Methods for Virtual World Construction / Representation

- The third Group of "Virtual Reality " Research Project -

Michitaka Hirose
Department of Mechano-Informatics
the University of Tokyo

1. Introduction

The third research group of Monbusho scientific research project on the priority areas "Virtual Reality" is working on the topic of "Methodologies of Virtual World Generation". In other words, software aspect of Virtual Reality is the major interest in the third group. Projects such as development of rendering software for photo-realistic image generation, simulation software to implement physics of the virtual world, and communication software for networked VR system are included.

2. Virtual World Generation without 3D Models

The first topic is a software development for photo-realistic virtual world generation. In the field of computer graphics, we already have technology to generate very sophisticated image like a photograph. However, this technology cannot be used for the virtual reality technology, because VR image should be "interactive" and consequently generated within 10 milliseconds or so. Even though the capability of the graphics workstation is expected largely improved, we

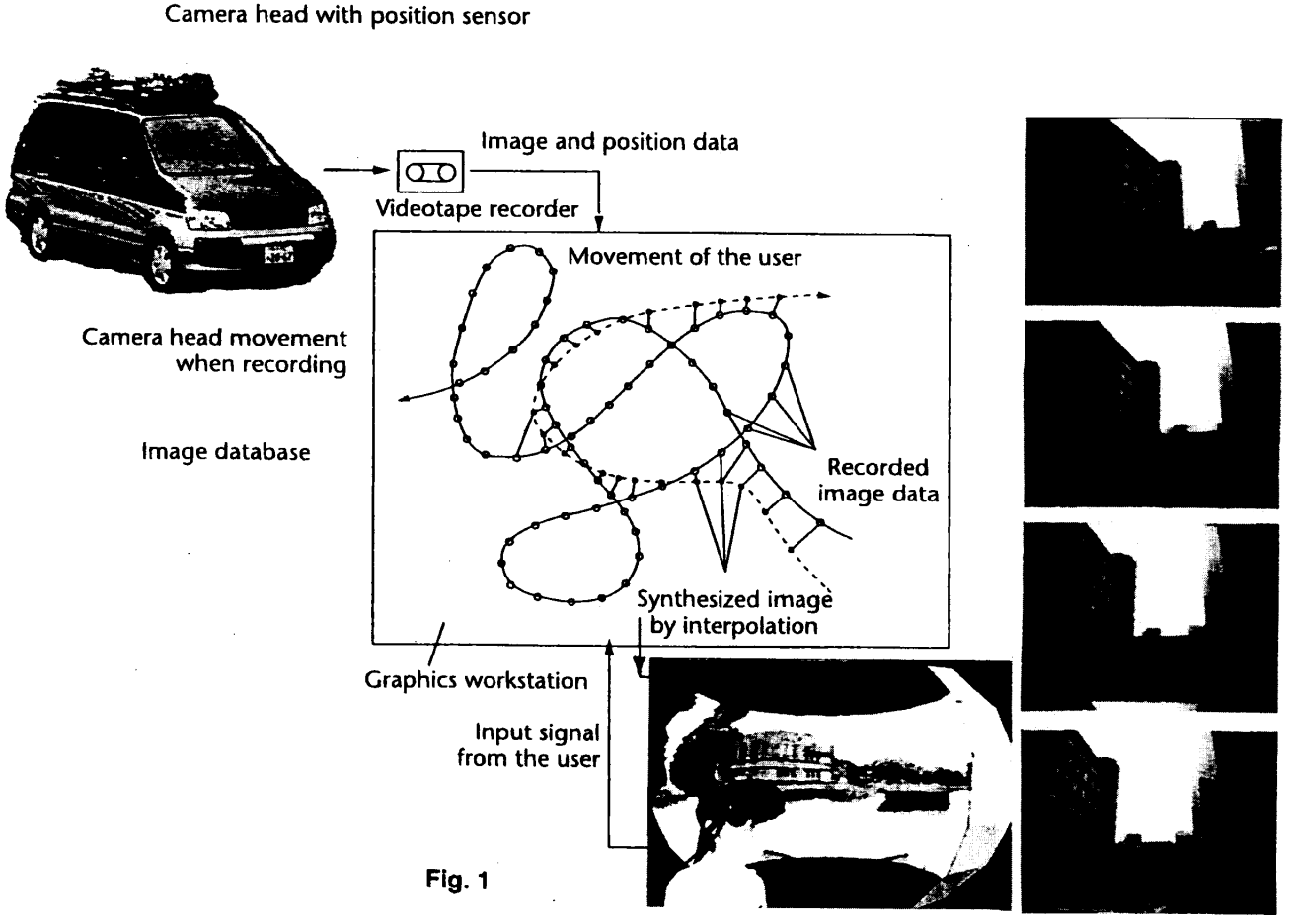

Fig. 1

won't be able to generate very complex virtual world such as landscape of city streets, within several years, if we still have to use a conventional 3D CG techniques.

