

Effective VR Visualization using Selectable Operation List

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1 Introduction

Visualization is a powerful measure to analyse three-dimensional simulation data (also observation data) and to extract information of specific physical phenomena that are included in it. In particular, the immersive visualization environment (IVE) based on the technology of virtual reality (VR) is known as one of the effective measures to analyse such the complex data [1].

VR visualization on IVE has the following two advantages as compared with desktop visualization. One is that user can understand easily and intuitively the three-dimensional structure of the specific phenomena in the simulation data. The other is that IVE is better suited for pointing the exact three-dimensional position, essential for the three-dimensional data analysis, than the traditional operation using mouse and keyboard as the input devices. On the other hand, there is a problem in the reproducibility of the visualization parameters that were set interactively. Solving this problem will make VR visualization more effective.

In this paper, we describe a method that used the history information of user's visualization operation for the purpose of performing VR visualization more efficiently.

2 Problem of Interactive VR Visualization

In handling of various parameters required for visualization, there is a fundamental difference between desktop and VR visualization. In desktop visualization, the parameters are usually set by inputting values on command line directly or mouse actions on a graphical user interface (GUI). These parameters can be confirmed as numerical values and easily reused. In VR visualization, such parameters are set by user's interactive operations. It is difficult to confirm and reuse these parameters because many of these programs do not have functions to do them.

We show a typical example of complicated structure of a large amount of streamlines in Fig.1. Actually, it is impossible to reproduce a same result of streamlines, because it is difficult to locate the seed of streamline on the exact same place using some pointing devices in the IVE.

In order to ensure reproducibility of characteristic three-dimensional structures that were shown in Fig.1, it is necessary to keep information of user's visualization operations. One of the ideas to solve this problem is to implement undo and redo function to VR visualization programs.

However, In these functions, users can only move backward (undo) and forward (redo) within the list of the recorded operations, which includes large amount of unnecessary operations. The efficiency of the data analysis in the VR visualization can be improved, if we can extract only necessary operations selectively.

3 Selectable Operation List

The aim of this work is to improve the efficiency of VR visualization by extracting only necessary visualization operation selectively.

Fig.2 shows the system configuration of the prototype. Mobile device is utilized to select necessary operation in IVE

via Wi-Fi. Through Wi-Fi to send and receive information between the IVE and the mobile device, users do not have to move inside and outside of the IVE.

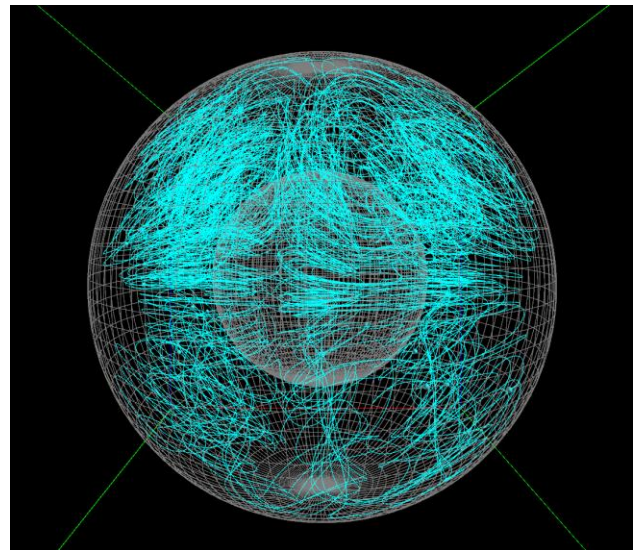


Fig. 1 Interweaving Streamlines using VFIVE [2], VR visualization program.

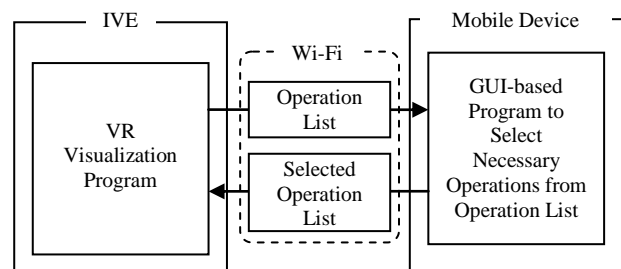


Fig.2 System Configuration

In order to achieve this method, we performed following things;

- A) implementations of the following two function to the VR visualization program:
 - A1) the function to record user's operations history,
 - A2) the function to restore only selected operations,
- B) consideration of the management methods of recorded user's operation,
- C) and development of the user interface to select necessary operations.

In this experiment, we utilize BRAVE [3], which is a CAVE-type VR system of JAMSTEC, as the IVE.

