Computer Graphics Seminar

MTAT.03.305

Fall 2015
Contact Information

- Raimond Tunnel – jee7@ut.ee
- Konstantin Tretjakov – kt@ut.ee
Organizational Information

- 15 seminars:
  - 3 introductory lectures
  - 10-12 student presentations
  - 2 project demonstrations
We hope that...

• ~15 seminars  
  Attendance: 22.5h = 0.85 credits

• 1 seminar  
  Preparation: 16h = 0.6 credits  
  Conducting: 1.5h = 0.05 credits

• Project  
  Everything: 40h = 1.5 credits
... but it may happen that ...

- ~15 seminars
  Attendance: 22.5h = 0.85 credits

- 1 seminar
  Preparation: 56h = 2.1 credits
  Conducting: 1.5h = 0.05 credits

- Project
  Everything: 0h = 0 credits
What am I even doing here?
What do I see?
What about this one?
This should be easy...
Regular seminars

- Listen to your fellow student's awesome presentation
- Ask questions, discuss
- $X > 1$ heads are better than one
Your seminar

- Choose an interesting CG topic
- Make the seminar fun and interactive
- Present some applications / demos
- Workshop
Sidetrack: Gamma correction
Sidetrack: Gamma correction

Sidetrack: Bloom effect

Need for Speed: Most Wanted

Elephant's Dream

Hitman: Absolution

Warframe: https://www.youtube.com/watch?v=gYHxhlvEyHk
Back to the main track
How do I choose a topic?

• I just gave you two possibilities:
  • Shader effects (like the Bloom effect)
  • Gamma correction

• Read something and find interesting topics
  • OpenGL's Red Book
  • GPU Gems
  • More "sophisticated" literature

• Continue on some already discovered theme
  • My example: Procedural tree generation?
How do I choose a topic?

- Continue on some already discovered theme
How to choose a topic?

- OpenGL ver 3.0 & 3.1
- Practical
- Basic topics:
  - Viewing
  - Color
  - Lighting
  - Blending
  - Textures
  - Buffers
How to choose a topic?

- Advanced topics:
  - Display lists (perf.)
  - Tessellation
  - Quadrics
  - Evaluators (curves & surfaces)
  - NURBS
How to choose a topic?

- OpenGL ver 4.3
  - Lots of new techniques and topics.
  - For example:
    - Tessellation shaders
    - Geometry shaders (access to all vertices)
    - Procedural texturing

How do I choose a topic?

- Covers all topics already mentioned and more
- Math heavy, but most of it you should be at home with
## Extra conditions!

<table>
<thead>
<tr>
<th>First time participant BSc, MSc</th>
<th>Returning participant MSc, PhD</th>
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<tbody>
<tr>
<td>No additional requirements – you can choose any CG-related topic.</td>
<td>Your topic should be related to several scientific articles / a book. ACM SIGGRAPH (Special Interest Group on GRAPHics and Interactive Techniques): <a href="http://www.siggraph.org/">http://www.siggraph.org/</a></td>
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Previously...

PREVIOUSLY, ON SCRUBS...

Oh Wait, This Ain't Scrubs...
3D Scan Data

Pointcloud in MeshLab

http://ikuz.eu/2014/04/03/proof-of-concept-from-3d-scanner-to-animated-model/

Constructed model in Blender
3D Printing
Physics Simulation

- Rigid-body transformations
- Rigid-body collisions

Real-Time Rigid Body Simulation on GPUs:
https://courses.cs.ut.ee/2015/cg/spring/Main/Project-RigidBodySimulation

- Soft body simulation
  - Spring-mass models
  - Finite element method
  - ...

https://www.youtube.com/watch?v=tsGWBmSQRDU
Physics Engines

- PhysX by Nvidia
  - Windows (free)
- Havok by Intel
  - Consoles
- Bullet library
  - Blender
  - LightWave 3D
Blending

- Z-buffer and z-fighting
- Soft Particles: Use of depth information with blending

Particle Chopper task, CGLearn
Blending

- General blending equation

\[
\text{blend}(\text{src}, \text{dest}) = (\text{src} \cdot \text{src}_{\text{factor}}) \text{func}(\text{dest} \cdot \text{dest}_{\text{factor}})
\]

