Model Simplification for Real-Time Rendering

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We are requesting a 60,000$ funding for research on display acceleration and model simplification.

The ever-increasing size of 3D models makes display acceleration a crucial issue. It can be addressed through two complementary approaches: fast culling of invisible portions of the scene, and model simplification. In addition, more attention must be paid to the integration of these techniques and to the design of strict real time rendering - i.e. with a time budget – that can adapt to the available resources. In this project, we are investigating new approaches to model simplification that address the limitations of current method

The simplification of a 3D model to a smaller number of primitives has for the most part relied on the greedy decimation of triangles, which can be seen as gradient descent in mesh space. Current solutions are very effective for outputs that still contain a significant number of primitives (several hundred triangles) and that have a continuous manifold structure. In contrast, *extreme simplification* aims at producing models with a number of primitives orders of magnitude smaller. In addition, we want to develop techniques that can simplify any class of models, including complex disconnected models such as vegetation.

This raises additional problems, including proper error metric and that of local minima in mesh space. We propose to address extreme simplification through two new approaches: the use of different primitives, and novel optimization strategies. We are working on a new representation called *billboard clouds* that bridges the gap between purely geometric (polygon-based) and image-based representations. Billboard clouds are very general primitives that consist in a set of rectangles with texture and alpha (transparency) masks. It is important to note that no only will billboard cloud offer a simplified version that permits faster display; they will also alleviate most flickering and aliasing issues by providing mip-mapping. Simplifying a model into a billboard cloud then reduces to the choice of a set of planes that best approximate the input model. This is an NP-hard geometric optimization problem that we plan to address through heuristics.

We also want to develop simplification techniques leveraged to the higher-order curved primitives that are becoming available on graphics hardware. These smooth primitives should allow tighter simplification, but they require the development of entirely new algorithms since previous methods rely heavily on the planar nature of triangles, for example through the use of linear algebra tools.