Real Image based Virtual Reality Contents Generation

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***Abstract* — Digital contents of virtual reality (VR) system are defined as dynamic objects, static objects and background in this paper. We used 3D object modeling of mesh from range image for generating the real image based static objects. For real image based dynamic objects, video avatar is studied and used to various applications. Real image based backgrounds in VR system were obtained from panorama image of real environment. The more realistic contents can be produced efficiently and rapidly using real image based methods.**

Keywords - digital contents; virtual reality; CAVE; 3D model; panorama; video avatar

I. INTRODUCTION

One of application of digital contents is virtual reality (VR) and its research has a wide spectrum. The continuum between real and virtual reality is proposed in [1]. The items of continuum depend on which is the base part and which is added to. This continuum was extended by new axis 'mediality' in [2]. The categorization of VR system is determined by its realness. Photographs can give more reality than paintings if you are not an artist. We thought a real image based approach can build more realistic system because we are not graphic designers. And generating contents of VR system from real images is more efficient. The contents of the disaster scene like earthquake or fire can be realistic if real images are used.

The application for disaster is one of main theme from the start of VR research; a command and control center for disaster relief using VR was developed in The Intelligent Room Project [3]. The researches about disaster using VR technology can be categorized into virtual therapy, education/training and simulations. VR therapy is one of psychological therapy in medicine. The application of VR to the treatment of civilians and disaster workers who suffer from posttraumatic stress disorder (PTSD) following the WTC attack was showed in [4]. VR researches for PTSD and stress inoculation training (SIT) under disaster situations are well surveyed in [5]. The education and training for disaster management has been studied using VR. The VR technology was applied to education and training in the disaster management field in [6]. It focused on the role of presence and affective intensity. The VR system MediSim for training medical first responders was presented in [7]. The initial application of this system is to battlefield medicine. VR and telepresence technologies for military medicine were presented in [8]. When huge disaster occurs, the military is moved there and their dealing methods can be applied to and are similar to the dealing methods to a disaster. There are many researches focusing the simulation of disaster environment. The simulation of occupant evacuation in an underground station when fire disaster occurs was presented in [9]. Their system simulated fire scene and evacuation process in a virtual environment. The RoboCup-Rescue Simulation Project [10] has been contributed to the disaster mitigation, search and rescue problem.

II. VIRTUAL REALITY CONTENT

We defined digital contents of VR system as dynamic objects, static objects and background. Dynamic objects can be deformed but static objects and background cannot. Dynamic and static objects interact with user but background does not. The relation among them are shown in Fig. 1.

We used 3D object modeling of mesh from range image for generating the static objects of VR contents and developed video avatar for the dynamic objects. As image-based approach for background, panorama background modeling is studied. Using the products of these approaches, real image based contents of VR system can be built. User interface for this whole system was also developed using computer vision technique.

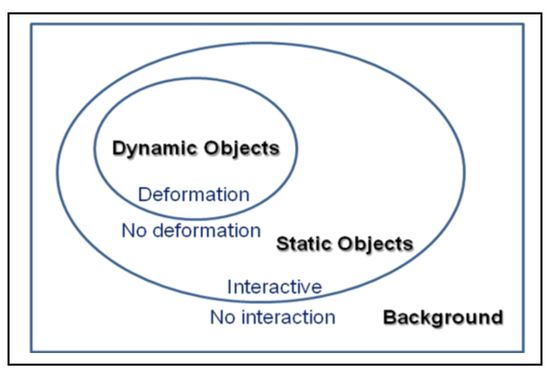

Figure 1. Contents of virtual reality system

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III. Static Object

As static objects, two conditions are considered for our approach; the texture of the surface of a object is made of real image and the geometry of the surface is defined for user's interactions. We selected range image based method instead image texture only with simple 3D object method. But the initial object made direct from range image has too many triangles to manipulate. To simplify the mesh (set of surface triangles), the level-of-detail (LOD) modeling is studied.

Because the number of objects or the complexity of the scene changed, the system performance is changed continuously in 3D graphic systems. An effective computer graphics system can be constructed if we can control the LOD of the object. LOD modeling consists of the representation of the mesh and the algorithm to produce a certain LOD. We used a wavelet-based LOD modeling [11] and a new data structure called marching cube octree [12], which is based on the data structure of a Marching Cube algorithm used to generate mesh from range data. The example meshes of our model are shown in Fig. 2. Upper part is rendered and wireframe view of 3D model in maximum LOD and lower part is in 20% LOD. (Dataset source: Cyberware™)