In order to solve this problem, so called "image based rendering"(IBR) has come to be considered seriously. This methodology uses 2D photographic images as a source of 3D virtual space generation. One of the pioneering works of IBR is "Aspen Movie Map" developed at MIT's Media Laboratory in the early 80's. This system could provide interactive image space of the "Virtual Aspen" by using successive images pre-recorded on laser desk.

Today, we should be able to develop more sophisticated system than the "Aspen Movie Map". For example, real-time interpolation can be effectively utilized. If there are two images obtained from the view point A and B, and distance between A and B is small enough, image from the view point C near A and B can be synthesized by image interpolation.

Fig. 1 shows the basic principle of the newly developed system for construction of VR system covering broader areas.(1) One of the typical devices is an automobile equipped with cameras and GPS. By driving the automobile, image data from various view point can be obtained with its position information measured by GPS. The data are integrated in a high performance graphics workstation. We can synthesize any images from given viewpoints by using image interpolation mentioned above.

This system will be effective for constructing very large scale virtual space. In other words, application such as urban space archiving will be one of the promising application. Although this methodology requires huge amount of memories, it can be an alternative of conventional computer graphics based on 3D models.

3. Physics of Virtual World

The next major topic is to add physics to virtual objects in a virtual world. Real time simulation software is essential to give virtual objects realistic motion.

Fig. 2 shows that a virtual rubber sheet is being torn.(2) The virtual rubber sheet has divided into many meshes (cells). If the stress states in one cell exceeds the certain limit, the cell is re-divided into smaller cells for more precise calculation. If the stress of a smaller cell exceeds the limit again, connection between cells is considered broken. This algorithm works in real time in the case of 2D virtual object such as a sheet.

Fig. 3 shows the situation that a virtual cloths are put on the virtual human body.(3) Fold of the cloths are simulated based on calculation. Although this algorithm cannot work in real time, pre-recorded video sequence will be helpful to generate short time cloth movement.

Physics of the virtual world consists of rigid objects can be more easily implemented. If the shape of the objects is simple, various behavior can be simulated in real time. For example, a virtual object can be inserted into a hole dug in a virtual desktop, or

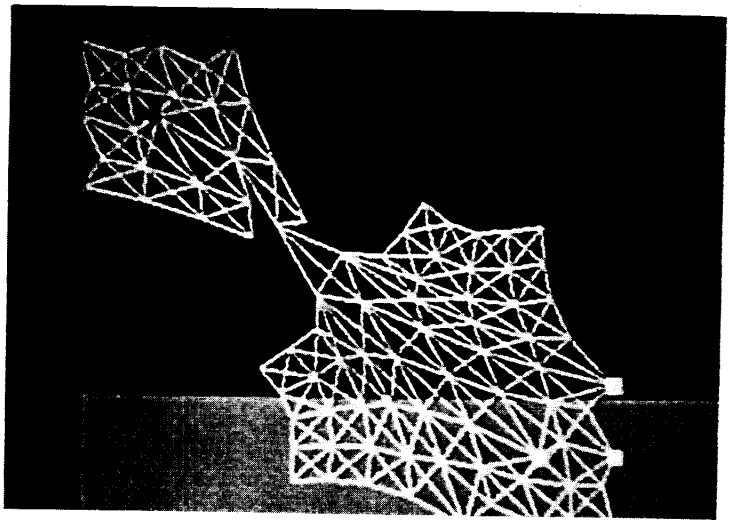

Fig.2

Fig. 3

manipulated under friction force along the desk surface, etc.. By using these basic software libraries, more complex virtual environment such as machine assembly simulator could be implemented as an application.

Living objects can also be included into a virtual world. These objects require biological laws in addition to the physical laws. In the third group, the motion of animals including human is synthesized from both data and algorithms.

4. Networked Virtual World

Virtual world can be implemented over a network. So called "Networked Reality" is one of the most important issues of the virtual world construction. Currently, VRML is the latest topic on the networked reality. By using VRML flame work, various virtual worlds have been able to be experienced over a internet. However, the current VRML still has many limitations.

For example, one virtual object cannot be manipulated by several users located in the different sites. In the third group, virtual " Lego assembly environment" were implemented. In this environment, users in distant place can share manipulation or assembly of virtual Lego-like objects over a network.(4)

