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Assignment on Advanced Computer Graphics - Sheet 1

Due Date 23. 04. 2015

Exercise 1 (Math For Ray Tracing Beginners, *5 Credits*)

In the lecture some methods for calculating intersections between a ray and arbitrary primitives were discussed (see slides: *Intersection Computations Ray-Primitive*).

1. Calculate, whether the triangle T with vertices $V_1 = (1,1,1), V_2 = (5,1,1), V_2 = (1,5,1)$ is intersected by the ray R_1 with $P = (3,2,0), d = (0,0,1)$.
2. Draw a suitable three-dimensional sketch that represents the relationship between ray R and triangle T.
3. Give and explain the algebraic method for calculating the intersection between a ray and a sphere
4. Calculate, with the algebraic or geometric method, whether a unit sphere S is intersected by the ray R_2 with $P = (0,0,5), d = (0,0,-1)$.
5. Make a suitable three-dimensional sketch, which represents the relationship between ray R_2 and sphere S
6. Calculate, whether the two-dimensional AABB with extremals $E_1 = (-2,-2)$, $E_2 = (3,5)$ is intersected by ray R_3 $P = (-3,6), d = (0.5,-0.2)$

Exercise 2 (Ray Tracing vs Scanline, *5 Credits*)

The complexity of ray tracing is sometimes called "output-sensitive"; this refers in general to algorithms the complexity of which scale with the size of the output (in our case: the size of the image).

Compare ray tracing and scanline conversion:

- For rendering a complete scene using scanline conversion, one must scan-convert each triangle with its vertices.
- For rendering a complete scene using ray tracing, one must trace a ray through each pixel.

1. Determine the (worst-case) complexity of rendering a polygonal scene with scanline conversion. You can assume that the complexity for each triangle depends on the number of its pixels; you can further assume that all triangles are inside the view frustum. Determine furthermore the complexity when rendering the scene with ray tracing. You can assume that only primary rays are used (no shadow rays, no secondary rays) and that the complexity for one intersection between ray and scene costs $log\ n$, where n is the number of polygons.
2. Estimate the (worst-case) complexity, when l light sources are present in the scene. For scanline conversion, assume the Phong model.