementations of selected algorithms (including occasionally their presentation of their solution in a laboratory class)

The final grade for the course will be computed as:

Final Grade = 0.4 Exam + 0.3 Partial + 0.3 Lab

BIBLIOGRAPHY

Basic:

Complementary: