Computer Graphics III
Winter Term 2018
Organization

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Contents and form

- **Advanced 3D computer graphics**
  - Main topic:
    - **Realistic rendering and Monte Carlo methods**
  - Loosely follows-up on *Computer Graphics II* (NPGR004)
  - Assumes working knowledge of basic computer graphics, rendering and specifically ray tracing. Background in linear algebra, integral calculus, and probability theory is also expected.
- **2/2 C + Ex**
  - Lecture once a week
  - Labs precede lecture in SW1

Lecture overview 1/2

- **Physical and mathematical fundamentals of image synthesis**
  - Light, radiometry, light reflection, rendering equation.
- **Monte Carlo integration**
  - Statistical estimators and their properties, variance reduction techniques, combined estimators.
- **Solution of the rendering equation via MC**
  - Path tracing

Lecture overview 2/2

- **Advanced image synthesis methods**
  - Bidirectional path tracing, photon mapping, irradiance caching, virtual point lights, Metropolis light transport, …
- **Volumetric rendering methods**

Labs

- **Pen-and-paper exercises on the material from lectures** (solution of problems)
- **Programming assignments or projects**
  - you choose
- **Student's presentation of scientific papers**

Evaluation – Points

- **Programming assignments**
  - **Max 45 pts** altogether for the assignments
  - Penalty of 50% pts for each week of delay in delivering any assignment
  - Extra points can be gained for extended assignments (max 10 pts)
    - Serves to compensate for loss of points
    - Altogether, **max 55 pts** from the assignments (including the extra points)
- **Paper presentation**
  - Max 10 pts
- **Final oral exam**
  - 0 – 45 pts

Evaluation

- 1 (výborně) 86 – 100 pts
- 2 (velmi dobře): 71 – 85 pts
- 3 (dobře): 51 – 70 pts
- 4 (Fail, nevyhověl/a): 0 – 50 pts

- In order to pass, students must obtain **at least 50% of points for each item** on the previous slide (including the final oral exam)

Final examination

- Oral
- **Three questions** in total
  - **Two questions** on the material covered in the lectures
    - Randomly selected from a list posted on the class web page
  - **One question** = discussion of a scientific paper
    a) Students choose three papers during semester
       - The paper topic should be related to realistic rendering
       - Great source: http://kesen.realtimerendering.com/
    b) I approve the students' paper choice
    c) At the exam, I pick one of the three and the student explains what the paper is about

Literature

- M. Pharr, W. Jakob, G. Humphreys: *Physically-based Rendering: From Theory to Implementation*, 3rd ed. Morgan Kaufmann, 2016. [https://www.pbrt.org/]
  - Everything you ever wanted to know about implementing a physically-based renderer. The book can be browsed online.

- E. Veach: *Robust Monte Carlo Methods for Light Transport simulation*, Ph.D. Thesis, Stanford University, 1998.
  [Thesis: http://graphics.stanford.edu/papers/veach_thesis/]
  [Tech Award: https://www.youtube.com/watch?v=e3ss_Ozb9Yg]
  - Everything you ever wanted to know about the theory of light transport

- M. Cohen, J. Wallace: *Radiosity and Realistic Image Synthesis*, Academic Press, 1993. (Chapter 1-2)
  - Chapters 1 and 2 give a good intro to radiometry and photometry.

- P. Dutré, Global Illumination Compendium, [http://people.cs.kuleuven.be/~philip.dutre/GI/]
  - Compendium of useful formulas for implementing a physically-based renderer.

Further graphics classes (winter)

- **Computer graphics seminar**
  - 0/2, NPGR005 (J. Křivánek)
- **Geometric modelling**
  - 2/2, NPGR021 (Z. Šír)
- **Digital image processing**
  - 3/0, NPGR002 (J. Flusser, ÚTIA AV ČR)
- **Autonomous robotics**
  - 2/2, NPGR001 (Václav Hlaváč, CIIRC)
- **Machine learning in computer vision**
  - 2/2, NPGR035 (Elena Šikudová)
- **Animation and graphics production**
  - 1/1, NPGR039 (Ondřej Javora, FF UK)
- **Interactive 3D graphics on the web**
  - 2/2, NPGR012 (Jiří Žára, FEL ČVUT)

ASSIGNMENT 1

Assignment 1

- Max 2 students may work together
- 10 pts for delivering the work
- 50% down for each week of delay
- Extra points:
  - 5 pts for the best rendering
  - 4 for the 2nd best
  - 3 for the 3rd best
  - 2 for the 4th best
  - 1 for the 5th best
- Due date: **Wed Oct 31th (at the practicals)**

Assignment 1

- Install 3ds Max, edu version
  - https://www.autodesk.com/education/free-software/3ds-max
  - Lear basics of 3ds max from the edu videos shipped & other online resources
- Install demo version of Corona renderer
  - https://corona-renderer.com/download
  - Lean the basics of rendering with Corona
    - https://corona-renderer.com/resources/tutorials
- (you may also use Cinema4D & Corona for C4D)

Assignment 1

- **Create & render your own scene**
  - Inspiration: https://corona-renderer.com/gallery
  - Ok to download resources from 3rd parties
    - https://evermotion.org/
    - https://www.turbosquid.com/
  - Ok to use Corona material library
    - Shipped with Corona 1.7+
    - Or download from: https://corona-renderer.com/resources/materials

Assignment 1 – requirements

- Show a wide variety of **materials** (at least 10)
  - https://www.youtube.com/watch?v=6l98ul6XwDg
- **Lights:** Use all of the following: HDRI lighting, Corona sun, and a regular light
  - https://www.youtube.com/watch?v=y8L4Lfem1uA
- **Render elements**: break your rendering down to direct / indirect / diffuse / reflections elements (passes) so you see what contributions make up the final image
  - https://www.youtube.com/watch?v=loSHF5kfeTc
- …

Assignment 1 – requirements

- …
- Show the use of **denoising**
  - https://www.youtube.com/watch?v=v4fZojsjGpQ
- Figure out for yourself **what makes rendering slow** (what kind of material / light combinations, lights close to geometry etc.)
- Assemble results into a HTML page, preferably using https://jeri.io/ (or other resources, since jeri needs a web server to run)
- You will show the results at the practicals