Module Description, available in: EN

Advanced computer graphics

General Information

Number of ECTS Credits

3

Module code

TSM_AdvCompG

Valid for academic year

2026-27

Last modification

2025-10-13

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	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).

This course is ideal in combination and/or as a continuation of the EVA complementary modules Computer Graphics (MS_CompGraph), Virtual Reality (MS_VirtReal), and Game Development (MS_GameDev).

Brief course description of module objectives and content

The objective of this course is to provide both theoretical knowledge and practical expertise in the techniques that enable modern computer games to achieve photorealistic graphics in real time.

You will learn to harness the immense computational power of modern GPUs and use it efficiently to get the highest performance when rendering lifelike scenes in real time. To that end, you will learn all about advanced lighting models using both rasterization and ray tracing. Additionally, the course covers a multitude of GPU-accelerated post-processing effects and techniques to increase the visual fidelity of complex 3D scenes.

Aims, content, methods

Learning objectives and competencies to be acquired

In this course, participants gain a deeper understanding of the ecosystem, technologies, and mathematics that power modern GPUs and enable photorealistic real-time rendering. This provides a solid foundation in cutting-edge techniques, allowing them to further advance in this field independently.

In addition to a strong theoretical background, the learning path includes tutorials and assignments focused on implementing these state-of-the-art technologies, fostering a complete understanding of how to exploit the full potential of GPU architectures.

Thanks to the hands-on experience gained in addressing the complexity of modern GPU programming and selected advanced rendering techniques used in the leading industry, students will be able to implement cutting-edge graphics in their own future projects. By the end of the course, they will have mastered the principles and techniques behind modern real-time graphics, with skills that apply across domains such as games, simulation, virtual reality, and interactive visualization.

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

Tomas Akenine-Möller et al. 2018. Real-Time Rendering (4th ed.). O'Reilly.

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

Wolfgang Engel et al. 2010-2016. GPU Pro Series (Vol. 1-7). A K Peters/CRC Press.

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).