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TECHNISCHE UNIVERSITÄT DARMSTADT

Game Technology
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Exercise 6

For bonus points upload your solutions until **Saturday, December 17, 2016, 9:50**

General Information

- The exercises may be solved by teams of up to three people.
- The solutions have to be uploaded to the Git repositories assigned to the individual teams.
- **The submission date (for practical and theoretical tasks) is noted on top of each exercise sheet.**
- If you have questions about the exercises write a mail to game-technology@kom.tu-darmstadt.de or use the forum at https://www.fachschaft.informatik.tu-darmstadt.de/forum/viewforum.php?f=557

P6. Practical Tasks: Bumps and Animations (5 Points)

Get the source code of this exercise from **https://github.com/TUDGameTechnology/Exercise6.git**. For a reference to how the exercise`s solution should look like, please look at the video on the course homepage.

Please remember to push into a branch called "exercise6".

P6.1 Normal Maps (2 points)

On the right side of the exercise, you can find a box. For this box, a tangent-space normal map is provided.

a) Implement the creation of the tangent space basis (see comments in Exercise.cpp). Use the vertices of the mesh and their UV coordinates for this task. Please finish Task T6.1 first, as you will be deriving the necessary formula there.

b) Implement the missing part of the pixel shader (see comments in shader.frag).

P6.2 Vertex Animation (3 points)

On the left side of the exercise, you can find a pie-chart with a peculiar shape... The object is provided as a mesh with the center of the shape at the model`s origin. Animate the model in the vertex shader so that the opening at the right side appears to open and close rhythmically.

Hints:

- You can treat the problem as 2D and ignore the z-coordinate of the model
- Think about how one vertex (e.g. at the "mouth") has to move and try to find functions which realize this movement, then apply them to all vertices.

T6. Theoretical Tasks: Graphics Mix (5 Points)

T6.1 Tangent Space Basis (1 point)

As a preparation for P6.1 a), please derive the formulae for calculating T and B, the tangent and binormal vectors, from the differences in the vertex positions and UV coordinates of the triangle:

$$\text{deltaPos1} = \text{deltaU1} * T + \text{deltaV1} * B$$
$$\text{deltaPos2} = \text{deltaU2} * T + \text{deltaV2} * B$$

Hint: Treat the two equations as a system of linear equations and solve it.

T6.2 Relief Parallax Mapping (1 point)

In the lecture, we looked at the techniques Parallax Mapping, Steep Parallax Mapping and Parallax Occlusion Mapping. We skipped one technique called *Relief Parallax Mapping*, developed by Manuel M. Oliveira. Research this technique and describe how it works in comparison to the other parallax mapping techniques we introduced.

T6.3 Particles (1 point)

Particle systems consist of lots and lots of semi-transparent billboards. Depth buffer-based 3D rendering does not handle transparency well. What problem must be avoided and can that be done efficiently? When all is set and done, what is likely to be the biggest performance burden when rendering particles?

T6.4 Deferred Shading (1 point)

Game engines using deferred shading usually add a forward shading pass for materials that require blending. Explain why this is necessary.

T6.5 Skeletal Animations (1 point)

Will the problem we referred to as "Achselhölle"/”candy wrapper problem” in the lecture also occur if the most number of bones that influence any vertex in the mesh is 1, i.e. if every vertex is only bound to one bone? Explain your answer.