Study of Large-Scale Data Visualization

Project Representative
Fumiaki Araki  The Earth Simulator Center, Japan Agency for Marine-Earth Science and Technology
Authors
Fumiaki Araki *1, Shintaro Kawahara *1 and Nobuaki Ohno *1
*1 The Earth Simulator Center, Japan Agency for Marine-Earth Science and Technology

Research and development for visualization technologies carried out by Advanced Perception Research Group of the Earth Simulator Center in the fiscal year 2008 are reported. In terms of YYView, a semi-interactive visualization and making animation system for large scale simulation data, two kinds of functions are newly developed. One is a function for multi-viewing function, which enables us to set a lot of different view volumes automatically, and the other is for re-editing camera path, which enables us to edit camera path parameters numerically on the key frame table. Armada, a software rendering version of MovieMaker, our parallel visualization program, is improved for plural scalar data visualization. For VFIVE, our virtual reality visualization program, several visualization functions are added. We are currently promoting VFIVE to each laboratory.

Keywords: large-scale data visualization, Parallel rendering, Virtual Reality

1. Introduction
Advanced Perception Research Group (APRG) of the Earth Simulator Center (ESC) focuses on two kinds of problems for scientific visualization of large-scale and three-dimensional simulation results with time evolution. One is the difficulty which comes from the fact that computational cost of data handling is much expensive, because the data size reaches several gigabytes per step. Interactive visualization, which is a typical style of data analysis on a researcher’s PC, is no longer possible without reduction of the data sufficiently small. For solving this problem, we have been developing a high-quality rendering and movie-making program, MovieMaker and a semi-interactive visualization program, YYView. Another is the fact that it is difficult to comprehend complicated structures like inter-twisted streamlines in the three-dimensional flow field. On the flat PC monitor, most of the depth information of visualized three-dimensional objects is lost, because of overwrapping each other. Virtual reality (VR), especially innovative visual display technology of VR, is a key to solve this problem. We have been developing three-dimensional VR visualization program named VFIVE, for several kinds of VR systems.

In this paper, we report the annual progress for researches and developments mentioned above. In Section 2, the progress on developments of the programs for large scale data visualization is reported. In Section 3, the progress of our virtual reality software VFIVE is reported. The final section is devoted to a summary.

2. Large-scale data visualization
2.1 Overview
One of the solutions for large-scale data visualization, we are continuously developing a program, named MovieMaker. MovieMaker is a parallel rendering program with one master process and slave processes, designed for the symmetric multiprocessor computer architecture [1]. A master process and slave processes share simulation data stored in a single shared main memory area. The master process performs the following tasks; (i) to read a configuration file, (ii) to read simulation data into the shared memory area; and (iii) to control the slave processes keeping a good load balance. Every slave process performs rendering tasks and then returns partial images back to the master via shared memory. Inter-process communications are performed with Message Passing Interface (MPI). The dynamic load balancing in MovieMaker is achieved by an active monitoring and dynamic control of the slave processes.

Before running MovieMaker, user should prepare a configuration file that includes information for data profiles and several kinds of visualization parameters such as lighting, viewvolume, color map and others for visualization functions. However, it is difficult to determine all of the parameters in advance. Those need to adjust interactively, watching results frequently displayed on user’s PC monitor. This difficulty has motivated us to develop a semi-interactive visualization program system, YYView.

YYView is composed of several kinds of tool programs such as a console program, a previewer, a color map editor, a
data reduction tool, a movie browser and MovieMaker as a renderer. Each of the tools is available as an independent program. However, when one uses each of them individually, whole of visualization procedures become cumbersome and complicated. YYView provides a simple and systematic work environment for user by linkage between those tools. In the YYView environment, a reduced data instead of the original (non-downsized) data is used for quick visualization. User can specify the appearance of visualization interactively through the previewer and the console program as shown in Fig. 1. After that, YYView throws the visualization parameters determined here to MovieMaker to generate high-quality images from the original large-scale data.

