Contact Information

- Raimond Tunnel – jee7@ut.ee
Organizational Information

- 16 seminars:
  - 4 introductory lectures
  - 8 student presentations
  - 1 ICS Day (03.10)
  - 1 cancelled (11.10)
  - 1 unknown

- 1 project expo
  (info TBA)
Organization

• 16 seminars
  Attendance: ~24h = 0.85 credits

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

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Organization

- 16 seminars
  Attendance: \( \sim 24h = 0.85 \text{ credits} \)

- 1 seminar
  Preparation: \( 56h = 2.1 \text{ credits} \)
    - Find suitable material (8h)
    - Read and understand the material (25h)
    - Synthesize a logical approach to the topic (10h)
    - Create a presentation (10h)
    - Practice the presentation (3h)

  Conducting: \( 1.5h = 0.05 \text{ credits} \)
Organization

- 16 seminars
  Attendance: ~24h = 0.85 credits

- 1 seminar
  Preparation: **56h = 2.1 credits**
    - Find suitable material (8h)
    - Read and understand the material (25h 10h)
    - Synthesize a logical approach to the topic (40h 2h)
    - Create a presentation (40h 5h)
    - Practice the presentation (3h)
    - Implement a demo (28h)

  Conducting: 1.5h = 0.05 credits
What am I even doing here?

CONFUSION
looks better sideways
What do I see?
What about this one?
Or this one?
Or this one?
This one should be easy...
The Seminar

- Explore an interesting CG topic
The Seminar

• Tackle a difficult subject together
The Seminar

- Tell (teach) others about your discoveries
How do I choose a topic?
How do I choose a topic?

- What do you need to understand for your thesis?
How do I choose a topic?

- What do you need to understand for your thesis?
- What knowledge will benefit you after the uni?

Ninja Theory developer talking about atmospheric VFX in Hellblade: https://www.youtube.com/watch?v=jdZ1s3FHTFI
How do I choose a topic?

- What do you need to understand for your thesis?
- What knowledge will benefit you after the uni?
- What did you come here to learn about CG?
How do I choose a topic?

- What do you need to understand for your thesis?
- What knowledge will benefit you after the uni?
- What did you come here to learn about CG?
- What do you find interesting in CG?

Fractal by Julius Horsthuis
http://www.julius-horsthuis.com/
How do I choose a topic?

- What do you need to understand for your thesis?
- What knowledge will benefit you after the uni?
- What did you come here to learn about CG?
- What do you find interesting in CG?

John Carmack

Procedural generation by Andreas Sepp
Post-Processing: Bloom effect

Need for Speed: Most Wanted

Elephant's Dream

Hitman: Absolution

Warframe: https://www.youtube.com/watch?v=gYHxhlvEyHk
Post-Processing: Bloom effect

Elder Scrolls 3: Oblivion
Back to the main track
How to find materials?
How to find materials?

• The Interwebs.
  • Examples of some quality web articles:
    – GTA V Graphics Study by Adrian Courreges
      http://www.adriancourreges.com/blog/2015/11/02/gta-v-graphics-study/
    – Article lists by Jendrik Illner
      https://www.jendrikillner.com/post/
    – Volumetric Fog by Kostas Anagnostou
      https://interplayoflight.wordpress.com/2015/07/03/adventures-in-postprocessing-with-unity/
  
• Just Google and be critical about what you find!
How to find materials?

- The Interwebs.
- UT library databases.
  - https://utlib.ut.ee/andmebaasid
  - ACM SIGGRAPH
  - IEEE Transactions on Visualization and CG
  - IEEE Transactions on Games

Be critical here as well...
How to find materials?

- The Interwebs.
- UT library databases.
- Books.
  - Fundamentals of Computer Graphics
  - GPU Pro 1-7, GPU Zen
  - Many-many others...
How to find materials?

- The Interwebs.
- UT library databases.
- Books.
- The CGVR Lab's Literature Page:
## Conditions

<table>
<thead>
<tr>
<th>First time student BSc, MSc</th>
<th>Choose any CG-related topic you want!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Returning student MSc, PhD</td>
<td>Your topic should be related to several scientific articles or books.</td>
</tr>
</tbody>
</table>

- In either case, **ensure you benefit** from the topic!
  - Eg, that it is related to your thesis or other work.

- Can be the same that others have done before.
Previously...

PREVIOUSLY, ON SCRUBS...

