Using Depth Perception to Enhance Volume Rendering

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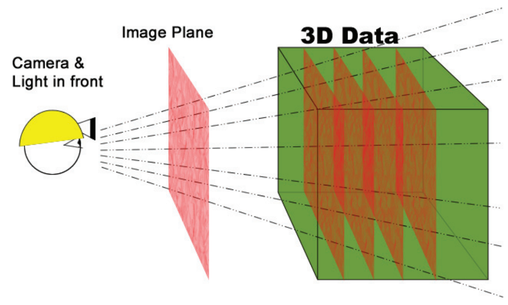
Volume Rendering is a technique that allows us to interactively and in 3D, visualize data from simulations, CT Scans & MRI. It is mainly used to allow scientists and researchers to visualize data.

The raw data is often too massive to comprehend. However, humans are inherently good at looking at pictures and animations. Our job is to accurately visualize these datasets so that scientists can better understand them.



Occlusion Shading & Depth of Field

The simplest volume rendering only maps colors to scalar values in the dataset. Our aim is to provide commonly found depth cues to allow for better depth perception in the datasets.

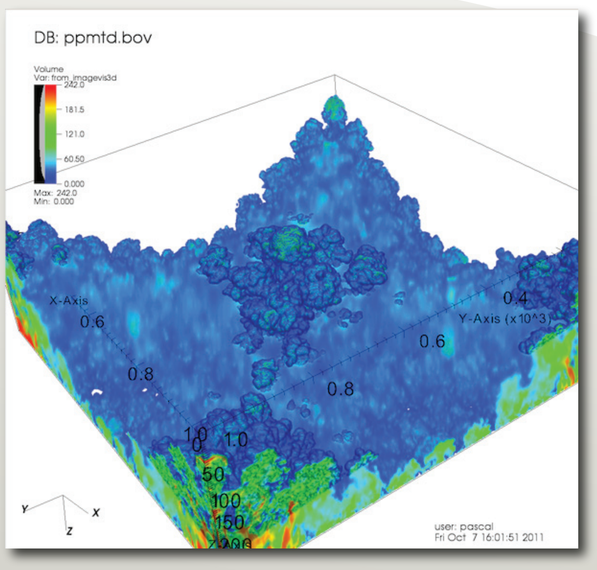
Occlusion Shading darkens regions that less light reaches compared to regions that are directly in front of a light source. It allows us to better differentiate between different regions directly in front of a light source and those in shadows. For example in the tree dataset on the right, for the region on the right, we can easily see which leaves are behind others. This mimics a real tree where leaves inside get less light.

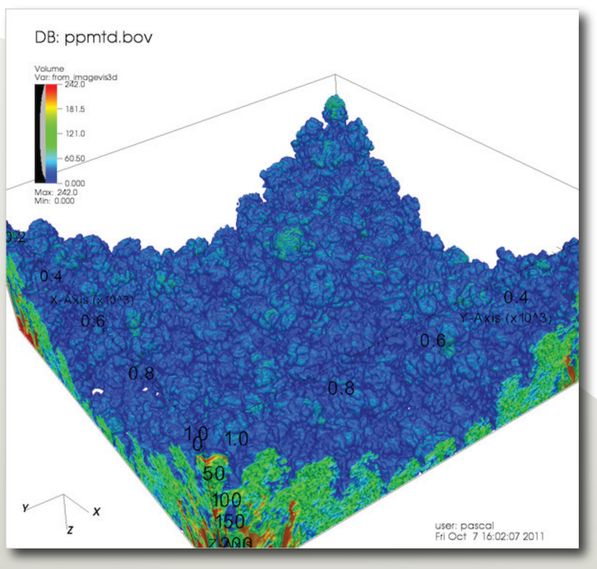
Depth of Field allows us to focus on a specific part of an object while blurring the regions not in focus. It allows us to differentiate between regions in front and behind what we are focussing on.

