A Directional Occlusion Shading Model for Interactive Direct Volume Rendering

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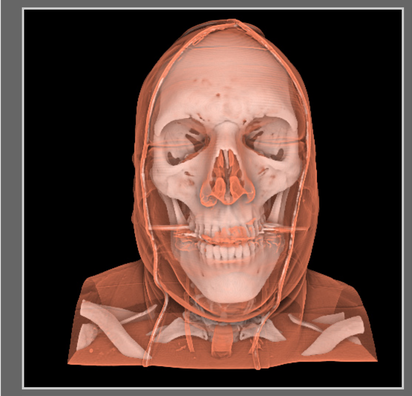
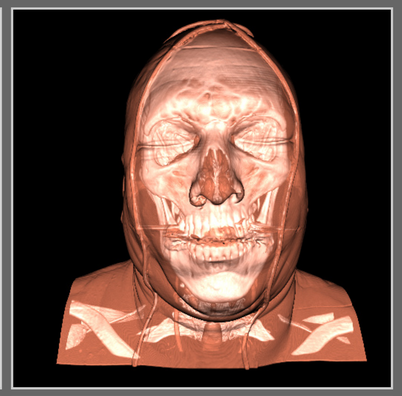
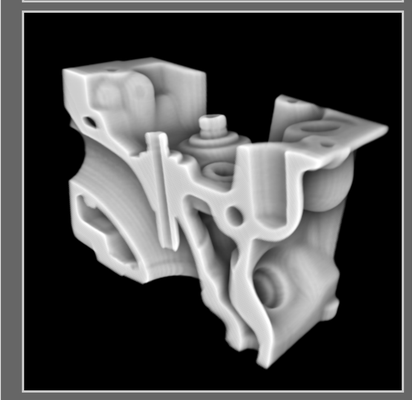
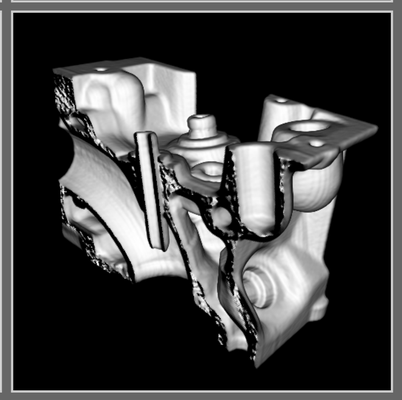
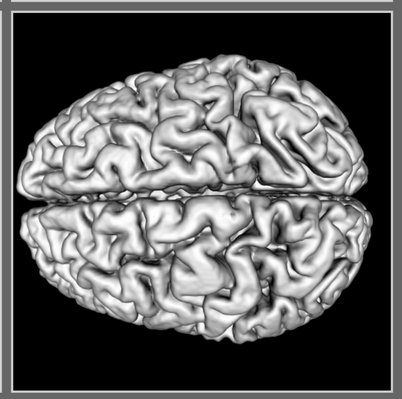
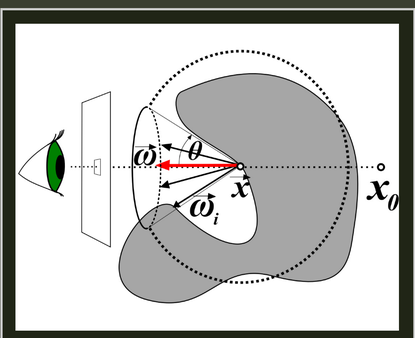









