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Fast Scene Voxelization and Applications

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Abstract

This sketch paper presents an overview of “Fast Scene Voxelization
and Applications” published at the ACM SIGGRAPH Symposium
on Interactive 3D Graphics and Games. It introduces slicemaps
that correspond to a GPU friendly voxel representation of a scene.
This voxelization is done at run-time in the order of milliseconds,
even for complex and dynamic scenes containing more than 1M
polygons. Creation and storage is performed on the graphics card
avoiding unnecessary data transfer. Regular but also deformed grids
are possible, in particular to better fit the scene geometry. Several
applications are demonstrated: shadow calculation, refraction si-
mulation and shadow volume culling/clamping.

1 Method

Voxelizing a scene means testing geometry for intersection with an
englobing grid of cells. Our approach accomplishes this task effi-
ciently with graphics hardware. Instead of interpreting RGBA as 4
unsigned byte values, we will consider it as a 32 bit vector, which
itself corresponds to a 32 cell column in the voxelization. An image
is thus nothing but a voxel grid, in which each cell is represented
by one bit. We call this representation slicemap. The implementa-
tion is simple and allows the voxelization of millions of polygons
in real-time. In the future, when 32 bit logical operations become
available, 4 MRT×4 channels×32 bits = 512 slices are obtained
in a single pass. Our approach shows several similarities to the
work by Dong et al.[Dong et al. 2004], who also store depth in bits.
Some major differences exist. First we do not fuse several views
(which reduces cracks, but limits resolution). Second voxel grids
usually contain axis-aligned cubes, whereas our approach offers se-
veral ways to deform the grid (e.g. improving precision by local
refinement based on two depth masks containing the furthest and
closest fragment for each pixel). We also present a fast technique
to obtain a filled voxelization without iterative flood fill operations
and present all-new applications.

2 Applications

Transmittance Shadow Maps: Illumination is attenuated based on
the number of blockers traversed by each light ray before impinging
on the surface. This calculation can be performed quickly due to
the way we represent voxels and leads to convincing effects for
complicated objects like trees or hair at low cost.

Shadow Volume Culling and Clamping: Slicemaps offer the pos-
sibility to cull and clamp shadow volumes [Lloyd et al. 2004]. The
aforementioned possibility to deform the voxel grid is key here.

Refraction: Given a watertight object, we obtain a filled voxel re-
presentation avoiding flood fill. We estimate the object’s volume
and use it for refraction and scattering effects.

3 Conclusion

The paper presents a GPU adapted voxel representation, applicable
to any rasterizable object providing depth. The presented applica-
tions are not straightforward and present contributions on their own.
Local refinement combines the advantage of exact shape informa-
tion and approximated volume and results in a good overall estima-
tion. Error analysis and conservativity remain future research.

References

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