Occlusion Shading

Depth of Field

Results



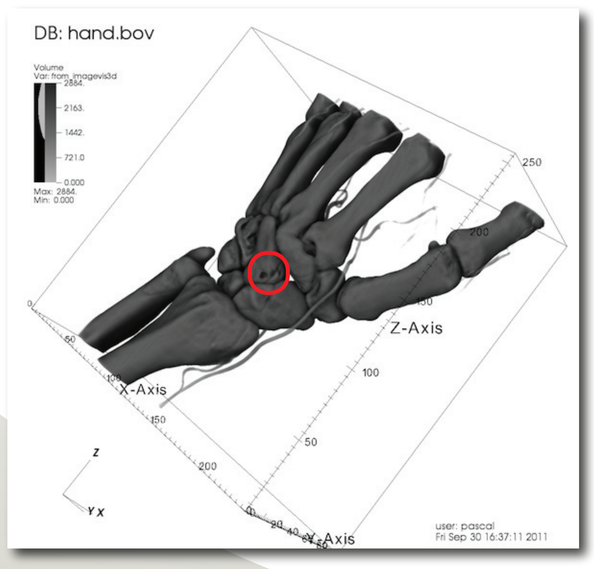


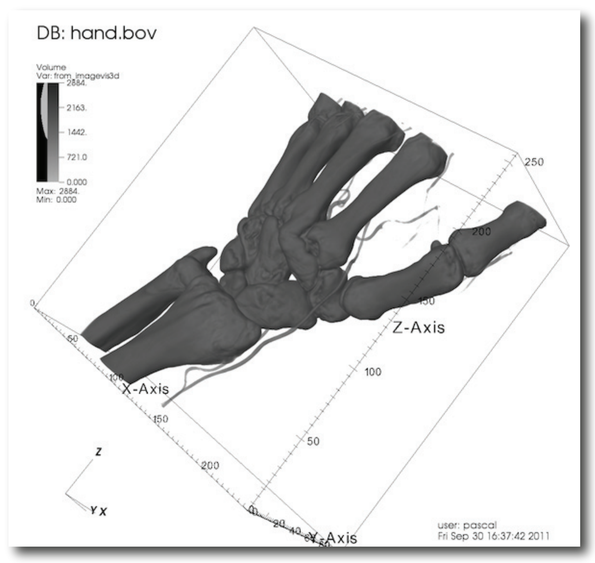
Depth of Field

The image on the left shows a combustion dataset with depth of field while the one on the right shows the usual shading in volume rendering.

Notice how cluttered the image on the right hand side is. It makes the data hard to examine as there are too many features.

Depth of Field allows us to preserve context while at the same time allowing us to focus on regions of interest in the volume.





Occlusion Shading

The image on the left shows a hand dataset with occlusion shading while the one on the right shows the usual shading in volume rendering.

Notice how the details are much more visible for the left hand side, like the holes, circled in red, compared to the right hand side.

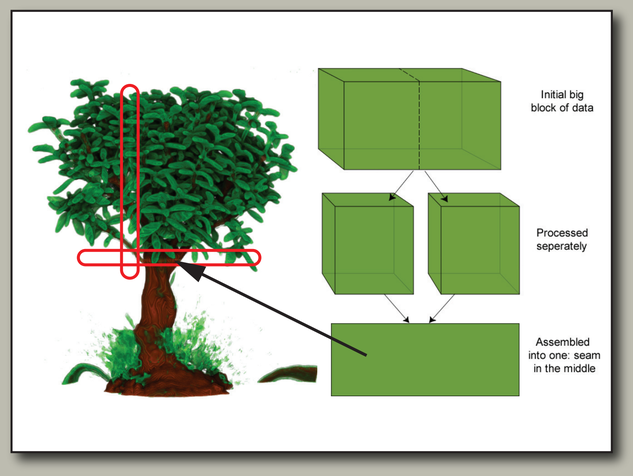
This makes occlusion shading an extremely valuable tool to allow scientists to spot details in their data.

Future Works & Challenges

A lot of data produced by simulations are massive and cannot be loaded and processed all at once into the computer's memory. So we break the data into smaller chunks (or bricks) that the computer can handle. However, it is hard to apply our improved visualization techniques when bricks are processed separately and not have visualization artifacts in the process.

Notice the white lines circled in red on the tree. The lines show where the dataset has cut in bricks.

We are working on eliminating those artifacts.



References

1. Mathias Schott, Vincent Pegoraro, Charles D. Hansen, Kevin Boulanger, Kadi Bouatouch: A Directional Occlusion Shading Model for Interactive Direct Volume Rendering. Comput. Graph. Forum 28(3): 855-862 (2009)
2. Mathias Schott, A. V. Pascal Grosset, Tobias Martin, Vincent Pegoraro, Sean T. Smith, Charles D. Hansen: Depth of Field Effects for Interactive Direct Volume Rendering. Comput. Graph. Forum 30(3): 941-950 (2011)

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These developments will be integrated in VisIt: an Open Source visualization software that can display a number of different visualizations. VisIt is developed by:

Lawrence Livermore National Laboratory

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