The Eighteenth International Symposium on Artificial Life and Robotics 2013 (AROB 18th '13),
Daejeon Convention Center, Daejeon, Korea, January 30-February 1, 2013

Fusion visualization of surface and volume on AVS/Express

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Abstract: Due to the innovation of super computer technology, the output of simulation by using such high performance computers has complexity and the data size is going to be too large. That makes difficulty to visualize the output for the evaluation and the analysis. To solve the issue, we have started a project sponsored by Japan Science and Technology Agency (JST) in which we develop a new visualization system named "Fusion Visualization" on a commercial software package AVS/Express. It will provide the volume rendering visualization with the surface rendering for conventional visualization methods. In this paper, we will present the plan and some preliminary visualization outputs by using the prototype system.

Keywords: visualization, super computing, volume rendering

1 INTRODUCTION

A volume rendering has an advantage that is smaller memory cost than a surface rendering. However, most of volume rendering methods requires the sorting of objects when the scene includes semi-transparency cells. It makes a difficulty of the parallel processing. To avoid the drawback, we have developed a sort free volume rendering method called Particle Base Volume Rendering (PBVR).[1] It solved the parallel issue, but it brought about a new problem. That was a difficulty of combining with surface rendering.

Then, we have started a project to develop new visualization software which can apply a volume rendering and a surface rendering to a scene. In this paper, we introduce the project plan and some outputs by the prototype version.

2 Particle Base Volume Rendering

A volume rendering is an image generation method that can be applied to scalar value defined at volume cells. In a typical method: ray casting method, a ray is extended from a pixel on a screen and sampling points are generated on the ray. Then, color and opacity values at each sampling point are calculated from the scalar value by a transfer function. Finally the color and opacity values on the pixel are calculated by integrating values along the ray (Fig.1).

Within this method, the integration has to be accumulated from the back to the front if one or more semi-transparency volume cell exist. It brings about the performance down especially to unstructured grid data.

To overcome the drawback, we have proposed a new model to volume rendering shown in Fig.2. In our model, it assumed that the inside of a cell is full of the light emission particles. The density of the particles is defined by the cell's transparency value. High transparency cell has a probability of small number of particles and low transparency cell has a probability of large number of particles.

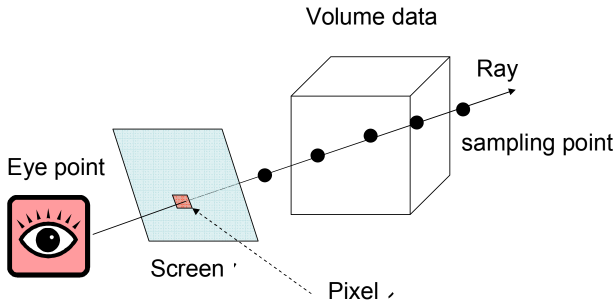

Fig.1 Ray casting volume rendering

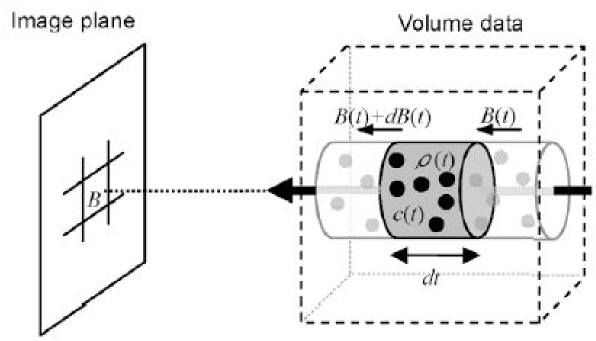

Fig.2 Light emission particles model

Particles generation and volume rendering are performed repeatedly. It is known that the ensemble average of all images is approaching to the correct image. We called this method PBVR. This method does not require the sorting of cells, but requires much computer cost in proportion to the number of rendering. However, the number is controllable. Users can select the number of repeat according to the image quality needed.