- Multipliciative blending

- Additive blending

World Remade by Jaanus Jaggo
Shadows

- Umbra
- Penumbra
- Antumbra
Shadow Algorithms

- Projected shadows
- Projection shadows
- Shadow mapping
- Shadow volume
Distance Fields

- 3D texture specifying the distance to object's boundary
- Decal / font rendering

If this is the alpha, then we get a blurred edge

If this is a distance field, then the borders stay the same

http://chimera.labs.oreilly.com/books/123400001814/ch07.html#ch07_id36000844
Distance Fields

- Unreal Engine 4 uses them for:
  - Ambient occlusion (FDAO)
  - Ray Traced Distance Field Soft Shadows (RTDFSS)

Details from the year 2008. Quote: „It will very soon be realtime.“
3D Fractal Generated Worlds with Cellular Automata

- Patterns in nature
- Fractals
- Cellular automation
  - Cells with behaviour rules
  - Conway's Game of Life
3D Fractal Generated Worlds with Cellular Automata

• Cellular automata created interesting patterns

Natural Simulation with JavaScript using Processing.js

- Vectors and physics

- Randomness, noise
Natural Simulation with JavaScript using Processing.js

- Different JavaScript CG apps.
  - My Life Aquatic: http://mylifeaquatic.herokuapp.com/
  - BitTorrent visualization: http://mg8.org/processing/bt.html
  - Delaunay Triangulation: http://www.whyi.net/geometry/Delaunay/
  - https://mattbierbaum.github.io/moshpits.js/
Animation

- Animation – 12 key principles

- Types of animation
  - Morph target
  - Skeletal meshes
  - Kinematics
  - Keyframe
  - Motion capture
Game Development in JavaScript

- Logic cycle vs graphics cycle

- JavaScript performance

- Graphics and physics libraries
  - Three.js
  - Cannon, Ammo, Box2D, PhysiJS

Game Development in JavaScript

- GTA 2 remake in JS by Erich Jagomägis

https://courses.cs.ut.ee/2015/cg/spring/Main/Project-GTA2
CGLearn

- Computer Graphics learning environment
- With interactive examples
Still confused?
You can...

- ... pick any topic from previous year
- ... pick some other CG related topic
World is a vast and mysterious place!

Ok, so I have a topic now...

- Look for materials
- Investigate, research
- Find examples
- Try it out yourself
- Present your findings
- Engage others
  - Discussion
  - Interactive demo
  - Workshop
What about the project?

- Interactive demo on the same topic as your seminar
What about the project?

- Advance something you've already done
What about the project?

- Can, of course, be a team / group effort!
What about the project?

- Do something fun and exciting

You can do it!
I didn't understand >70% of what you said...

- Don't worry about it!
- Pick a topic that suits your knowledge base
- Your topic may very well be:
  - Rasterization of triangles
  - Comparison of lighting models
  - How to do simple shadows?
  - Raytracing explained
  - etc
I don't even know where to start!

- There will be 2 more introductory lectures about the basics.

- Check out slides and exercises from Computer Graphics MTAT.03.015:
  - https://courses.cs.ut.ee/2013/cg/fall
  - https://courses.cs.ut.ee/2015/cg/spring

- Check out the slides from the previous seminar:
  - https://courses.cs.ut.ee/2014/cg-sem/fall/Main/Seminars
  - https://courses.cs.ut.ee/2015/cg-sem/spring/Main/Seminars

- Find some online tutorial that seems manageable for you and try it out.
Questions?
List of some topics

1. **Color blending** – What happens when there are transparent objects in your scene?
2. **Lighting models** – What are the common models? Where and when are they used?
3. **Texturing** – How can one sample from a texture? What kinds of artefacts may appear?
4. **Curves** – Why are they important in CG? What about curved surfaces?
5. **Global illumination** – Pick one or compare different methods: Radiosity, path tracing, photon mapping.
6. **Realtime realistic rendering** – Provide an overview of the common methods or pick some effect (light, wetness, fog, fur / hair) and find out how it's rendered realistically in real time.
7. **Non-realistic rendering** – Where is it used and how is it achieved? Realtime vs prerendered?
8. **Tessellation** – How can this be done in OpenGL 4?
9. **Post-processing effects** – What effects are there? When and how are they used?
10. **Procedural generation** – Where and how is it used? How to apply procedural textures to procedurally generated meshes?