Course guide
270674 - SRGGE - Scalable Rendering for Graphics and Game Engines

Last modified: 02/02/2024

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: 2023 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: ANTONIO CHICA CALAF

Others: Segon quadrimestre:
OSCAR ARGUDO MEDRANO - 10
ANTONIO CHICA CALAF - 10

PRIOR SKILLS

Students that take this course need to know OpenGL and have taken some computer graphics course previously.

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 priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.

Generical:
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:
CTR5. APPROPIATE 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.

Basic:
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.

TEACHING METHODOLOGY

This course is structured in three session types:

* T sessions (theory): presentation by the corresponding professor. The professor will ask the students to do some short exercises on the subjects covered in these sessions.

* D sessions (discussion): sessions conducted by the professor, in which some students will solve exercises or present previously distributed papers. Each student has to prepare the corresponding presentation and a supporting document, which have to sent to the course coordinator before his D session.

* L sessions (lab): in these sessions students will have to solve practical problems programmings some of the algorithms presented in the theory sessions. L sessions will start with a short lecture section.

LEARNING OBJECTIVES OF THE SUBJECT

1.Using Hierarchical Geometric Models for the display of very large models.
2.Simplification algorithms for triangle meshes.
3.Visibility computation algorithms
4.Interactive navigation in complex environments

STUDY LOAD

Type	Hours	Percentage
Hours small group	18,0	12.00
Self study	96,0	64.00
Hours large group	36,0	24.00

Total learning time: 150 h

CONTENTS

Hierarchical geometric models

Description:
Algorithms for space subdivision (regular grids, octrees, BSP trees, Kd-trees), scene subdivision (BVHs) and external memory-based data structures.

Mesh representation data structures

Description:
Triangle and polyognal mesh representation: Independent face set, Indexed face set, Adjacency lists, Winged edge, Half edge, Corner table.

Simplification of triangle meshes

Description:
Introduction to the basic concepts, operators and error metrics used in geometry and topology-based simplification. Its application to appearance-preserving simplification and out-of-core gigantic model simplification.

Level of detail

Description:
Introduction to object level of detail (LOD) and its application to complex scenes (time critical rendering). Strategies for LOD: Discrete, Continuous, or View-Dependent. Popping effect prevention.

Visibility computation

Description:
Introduction to the basic concepts and algorithms for visibility computation, including visibility preprocessing, point and region visibility, and visibility computation using the GPU. PVS compression.

Interactive navigation in complex environments

Description:
How to estructure gigantic data for out-of-core visualization of huge scenes. Use of view dependent visualization. Algorithms for collision detection in gigantic models.

ACTIVITIES

Hierarchical Geometric Models

Specific objectives:
1

Related competencies :
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.
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 priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
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.
CTR5. APPROPIATE 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.

Full-or-part-time: 45h
Theory classes: 12h
Laboratory classes: 6h
Self study: 27h

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Simplification algorithms for triangle meshes

Specific objectives:
2

Related competencies :
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.
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 priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
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.
CTR5. APPROPIATE 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.

Full-or-part-time: 30h
Theory classes: 8h
Laboratory classes: 4h
Self study: 18h

Visibility computation algorithms

Specific objectives:
3

Related competencies :
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.
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 priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
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.
CTR5. APPROPIATE 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.

Full-or-part-time: 30h
Theory classes: 8h
Laboratory classes: 4h
Self study: 18h

Interactive navigation in complex environments

Specific objectives:
4

Related competencies :
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.
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 priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
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.
CTR5. APPROPIATE 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.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.

Full-or-part-time: 30h
Theory classes: 8h
Laboratory classes: 4h
Self study: 18h

Paper presentation

Description:
Each student has to prepare the corresponding presentation and a supporting document, which have to sent to the course coordinator before the session.

Specific objectives:
1, 2, 3, 4

Related competencies :
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.
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 priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
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.
CTR5. APPROPIATE 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.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.

Full-or-part-time: 9h
Guided activities: 3h
Self study: 6h

Exercises

Description:
Set of exercises raised during the course to assess knowledge acquisition by students during the course.

Full-or-part-time: 9h
Self study: 9h

GRADING SYSTEM

The final qualification is computed as:

FinalQualification = 0.25 * ShortExercises + 0.25 * DPresentation + 0.5 * LabQualification

where:

* ShortExercises represents the short problems the instructor will ask during T sessions.

* DPresentation is the presentation the students will do on a paper selected from a list.

* LabQualification will be the qualification obtained by the students in the L sessions.

BIBLIOGRAPHY

Basic:
- Samet, H. Foundations of multidimensional and metric data structures. Amsterdam: Elsevier ; Morgan Kaufmann, 2006. ISBN 0123694469.
- Möller, T.A. [et al.]. Real-time rendering. 4th ed. Boca Raton: CRC Press, 2018. ISBN 9781138627000.
- Luebke, D. [et al.]. Level of detail for 3D graphics. Amsterdam: Morgan Kaufmann, 2003. ISBN 1558608389.

Complementary:
- SIGGRAPH '08: ACM SIGGRAPH 2008 classes. Association for Computer Machinery, 2008.