2.2 Development of additional user interface

In last fiscal year, we developed software to edit camera parameters, as one of YYView’s tool programs, applied with techniques of Computational Visualization Center, the University of Texas at Austin [2, 3]. The use of this program made it easy to set camera parameters with viewpoint motion for YYView. In this fiscal year, two visualization functions were implemented to this software.

1) Multi-view camera function

Observing simulation data from various viewpoints is one of efficient analysis method. However, it is difficult to set a large amount of viewpoints for visualization manually in general visualization software. Using this function, viewpoints are set up automatically on the spherical surface centered on the origin of the data area at regular intervals, and this information is generated as camera parameters for YYView. Users can only set the number of subdivision in horizontal and vertical direction by dragging GUI sliders. Fig. 2 shows visualization results using camera parameters that were generated by this function.

2) Re-editing function of camera path parameters

In previous version, once a camera path was set, the only way to modify it is to delete current path and create new path. By this improvement, users can re-edit camera path inputting immediate values on key frame table that looks like spreadsheet software.

2.3 Derivative developments of MovieMaker

We have developed parallel visualization software called Armada based on MovieMaker [4]. The aim of this software is to visualize large scale data on supercomputers, and therefore it does not require any graphics hardware. So far, the visualization methods that this software could utilize were isosurface, slicing and volume rendering for scalar data and stream lines for vector data. For scalar data only one scalar
Chapter 4  Visualization

Fig. 4  A CAVE system "BRAVE" installed in ESC.

We opened its basic version to the public last year. Currently, everyone can download its source code from the web site of the Earth Simulator Center [7] and use it free of charge. The CAVE systems based on PC cluster with Windows are now widely spreading in Japan, however, the openedVFIVE is not executable on them. Actually we use SGI Onyx3800, not PC cluster. To increase the number of potential users, we successfully adjusted its source code to be executable on PC cluster based CAVE system. We have already handed VFIVE executable on PC cluster based CAVE to several institutes and universities, such as Osaka University and Chuo University (see Fig. 5), and now we are preparing to upload it on the web site of the Earth Simulator Center so that anyone can download and use it.

4. Conclusion
In this fiscal year, we developed several functions for setting camera parameters of YYView. For Armada, a visualization function plural scalar data is newly installed. In terms of VFIVE, we improved it for PC clusters and are currently promoting it to several laboratories such as Osaka University, Chuo University and so on. We have developed MovieMaker and VFIVE, for years of the medium-term programs of JAMSTEC. We think that these programs have been achieved our goal.

References


大規模データ可視化の研究

プロジェクト責任者
荒木 文明 海洋研究開発機構 地球シミュレータセンター

著者
荒木 文明*1, 丸原 慎太郎*1, 大野 暢亮*1

*1 海洋研究開発機構 地球シミュレータセンター

地球シミュレータセンターの高次計算表現法研究グループで本年度実施した可視化技術に関する研究開発を報告する。本グループでは、並列レンダリング型可視化プログラムMovieMaker、MovieMakerを核とした準対話型可視化プログラムシステムYYView、MovieMakerから派生したスーパーコンピュータ上でも動作する並列可視化プログラムArmada、およびパーソナルリアルティ可視化プログラムVFIVEの開発を継続的に進めている。YYViewに関しては、昨年度開発したYYView用カメラパラメータツールにマルチビュー・カメラ設定機能およびカメラパース再編集機能を加えた。Armadaについては、矢印によるベクトルデータの可視化機能や複数のスカラー・データを同時に可視化する機能を追加した。VFIVEについては、PCクラスタを用いたCAVE装置で動作するようソースコードの変更を行った。また、PCクラスタベースのCAVEを持つ複数の大学・研究機関に配布し普及に努めている。

キーワード: 大規模データ可視化, 並列レンダリング, パーソナルリアリティ