Oh Wait, This Ain't Scrubs...
Post-Processing Effects
Depth of Field: Blurs and Convolution

\[
\begin{bmatrix}
a & b & c \\
0 & 0 & 0 \\
d & e & f \\
0 & 0 & 0 \\
\end{bmatrix} \times 
\begin{bmatrix}
ad & ae & af \\
bd & be & bf \\
cd & ce & cf \\
\end{bmatrix} =
\begin{bmatrix}
std=1 \\
std=3 \\
std=6 \\
\end{bmatrix}
\]

Multiplication

\[
\begin{bmatrix}
a & b & a \\
b & c & b \\
a & b & a \\
\end{bmatrix} \times 
\begin{bmatrix}
ad & ae & af \\
bd & be & bf \\
cd & ce & cf \\
\end{bmatrix}
\]

GPU Pipeline

Screen

\[
K = v_0 \cdot v_0^T
\]
Facial Animations
Real-Time Weather Rendering
Environment Design in 90 Minutes
The CGVR Lab Field Trip
Texturing

Aliased polygons (jagged edges) vs. Anti-aliased polygons

Geometry vs. Display vs. Image
Academic Poster Workshop

- All design is re-design.
CGP Expo
Student Project Contest
Still confused?
World is a vast and mysterious place!

When you have a topic...

- Look for materials
- Investigate, research
- Find examples
- Try it out yourself
- Present your findings
- Engage others
  - Discussion
  - Interactive demo
  - Workshop
Creating a Presentation
Creating a Presentation

Ensure you understand what you put on the slide!

\[ L_o = L_e + \int_{\Omega} L_i \cdot f_r \cdot \cos \theta \cdot d\omega \]
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Use big fonts, use your slide space optimally.
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paint.net
draw.io
GeoGebra
Dynamic Mathematics for Everyone
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Put drawings, diagrams etc on the slides!
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Try to implement what you share.
Creating a Presentation

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The quality should be on par with a thesis level.
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You are the master of your topic!
Creating a Presentation

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- The quality should be on par with a thesis level.
- You are the master of your topic!
Want to do projects?

- **Computer Graphics Project** (MTAT.03.328)
  - 3 credits course
  - Consists entirely of a project
  - Work on your own idea throughout the semester
  - Roughly 7h per every 2 weeks
I don't even know where to start!?

- There will be 3 introductory lectures about the basics.

- Check out the topics from Computer Graphics:

- Check out the topics from the previous seminar:
  - https://courses.cs.ut.ee/2019/cg-sem/spring/Main/Seminars

- Find some online tutorial and try it out.
Goal:

The goal of the module is to give students the opportunity to deepen their understanding of the field most interesting for them and to develop their communication skills.

Learning outcomes:

After completing the module the student:
- is capable of independent work with modern research literature and other field-related material;  
- can effectively communicate his knowledge of the field to others.
Questions?
List of some arbitrary 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-photorealistic 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?
11. **Physically-Based Shading** – What is it? Why is it important to understand physical properties of materials for shading? What games / game engines use it?

12. **Rendering in VR** – What extra considerations are in VR? How do different technologies overcome them?

13. **Vulkan / WebGL 2.0** – What is it for? Why is it useful? How to Vulkan / WebGL 2.0?

14. **Subsurface scattering** – What is it? How it is implemented? What does it solve?

15. **Reflections and caustics** – What are the modern techniques, which do those?

16. **GLSL vs HLSL** – What are the differences? How are both used?

17. **Use case study** – Find out in detail how graphics are done in one game or movie.

18. **Motion capture** – What are the difficulties today? Best budget setup for it?

19. **Modern GPU architecture** – How are GPU-s built today? What are they optimized for?

20. **Graphics on consoles / smartphones** – What limitations are there in consoles or embedded systems vs the PC? How to overcome them compared to the PC approach?
List of some other topics

21. **Tileable Textures** – What methods are there for creating those?
22. **Ray Tracing with RTX** – What can be done with Nvidia's RTX cards?
23. **Occlusion Culling** – How is this achieved? What data structures are used?
24. **Volumetric Rendering** – How to simulate volumetric light transport? Fog, fire?
25. **Facial Animations** – What are the modern, cheapest, professional solutions?

Full list: [https://courses.cs.ut.ee/2019/cg-sem/fall/Main/Seminars#topics](https://courses.cs.ut.ee/2019/cg-sem/fall/Main/Seminars#topics) (with links)