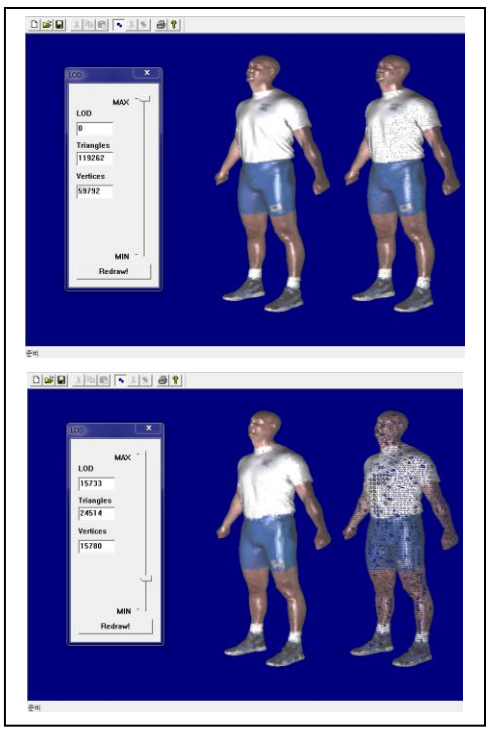

Figure 2. 3D model with 100% and 20% level-of-detail

IV. Dynamic Object

Human or other user is one of important roles in virtual reality system. It can be used for other applications like TV broadcast contents, digital museum, telecommunication and etc. Video avatar was studied to generate dynamic object in VR system. Video avatar technology made users can share a virtual space between remote sites. Users can point out the 3D data more precisely using video avatar with stereoscopic devices. The example of video avatar is shown in the left of Fig. 3. Video avatar technology can be applied to the display of the digital museum [13] and it is shown in the right of Fig. 3. Background image is extracted from recorded video stream using chroma key and send the stream to remote host. Also we applied video avatar to tiled display communication [14]. We capture and send/receive the user's image using fish-eye camera. Using multiple fish-eye camera, eye to eye directional communication is possible and fingertip can be also detected.

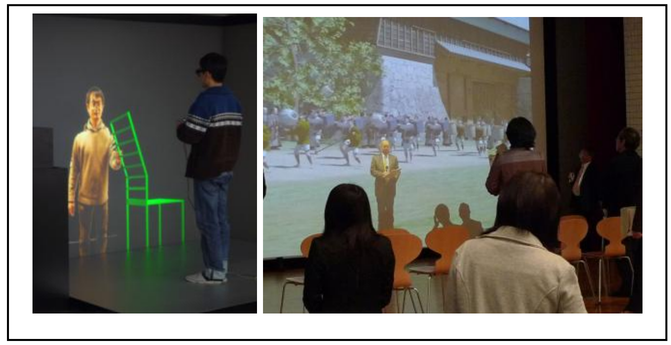

Figure 3. Video avatar in CAVE and on huge screen

V. Background

We made the panoramic images from the real environment using a digital camera and a panoramic tripod head and apply them to the CAVE like system to produce real image based background contents of VR world. It can be increase user's immersion. A virtual sphere surrounding CAVE was defined in graphic system. And we took the panorama photos as texture and mapped into inside of the defined virtual sphere. Only one panoramic image is constructed using a digital camera and panoramic tripod head in [15] and the stereo background modeling is made by two panoramic images for left and right eye in [16]. The more efficient method for take picture of environment is improved with 3D panorama sweep function in [17]. The example of CAVE system with real image based background modeling is shown in Fig. 5. As an application, we used panorama background modeling to present the Great East Japan Earthquake to users effectively [18].

VI. Interface

For our systems, we had used game pad for manipulate the background but more unaffected interface was needed. To make such interface, a device held or attached to body like game pad, glove and hat is excluded. Because of seamless feature of screens of CAVE, standalone system like wireless network connected notebook, tablet pc is preferred for interface processing (upper part of Fig. 4). So we developed an interface of gesture recognition using motion templates method [19]. The computer vision module recognizes predefined user's gestures and sends commands to master/render modules of CAVE system via internet. Using this method, we can add unaffected user interface to our system. We improved our interface using blob detection [20] to increase accuracy. The intermediate result of motion template method is shown in the left of lower part of Fig. 4 and of blob detection is shown in the right of lower part of Fig. 4.

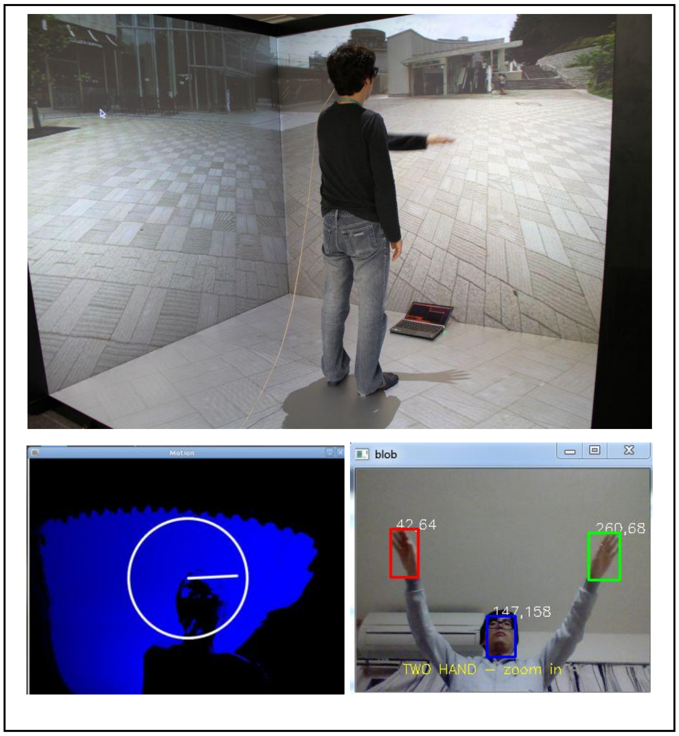

Figure 4. Computer vision based interface (upper) and immediate result of motion template method (lower, left) and blob detection (lower, right).

VII. CONCLUSION

In this paper, digital contents of VR system are defined as dynamic objects, static objects and background. Real image based approaches for each items are studied. We used 3D object modeling of mesh from range image for generating the static objects. For dynamic objects, video avatar is studied and used to various applications. Image based backgrounds in VR were obtained from panorama image of real environment. The more realistic contents can be produced efficiently and rapidly using real image based methods.

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Figure 5. CAVE system with real image based background modeling