5. Development of Common Software Platform - CABIN

In order to integrate the results of the research

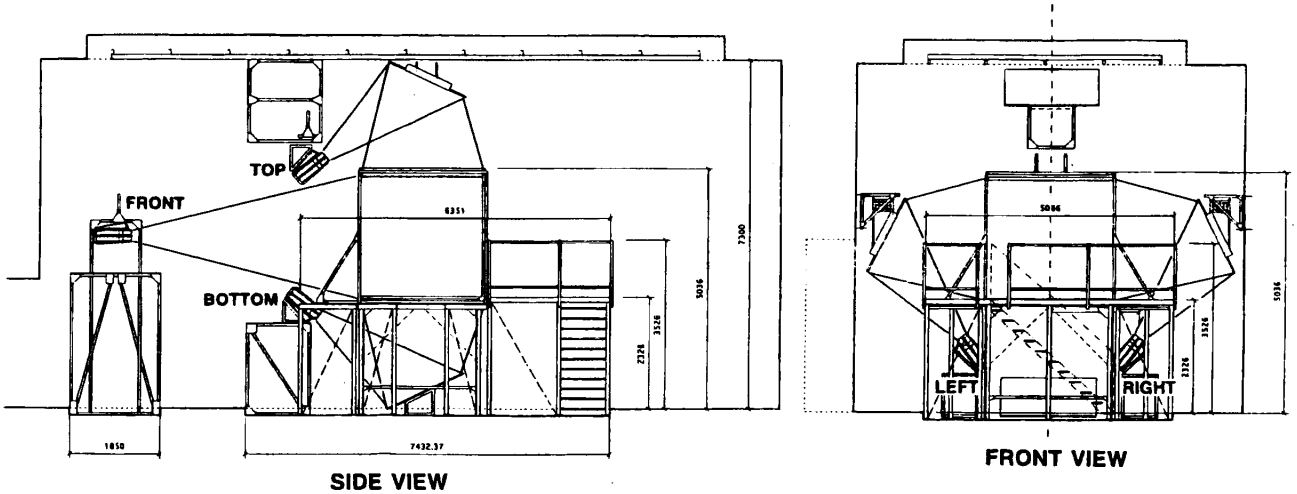

Fig. 4

Fig. 5

group, which are software developed by each members, sophisticated VR hardware has been planned and implemented in the IML (Intelligent Modeling Laboratory) at the university of Tokyo this spring. This system includes CABIN (Computer Augmented Booth for Image Navigation) display which is the multi screen immersive virtual environment.(5) Fig. 4 shows the structure of the CABIN consisting of five 2.5m square screens and stereo projectors which correspond to front, right, left, top, and bottom respectively. Fig. 5 is the photograph of the CABIN. One of the technical difficulties involved in implementing a five screen system concerns the implementation of the bottom screen. We used a tempered glass floor for the bottom screen. This glass floor's maximum load was 2000kgw (approx. 20 people).

The image generation system consists of five graphics workstations (SGI i-station) synchronized by high speed communication network (ScramNet) (Fig. 6). One graphics workstation was assigned to each screen. LC (Liquid Crystal) shutter glasses (StereoGraphics CrystalEyes) are used for stereo image generation(left and right image are supplied successively and separated for each eye via shuttering).

CABIN will be used for common demonstration platform at the final stage of the Monbusho "Virtual Reality" research project.

6. Conclusion

In this paper, the author introduced only an engineering aspect of research activities of the research group. However, contents oriented topics, such as contents development are also very important. Because of the space limitation, this topics have been omitted in this paper.

7. Reference

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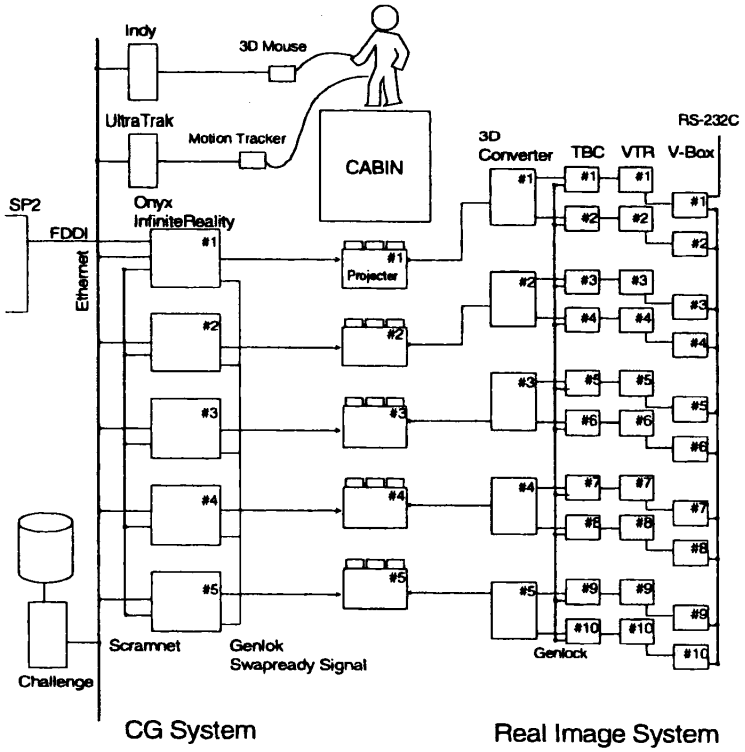

Fig. 6