Module Description, available in: EN

Advanced computer graphics

General Information

Number of ECTS Credits

3

Module code

TSM_AdvCompG

Valid for academic year

2025-26

Last modification

2024-10-18

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Linear algebra (vectors, matrices, homogeneous coordinates), C/C++ programming, 3D computer graphics (basic real-time rasterization).

Brief course description of module objectives and content

The objective of this course is to offer both theoretical knowledge and practical expertise in the realm of contemporary real-time 3D Computer Graphics (CG) systems.

In this class, you will delve deep into the world of modern GPU programming techniques, gaining firsthand experience to enhance the realism and performance of 3D rendering software. You'll explore the generation of complex synthetic images, mastering the intricacies of advanced lighting models, shadows, a multitude of post-processing filters, and achieving precise transparency effects, among other topics.

Aims, content, methods

Learning objectives and competencies to be acquired

Through this course, the student acquires a better understanding of the ecosystem, technology, and mathematics behind current generation's real-time rendering software, and gets solid foundations to further move in this field on his/her own.

The course contents are not only approached from a theoretical or introductory point of view, but always discussed in-depth and supported by their direct, effective implementation (via tutorials and assignments) on dedicated hardware.

Thanks to the direct experience gained in dealing with the complexity of modern GPU programming and selected state-of-the-art techniques used by the leading industry, students can integrate similar solutions in their projects.

Module content with weighting of different components

The module covers the following topics (including the % of weight given to each of them):

- GPU programming and software architecturing via a modern API with particular focus on code design and performance implications (30%).
- Realistic lighting through Physically-Based Rendering (PBR), global illumination, real-time ray tracing, and shadow mapping (30%).
- Deferred rendering: advantages and limitations (15%).
- The problem of correct Order-Independent Transparency (OIT) and its solutions (15%).
- Post-processing effects to enhance image quality: anti-aliasing, High-Dynamic Range (HDR), tone mapping, and ambient occlusion (10%).

Teaching and learning methods

Lectures, tutorials, demos, and practical work on computer and dedicated hardware. Students will be asked to implement selected techniques on their own as assignment.

Literature

Graham Sellers, Richard S. Wright, and Nicholas Haemel. 2015. OpenGL Superbible: Comprehensive Tutorial and Reference (7th ed.). Addison-Wesley Professional.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

A practical group project will be required, contributing 33% to the final grade. Students will work in teams, select a specific topic, and deepen their understanding by implementing a small demonstrator of the chosen technique. By the end of the semester, they will submit the working source code and briefly present their project to the class.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

A simple calculator (without any communication feature).

Other permissible aids

Paper-printed slides and lecture notes.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

None

Other permissible aids

The student can bring and consult a short summary during the examination (on maximum one A4 sheet, front and back).