Doc. Dr. Alexander Wilkie
CGG KSVI MFF
Charles University in Prague

Prague, May 14th, 2012

Assessment (posudek vedoucího) of the Master's thesis titled

"Acceleration of Ray-Casting for CSG scenes"

submitted by Bc. Petr Zajíček

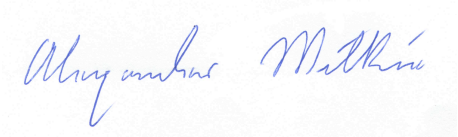
In his thesis, the candidate deals with the problem of accelerating ray-object intersection calculations, which are the most performance-critical component of modern renderers, for scenes that are modelled by using set-theoretic Constructive Solid Geometry (CSG) operations. While during the past 10 years considerable advances in the speed of ray-object intersections were made via the introduction of specially tuned versions of acceleration data structures such as kD-trees, these so far are only applicable to scenes that only consist of polygons.

The candidate uses one of the proven acceleration structures for polygonal scenes (kD-trees), and adds a separate tracking data structure (the OKD-tree) to it that allows it to handle the semantics of CSG with minimal overhead. The speed of such a hybrid CSG tree is of course lower than that of hard-wired triangle mesh code. But as the results of the candidate show, the much reduced number of geometric primitives in a CSG scene can counteract this effect, up to the point that the CSG ray casting of similar shapes is on par with polygon mesh raycasting in terms of speed, while retaining the original geometry without any tessellation artefacts. Especially for high-quality rendering, the latter point can be an advantage, since high-quality tessellations consume large amounts of resources.

The main weak point of the thesis is the comparatively limited evaluation that was done. A number of carefully chosen and representative scenes was evaluated, but especially given that the technique appears to perform well, it would have been very interesting to see how it behaves for a wider array of more complex models, such as objects taken from engineering software, where CSG is commonly used. It would also have been very interesting to see “heatmap” visualisations of kD-tree traversal effort on a per-pixel basis (a common evaluation in ray tracing research), and to investigate the effect that scene graph reordering might have on the efficiency of the technique, especially with regard to reduction of object overlap.

But overall, the fact that the candidate managed to get the OKD-tree to work as efficiently as he did is a substantial achievement by itself that will probably be published at a later point. As such, the presented work is a solid result. In the opinion of the supervisor, the thesis achieved its stated goals, can be recommended for acceptance.

Sincerely,



Alexander Wilkie