3 Integrating PBVR to conventional surface ren dering

There are two ways to integrate volume rendering to surface rendering. The first is a method of carrying out a volume rendering after a surface rendering. The color and Z value which the surface rendering generated are used as an initial value of volume rendering. The second is voxelization. A volume rendering is carried out after converting surfaces to volume. Most of cases are using the first way.

Figure 3 shows an integration result of surface and volume rendering by a commercial software package: AVS/Express[2].

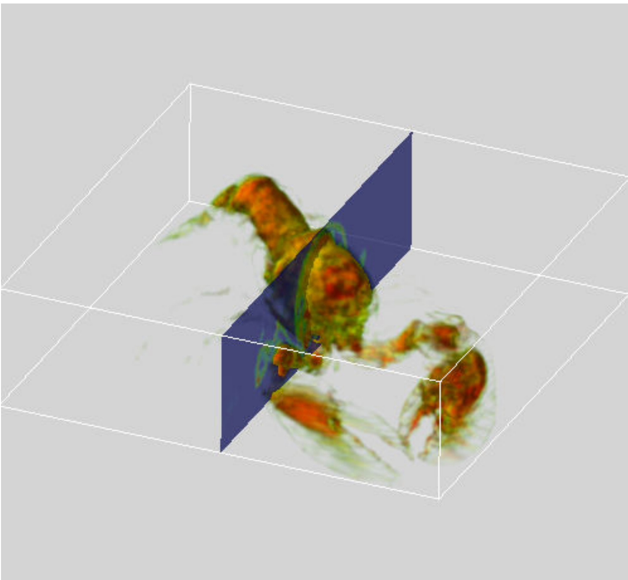

Fig.3 Integration of surface and volume rendering

The volume data in Fig.3 includes a lobster CT-scan image. A volume rendering visualizes the shape of the lobster and a surface rendering visualizes the density profile on a cross section and the external edges of the volume data. It may seem perfect, but it is not guaranteed the correct rendering when the visualization includes semi-transparency surface and volume.

Figure 4 is a case that the conventional method makes an ambiguous visualization about depth judging. This figure includes a teapot and a hydrogen molecule. The teapot is shown by a surface rendering and the hydrogen is shown by a volume rendering.

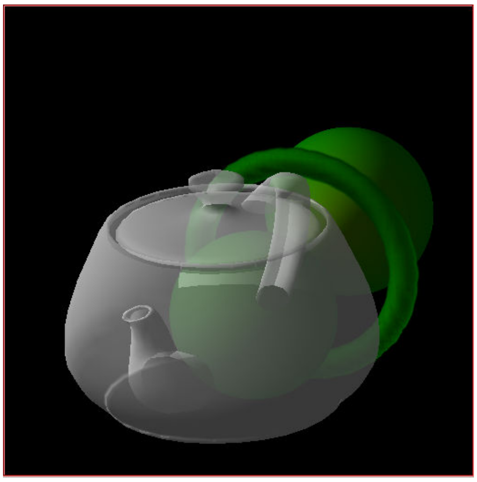

Fig.4 Ambiguous depth judging

As far as seeing this picture, it seems that the teapot is located in front of the molecule. It is misunderstanding which comes from the ambiguity of a depth judging.

4 Our goal and the implementation plan

We are going to implement a fusion visualization in which PBVR is integrated to conventional surface rendering. The goal of our project is to make a base of a sustainable product. Therefore, we are planning to implement the new visualization method on AVS/Express which has been maintained by CYBERNET SYSTEMS CO., LTD.(Tokyo, Japan) and .Advanced Visual Systems Inc.(MA, USA). The user interface is shown in Fig.5.