3.1 Record of User's Operations

In this prototype, to implement the recording function of user's visualization operations, we choose VFIVE. This is because that VFIVE is an open-sourced program and easy to expand. The list of recorded operations is generated as a file of ASCII format data. Fig.3 shows an example of the operation list that is generated by expanded VFIVE. User's operations are recorded as time series data.

```

Isosurface Scalar 1 t00
StreamLine Vector 1 x0, y0, z0
StreamLine Vector 1 x1, y1, z1
ColorContour Scalar 2 XY z0
Isosurface Scalar 2 t10
ColorContour Scalar 2 XY z1
Isosurface Scalar 1 t01
StreamLine Vector 1 x2, y2, z2
    
```

Fig. 3 An Example of Operation List

However, when the amount of these operations become huge, it is difficult to find only specified operations stored on the operation list. For this reason, it is necessary to devise in some way that only important operations are presented to the user. As a trial to solve this problem, we implemented the bookmarking function to VFIVE. Fig.4 shows the conceptual diagram of this function. When characteristic structures were discovered during visualization, user can record its timing as bookmarks by using this function. By displaying only the previous operations of bookmarks, the amount of information that is presented to the user is restricted.

We also implemented the function to restore visualization operations that are selected by the client program.

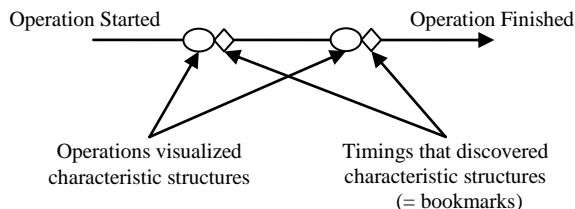


Fig.4 Conceptual Diagram of Bookmarking Function

3.2 Development of User Interface

The operations shown in Fig.3 can be expressed as a tree diagram, which is temporally called as "the selectable operation list", shown in Fig.5 when classifying each visualization method. Such the diagram representation is effective to pick the necessary operations from all of the operations. We developed a GUI program to generate the diagram automatically and to call each operation selectively. In this prototype, we used laptop PC in order to execute the developed program, though smaller mobile devices such as PDA, smartphone, and tablet PC are useful because these are lightweight when using that device in IVE.

4 Conclusion

In this paper, we described a method using the selectable operation list for the purpose of performing VR visualization more efficiently.

As future works, we are planning to verify the effectiveness of this method and to apply it to the other mobile devices.

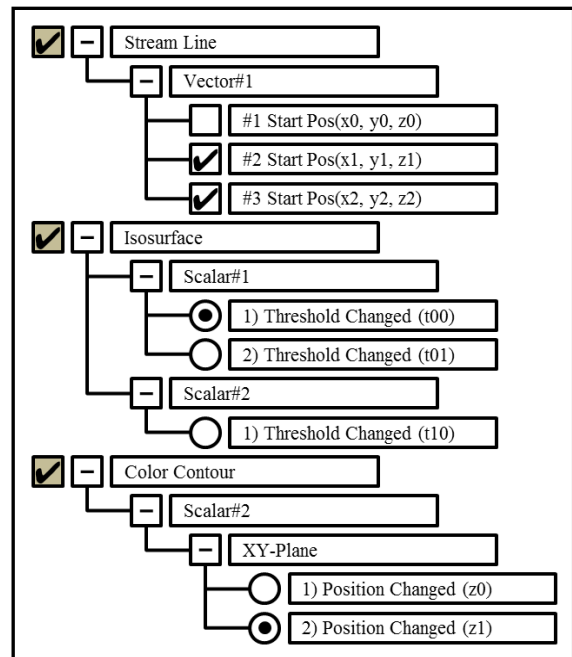


Fig. 5 An Example of GUI Framework (Tree View)

References

- [1] Andries van Dam, Andrew Forsberg, David Laidlaw, Joseph LaViola, and Rosemary Simpson, "Immersive VR for Scientific Visualization: A progress report", IEEE Computer Graphics and Application, Nov./Dec. 2000, pp. 26-52, 2000
- [2] Akira Kageyama, Yuichi Tamura and Tetsuya Sato, "Visualization of Vector Field by Virtual Reality", Progress of Theoretical Physics Supplement, No.138, pp.665-673, 2000
- [3] Fumiaki Araki, Hitoshi Uehara, Nobuaki Ohno, Shintaro Kawahara, Mikito Furuichi and Akira Kageyama, "Visualizations of Large-scale Data Generated by the Earth Simulator", Journal of the Earth Simulator, vol.6, pp.25-34, 2006