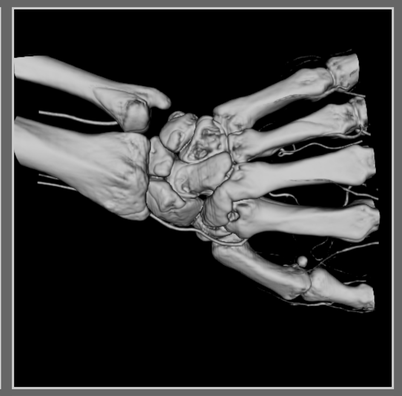
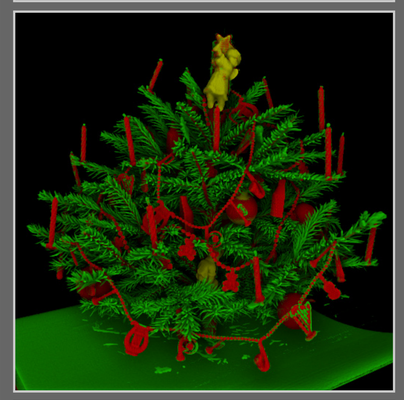
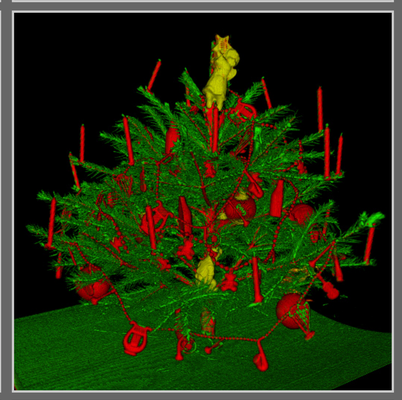
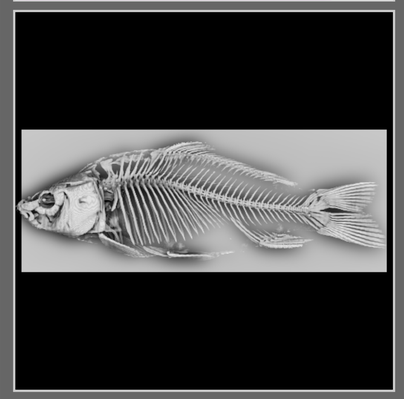
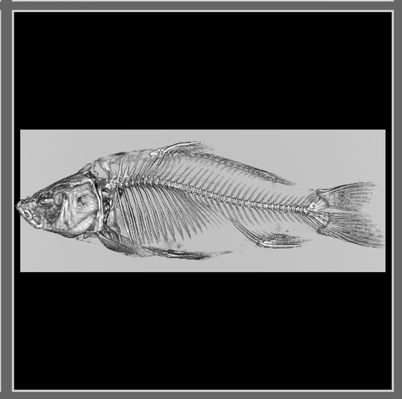
- **Volumetric rendering** is widely used to examine 3D scalar fields
  - Key aspect: provide perceptual cues to aid in understanding the data set
- Shading models with natural lighting conditions better convey depth information and spatial relationships
  - Traditionally require considerable (pre)computation.
- **Directional Occlusion Shading** (DOS)
  - Plausible occlusion effects
    - Qualitatively similar to full ambient occlusion
    - Solid and semi-transparent features
  - **interactive change** of
    - Transfer function
    - Clipping planes
    - Camera position
- Global ambient occlusion solution expensive
- Other methods compute locally spherical occlusion
- DOS considers all features between a point and the ambient light
  - Restricted to a subset of the sphere
- **Specialized phase function**
  - Backward peaked cone
  - User specifiable aperture angle



The geometric setup of the proposed direct occlusion shading model showing the conical subset of the sphere used to compute the occlusion.



A Monte-Carlo raytracer was used to empirically compare volumetric ambient occlusion with an isotropic phase function (left) and directional occlusion (center). While the results differ, the cone phase function is able to highlight features of interest for visualization purposes in a manner similar to full ambient occlusion. The interactive approximation (right) presents slight differences with the reference images, it allows most of the complex shading effects to be rendered at interactive frame rates.

Various data sets showing the difference between directional occlusion shading (left column) and diffuse Lambertian shading (right column) for different data sets, whose features have been highlighted using two-dimensional transfer functions.

On the left side, from top to bottom: a) Visible male data set with occlusion of solid and transparent materials **b)** CT scan of an engine block where a clipping plane was used to show the exhaust port **c)** Tree data set of which complex features are exposed by the ambient occlusion approximation **d)** The creases of the brain data set are highlighted by the occlusion shading model

On the right side, from top to bottom: a) a hand, **b)** a decorated tree , **c)** a carp and **d)** a skull. Even though the diffuse shading model provides basic hints about shape, the directional occlusion shading model accentuates structures such as concavities and depth discontinuities.

Citation: M. Schott, V. Pegoraro, C. Hansen, K. Boulanger, and K. Bouatouch. A directional occlusion shading model for interactive direct volume rendering. In Computer Graphics Forum (Proceedings of Eurographics/ IEEE VGTC Symposium on Visualization 2009), pages 855–862, 2009.