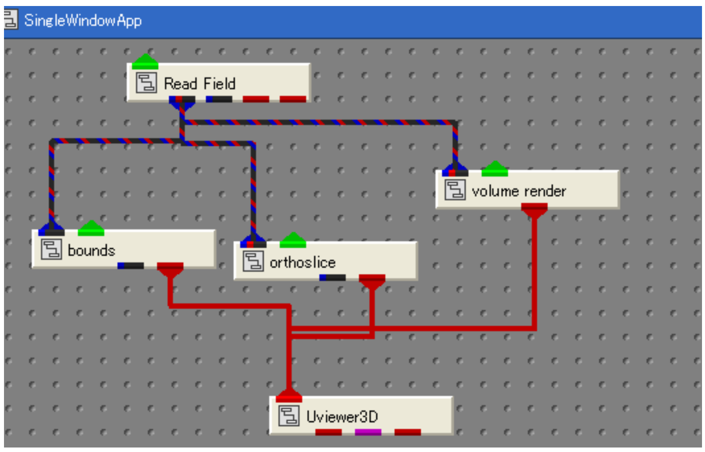

Fig. 5 User interface of AVS/Express

AVS/Express is designed by object orientation. Rectangle icons in Fig.5 represent modules. Lines between icons represent data flow. A set of the modules and the lines is called network that means a visualization program. For example, figure 5 illustrates the program to visualize Fig.3. Read Field loads the lobster volume data from a disk. And bounds, orthoslice and volume render visualize the external edge, the cross section profile and the lobster volume rendering respectively. Uviewer3D gives us mouse interaction to rotate, scale or translate the object. We plan to implement our fusion visualization as modules in it.

Within the first year (Oct 1st 2012 - Mar 31st 2013), we will develop the prototype version. It works on AVS/Express and visualize surface and volume data by OpenGL surface rendering and PBVR respectively. In the second year (Apr 1st 2013 – Mar 31st 2014), we will evaluate the prototype. We are looking for the evaluation partners who need large scale visualization or complex visual data mining. The points of the evaluation are as follows.

(1) Ease of use of a user interface
(2) Performance and efficient memory use
(3) Image quality of fusion visualization

In the final year (Apr 1st 2014 – Mar 31st 2015), we will enhance the software to respond the comments from evaluators.

5 Preliminary results by early prototype

5.1 Correct depth judging

Figure 6 shows the visualization result by our early prototype.

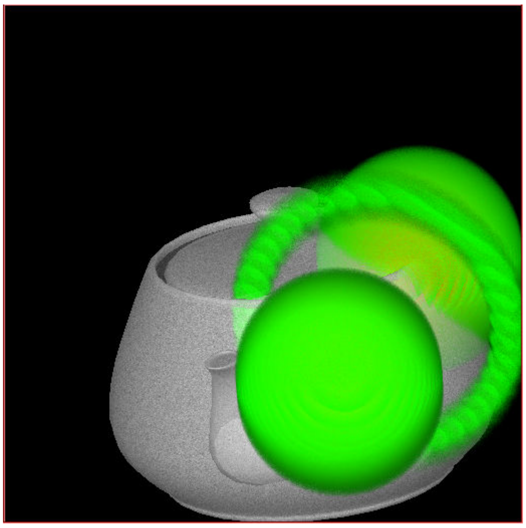

Fig. 6 Correct dept judging by our early prototype

The visualized data is the same as Fig.4. The conventional method could not visualize it with the correct depth judging. On the other hand, PBVR can visualize it correctly. The teapot and hydrogen are located in the same area.

5.2 Visualization of ocean data

Another trial result is shown in Fig.7. It shows a oceanographic data set simulated by the MRI Multivariate Ocean Variational Estimation (MOVE) System developed by Japan Meteorological Agency (JMA) and Meteorological Research Institute (MRI).

