Computer Graphics Seminar

MTAT.03.305

Fall 2017

Raimond Tunnel
Contact Information

- Raimond Tunnel – jee7@ut.ee
Organizational Information

- 16 seminars:
  - 3 introductory lectures
  - 8 student presentations
  - 2? special events
  - 1 holiday

- 2 project demonstrations
We hope that...

- **16 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 …

- 16 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

I read 3 books and am now a master of the subject.

Ain't nobody got time for that...
What am I even doing here?

CONFUSION
looks better sideways
What do I see?
What about this one?
Or this one?
This one 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
Sidetrack: Bloom effect

Elder Scrolls 3: Oblivion
Back to the main track
How do I choose a topic?

• There just were two ideas:
  • 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</th>
<th>Returning participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSc, MSc</td>
<td>MSc, PhD</td>
</tr>
<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>
</tr>
</tbody>
</table>
Previously...

PREVIOUSLY, ON SCRUBS...
Oh Wait, This Ain’t Scrubs...
Graphics Glitches

- Screen tearing
- Popping
- ...
Procedural Animation

- Inverse kinematics
- Physics-based animations
- Fur & hair dynamics
GLSL vs HLSL

**Vertex Shader**

**GLSL**
```glsl
class vertex_shader
{
    varying vec4 foo;
    varying vec4 bar;

del void main()
{
    ...
    foo = ... 
    bar = ...
}
}
```

**HLSL**
```hlsl
class vertex_shader
{
    struct VS_OUTPUT
    {
        float4 foo : TEXCOORD3;
        float4 bar : COLOR2;
    }

    VS_OUTPUT whatever()
    {
        VS_OUTPUT out;
        out.foo = ... 
        out.bar = ...
        return out;
    }
}
```

**Fragment Shader**

**GLSL**
```glsl
class fragment_shader
{
    varying vec4 foo;
    varying vec4 bar;

del void main()
{
    gl_FragColor = foo * bar;
}
}
```

**HLSL**
```hlsl
class fragment_shader
{

del void main(float4 foo : TEXCOORD3,
             float4 bar : COLOR2) : COLOR
{
    return foo * bar;
}
```

**Pixel Shader**

**GLSL**
```glsl
class pixel_shader
{

del void main()
{
    gl_FragColor = foo * bar;
}
}
```

**HLSL**
```hlsl
class pixel_shader
{

del void main()
{
    return foo * bar;
}
```
Physically-Based Shading

Absorption of non-red spectrum. The red is diffusely reflected.

Red light diffusely reflected, full spectrum specular reflections.
Physically-Based Shading

- The Fersnel Effect
Physically-Based Shading

- Micosurface reflection

“Blurry” Reflection

- “Gloss”
- “Smoothness”
- “Roughness”
Reflections and Caustics

- Fake rooms
- Caustic textures
Reflections and Caustics

- Radiosity
- Path Tracing
- Photon Mapping
- Metrolopis Light Transfer
2D Dynamic and Static Shadows
2D Dynamic and Static Shadows

- Blurry vs sharp shadow
- Differently diffusing lights
2D Dynamic and Static Shadows

- Color
- Shape
2D Dynamic and Static Shadows

- Statics vs dynamic objects and shadows
2D Dynamic and Static Shadows

- 3D vs 2D
Non-Photorealistic Rendering

- Cel-Shading
Non-Photorealistic Rendering

- Gooch Shading
Non-Photorealistic Rendering

- Edge classification
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
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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Put drawings, diagrams etc on the slides!
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Put drawings, diagrams etc on the slides!
Try to implement what you share.
Creating a Presentation

Ensure you understand what

Use big fonts, use your slide

Try to make the drawings, diagrams etc on your slide

Put drawings, diagrams etc on your slide

Try to implement what you share

The quality should be on par with a thesis level.
Creating a Presentation

Ensure you understand what you put on the slide!
Use big fonts, use your slide space optimally.
Try to make the drawings, diagrams etc yourself.
Put drawings, diagrams etc on the slides!
Try to implement what you share.
The quality should be on par with a thesis level.

You are the master of your topic!
Creating a Presentation

- Ensure you understand what you put on the slide!
- Use big fonts, use your slide space optimally.
- Try to make the drawings, diagrams etc yourself.
- Put drawings, diagrams etc on the slides!
- Try to implement what you share.
- 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.03.316)
  - 3 credits course
  - Consists entirely of a project
  - Work on your own idea throughout the semester
  - Roughly 6h per every 2 weeks
  - [https://courses.cs.ut.ee/2016/cg-project/fall](https://courses.cs.ut.ee/2016/cg-project/fall)
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 tasks from Computer Graphics MTAT.03.015:
  - https://courses.cs.ut.ee/2016/cg/fall
  - https://courses.cs.ut.ee/2015/cg/fall

- Check out the slides from the previous seminar:
  - https://courses.cs.ut.ee/2016/cg-sem/spring/Main/Seminars
  - https://courses.cs.ut.ee/2017/cg-sem/spring/Main/Seminars

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

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 – What can be done with it? Why is it useful? How to Vulkan?

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?