Course guide
270675 - GPR - Geometry Processing

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: ANTONIO CHICA CALAF

Others: Primer quadrimestre:
CARLOS ANTONIO ANDUJAR GRAN - 10
ANTONIO CHICA CALAF - 10

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.
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:
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:
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:
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.

TEACHING METHODOLOGY

The course will consist in lectures on the theoretical foundations of GP, which will include discussions of problems and applications. There will also be lab sessions where the students will tackle specific problems assigned to them, and will hand in working programs addressing these problems.

LEARNING OBJECTIVES OF THE SUBJECT

1.Upon completing this course, the student will understand the main processes and algorithms behind current-day geometry processing. More specifically they will be

STUDY LOAD

Type	Hours	Percentage
Guided activities	6,0	4.00
Hours small group	12,0	8.00
Self study	96,0	64.00
Hours medium group	6,0	4.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

Mathematical Preliminaries

Description:
Review concepts the students should already know, establish notation, and introduce some new material that will be needed for the course, including elementary continuous and discrete differential geometry of curves and surfaces.

Acquisition of Models; reconstruction, registration, zipping.

Description:
Discussion of the techniques whereby we can capture complex geometric meshes from physical objects.

Mesh repair

Description:
Difficulties found in acquired models, and need for fix-ups. Some techniques to automatically reduce mesh artifacts.

Smoothing

Description:
Presentation of techniques used to filter noise and improve the quality of meshes. Geometric and topological noise. Feature preservation.

Synthetic meshes

Description:
Presentation of some of the methods available to generate complex smooth shapes synthetically.

Parameterization of meshes. Remeshing and simplifying meshes.

Description:
Importance of parameterizations. Methods to achieve smooth parameterizations. Parameterizations and remeshing.

Mesh deformations and animation.

Description:
Skeleton and cage-based methods for deforming meshes.

ACTIVITIES

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 Linux or MacOSX.

Full-or-part-time: 48h
Laboratory classes: 12h
Self study: 36h

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.

Specific objectives:
1

Full-or-part-time: 76h 36m
Theory classes: 30h
Practical classes: 3h
Self study: 43h 36m

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 24m
Guided activities: 2h 24m

Problems to solve independently

Description:
You must develop solutions to problems that will be assigned in class; these will either be presented and discussed at a later date or turned in for grading.

Full-or-part-time: 23h
Practical classes: 3h
Self study: 20h

GRADING SYSTEM

The students will be marked for their attendance and participation in class (including the presentation of exercise solutions, their discussion, and exercises turned in for grading), yielding a mark "Class".

Another grade will stem from the student's implementations of selected algorithms (including occasionally their presentation of their solution in a laboratory class), yielding a mark "Lab".

Finally, students will receive a third mark based on their performance in the final exam, yielding "Exam".

The final grade for the course will be computed as

Final Grade = 0.3 Class + 0.3 Lab + 0.4 Exam.

BIBLIOGRAPHY

Basic:
- Botsch, M. [et al.]. Polygon mesh processing. A K Peters, 2010. ISBN 9781568814261.
- Agoston, M.K. Computer graphics and geometric modeling: vol 2: mathematics. Springer, 2004. ISBN 1852338172.

Complementary:
- Carmo, M.P. do. Differential geometry of curves and surfaces. Rev. & upd. 2nd ed. Mineola, New York: Dover Publications, 2016. ISBN 9780486806990.
- Golub, G.H.; Van Loan, C.F. Matrix computations. 4th ed. The Johns Hopkins University Press, 1996. ISBN 9781421407944.
- Stoer, J.; Bulirsch, R. Introduction to numerical analysis. 3rd ed. Springer, 2002. ISBN 9781441930064.