§2. Volume Rendering Using Texture Mapping

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When three-dimensional data have to be visualized, the volume rendering has been well used for more than a decade. This method enables complex volume data to be visualized effectively and directly, and the users to understand the important information in the volume data better. However, this method needs enormous computation, so creating images takes long time. In other words this process is generally very slow. Thus the creating images coinciding with the changes of the viewing direction is very difficult on CAVE[1] or the other systems without the hardwares for this method.

We propose a method of the volume rendering using texture mapping of OpenGL, which is enough fast without the hardwares. We introduce the volume rendering using the conventional method, ray casting, first and then our proposed method.

i) The Volume Rendering using Ray Casting

First the opacities are given to the each voxel of the volume data (The voxel is, simply speaking, the three-dimensional pixel.), and the projection plane are defined. This method decides the color of the pixel on the projection plane, say the intersectional point between the plane and the ray emitted from the viewing point, by sampling the colors of the voxels at an equally spaced interval along with the ray (see Fig.1) and then calculating following equation,

$$C = \sum_n C_n \times \alpha_n, \qquad (1)$$

where C_n is the color of the sampled voxel and α_n is the opacity of that. The contribution of each voxel is $C_n \times \alpha_n$. This process is done to all the pixels on that plane.

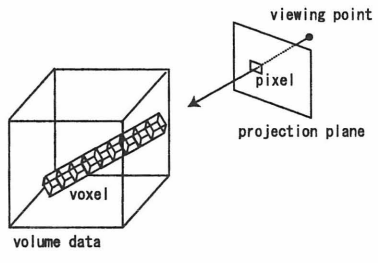

Figure 1: Concept of Volume Rendering

ii) Our Proposed Method

We can make computers draw pictures, photograghs and something like that easily and fast on the screen by the texture mapping of OpenGL. Further the pictures with the opacities can be drawn. The same effects as the volume rendering could be gotten by placing the pictures with the opacities in a row. We use this property.

Our method consists of creating three sets of the images related to the surfaces of the cubic volume data (see Fig.2) first and changing the displayed set of the images coinciding with the position of the viewing point. The defect of this method is that the viewing point being at the oblique point to the surface of the cubic, the displayed image becomes a little darker.

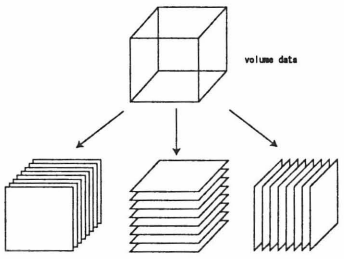

Figure 2: Concept of Our Method

We examine the frame rate of the volume rendering using the ray casting method and those using our method on CAVE which has no hardware for volume rendering, and find that the process of our method is much faster. Besides the images created by our method seem to be by no means inferior to those by the conventional method.

We think that this method is practical.

References

[1] C.Cruz-Neira, D.J.Sandin and T.A.DeFanti : "Surround-Screen Projection-Based Virtual Reality : The Design and Implementation of the CAVE", Proceedings of SIGGRAPH '93 Computer Graphics Conference, pp.135-142 (1993)