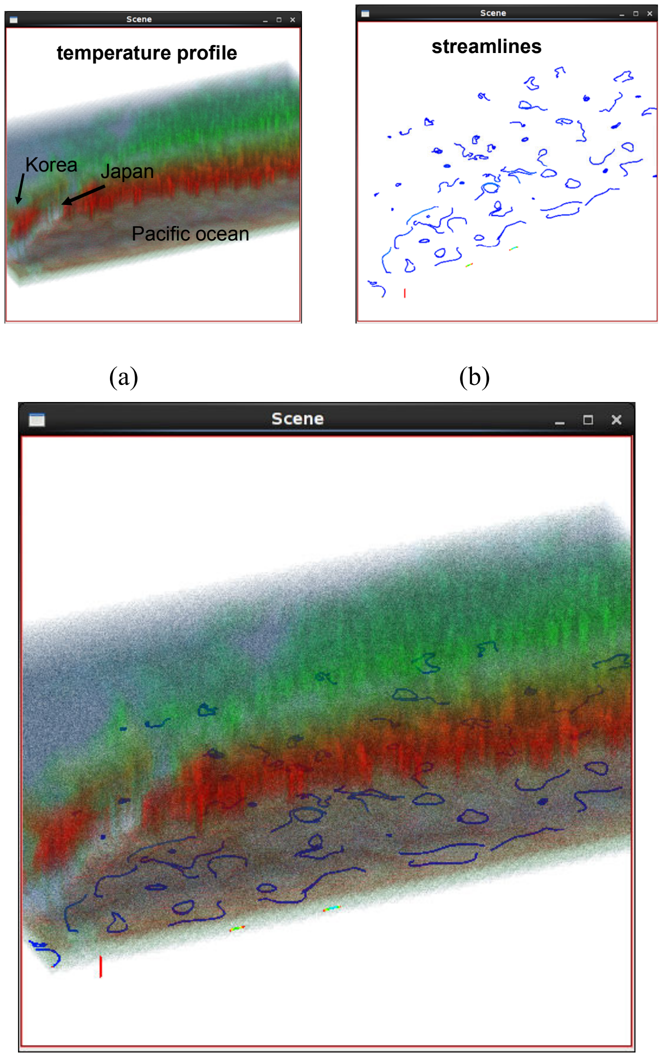

Fig.7 A fusion visualization trial result
(a) Volume rendering (b) Streamlines
(c) Fusion visualization

This picture Fig.7 (c) includes both surface rendering and volume rendering. The streamlines representing the velocity profile (Fig.7 (b)) are shown by surface rendering and the temperature profile (Fig.7 (a)) is shown by volume rendering. The transfer function should be more optimized for the picture, but the early prototype does not have interactive interface to adjust it. That point will be one of our future works.

4 CONCLUSION

We have proposed a fusion visualization of surface and volume rendering for large scale visualization. We have developed an early prototype and showed some trial results by it. We will finish the first version for evaluation until the end of March 2013 and evaluate it in 2014 with voluntary evaluators. In the spring of 2015, the fusion visualization system will work with commercial software: AVS/Express with easy-to-use interface.

Acknowledgment

This work was partially supported by a project A-STEP<AS2415031H>: "The research and development of Fusion Visualization technology", of Japan Science and Technology Agency (JST). We would like to thank Dr. Hiromichi Igarashi from Japan Agency for Marine-Earth Science and Technology (JAMSTEC) for giving us the oceanographic datasets and Mr. Takashi Uenaka for supporting to our visualization.

REFERENCES

[1] Naohisa Sakamoto, Takuma Kawamura, Koji Koyamada,, " Improvement of particle-based volume rendering for visualizing irregular volume data sets", Computers & Graphics, Vol.34, No.1,2010, pp.34-42, 2010

[2] C. Upson, T. Faulhaber, D. Kammins, D. Laidlaw, D. Schlegert, J. Vroom, R. Gurwitz and A. Van Dam.： The Application Visualization System: a computational environment for scientific visualization, IEEE Computer Graphics and Applictaions, Vol. 9, No. 7, July. pp. 30-42., 1989

