Computer Graphics
Summary, Applications, and Outlook

Matthias Teschner
Introduction to Computer Graphics

Rendering  Modeling  Simulation

Homogeneous Notation

Ray Casting  Bézier Curves  Particle Fluids

Rasterization  Piecewise Polynomial Curves

Phong
Simulations / Renderings vs. Experiments / Real-World Videos

– Less expensive
– Faster
– More flexible
– Less dangerous

... if sufficiently accurate
Application

The Ford Motor Company of Australia
Challenges

- Prototype
- Sensors
  - Wetting, pressure, volume, flow rate, pathline, ...
- Analysis
- Redesign
- Prototype
- ...

The Ford Motor Company of Australia
State-of-the-Art in 2014

Merkle & Partner
Commercial CFD Product
Current State-of-the-Art

Johan Idoffsson
Chalmers University

Volvo Cars

PreonLab
FIFTY2 Technology
Evaluation

PreonLab
FIFTY2 Technology
## Computer Science in Simulation

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<th>Efficiency</th>
<th>Usability</th>
<th>Reliability</th>
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<td>Neighbor search</td>
<td>Boundary representation</td>
<td>Implicit formulations</td>
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<td>flexible, fast pre-proc.</td>
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<td>Pressure solve</td>
<td>Pressure solver</td>
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<td>large time steps</td>
<td>simple, intuitive setup</td>
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<tr>
<td>Boundary handling</td>
<td>Monolithic solutions</td>
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<td>large time steps</td>
<td>e.g. rigid-body solver</td>
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<td>...</td>
<td>Pre- and Postprocessing</td>
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Further Applications

- Medicine
- Climate Research
- Entertainment
- ...
Modeling - Simulation - Rendering

Modeling

Rendering

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Modeling - Simulation - Rendering

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Modeling - Simulation - Rendering

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## Specialization Courses – Topics

### Rendering
- Light: Radiometric Quantities
- Material: BRDF
- Light / Material: Rendering Equation
- Radiosity
- Stochastic Raytracing

### Simulation
- Particle Motion
- Elastic Solids
- Fluids (Particles and Grids)
- Rigid Bodies
- Contact
### Specialization Courses – Concepts

<table>
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<td>Smoothed Particle Hydrodynamics</td>
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</table>
Rendering Equation

\[ L(p \to \omega_o) = L_e(p \to \omega_o) + \int_{\Omega} f_r(p, \omega_i \leftrightarrow \omega_o)L(p \leftarrow \omega_i) \cos(\omega_i, n_p) d\omega_i \]

- Establishes relations between incident and exitant radiances
- Expresses the steady state of radiances in a scene
- Governs the computation of radiances from all scene points into all directions

Akenine-Möller et al.
Solving the Rendering Equation

- Exitant radiances from all scene points into all directions

\[ L_e(p \rightarrow \omega_o) \]

\[ L(p \rightarrow \omega_o) \]

Cornell box
Particle Simulation
## Projects – Theses

### Rendering Track
- Simple Raytracer
- Data Structures
- Stochastic Raytracer

### Simulation Track
- Simple Fluid Solver
- Data Structures
- Incompressible SPH Solver

**Features / Performance / Research**

Please contact me per email two / three weeks before the semester starts.
Image Processing

- Slides, recordings, information on
  - https://lmb.informatik.uni-freiburg.de/lectures/image_processing/
- First class on
  - Tuesday, June 11, 14:15
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