Generating Adaptive Distance Fields from Triangle Meshes

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Representing surfaces as triangle meshes has been the standard for computer graphics due to their versatility and hardware-optimized rasterization algorithms. Nevertheless, certain operations, such as offsetting, require complex computations in this representation. Signed distance functions have the advantage of supporting a wider range of operations and can be rendered in real-time.

Using implicit representations of surfaces, complex objects can be constructed by set operations on simpler well-defined shapes. As a result, the complexity of a mesh greatly affects the rendering performance. This is especially problematic with the standardized triangle mesh representation of objects [1].

Unfortunately, it is infeasible to compute the analytical signed distance function for typical triangle meshes. To overcome this limitation, we discretize the distance function whilst generating an octree for efficient storage. This data structure can be optimized using a variety of adaptive techniques [2, 3] since its density and depth are strongly correlated with performance.

The aforementioned discretization relies on linear interpolation which in turn requires signed distance values to define the zero-level set of the surface. In our research, we investigated algorithms that attempt to robustly partition the space into inside and outside regions.

An efficient bidirectional mesh conversion to distance fields allows a variety of mesh operations such as offsetting and morphological operations like dilatation and erosion.

References

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