Virtual Reality Contents using Real Image based Techniques

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Abstract

In this paper, we proposed virtual reality contents generation methods using real images. Components of virtual world were defined as three categories - dynamic objects, static objects and background. For dynamic component, Video avatar was developed as image-based system using video stream. For static component, 3D object level-of-detail modeling of mesh from range image was developed. And as image-based approach for background, panorama background modeling is studied. User interface for this whole system was also proposed using computer vision technique. Using real image based contents generation, the more realistic contents can be produced efficiently.

Keywords: *Virtual Reality, CAVE, 3D Object Model, Panorama, Video Avatar, Gesture Recognition*

1. Introduction

Virtual reality (VR) is one of most contribution research area for digital contents generation and its spectrum spreads from reality to virtuality. The continuum between real and virtual reality is proposed in [1]. The points of continuum depend on the view point that which is the base part and which is added to. New axis 'mediality' added to this continuum in [2]. These spectrums are not for how users feel real about the system but how much portion of the system real or virtual is. We focused how to feel more realistic. For computer graphics, using photographs can give more reality than illustrations or paintings if you are not a designer or an artist. And we thought a real image based approach can build more realistic system because we are not graphic designers. Also it is more efficient to generate contents of VR system from real images. For example, the contents of the disaster scene like earthquake or fire can be realistic if real images are used.

Because the environment of disaster is very danger, simulation based applications for disasters have been very widely developed. In The Intelligent Room Project, a command and control center for disaster relief using VR was developed [3]. The researches about disaster using VR technology are virtual therapy, education, training, simulations and etc. VR therapy is one method 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 under disaster situations are well surveyed in [5]. The VR education and training for disaster management has been also studied. An education and training in the disaster management field using VR was studied in [6] and the role of presence and affective intensity were focused. The MediSim is a training system for medical first responders was presented in [7]. This system was applied to battlefield medicine at first development. A military medicine training system with telepresence technologies was presented in [8]. When national wide huge disaster occurs, the military usually moves that area and deals with the disaster. So many military education or training system using VR technology has been developed. There are many researches focusing the simulation of disaster environment itself. It is base technology for other VR disaster systems. The simulation of evacuation in an underground station under fire disaster was presented in [9]. Fire scene and evacuation process were simulated in a virtual environment. The RoboCup-Rescue Simulation Project has been developed in [10] and it was focused at the disaster mitigation, search and rescue problem.

Realistic contents are the key to develop VR applications like a disaster simulation efficiently. In this paper, we proposed VR contents generation methods using real images. It can be realistic because all contents are from real images. VR contents are categorized in chapter 2.1. The real image based methods we used are described in following chapters. And the vision based user interface is presented in chapter 3. After all we conclude our studies in chapter 4.

2. Virtual Reality Contents

2.1. Definition

Digital contents of VR system can be divided into three - 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 is shown as follows.

$$\text{VR Contents}\begin{cases}\text{Interaction}\begin{cases}\text{Deformation} - \textbf{Dynamic Objects}\\ \text{No Deformation} - \textbf{Static Objects}\end{cases}\\ \text{No Interaction} - \textbf{Background}\end{cases}$$

3D object modeling of mesh was used for generating the static objects of VR contents. These objects were produced from range image and the level-of-detail modeling was also developed. Video avatar was implemented for the dynamic objects. It shares virtual space between remote sites. As image-based approach for background, background modeling with panorama photos is studied. By mixing the products of these approaches, real image based contents of VR system can be built. User interface for this whole system was also added using computer vision technique.

2.2. Dynamic Objects

As dynamic objects, the most used objects are humans in VR application. It can be used for other applications like TV contents, digital movies, digital museum, telecommunication and etc. Video avatar was studied to generate dynamic object in VR system using real image stream. 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.

Figure 1. Video avatars in CAVE, huge display and tiled display

The examples of video avatar are shown in Figure 1. Video avatar can be part of CAVE contents as shown in the left image of Figure 1 and used for explanation of remote specialist in the display of the digital museum [11] as in the center image of Figure 1. Background image is extracted from live video stream using background range matrix method [12] and send the stream to remote host. Also we applied video avatar to tiled display communication [13] as shown in the right image of Figure 1. 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.

2.3. Static Objects

Static objects are defined as the objects in VR space which interact with a user but weren't deformed. The user can move and modify them like carving. The static objects cannot move or be modified by itself. As static object of VR contents, 3D model made from range image is considered. The texture of the surface of the object is made of real image and the geometry of the surface is added to it for user’s interactions. But the initial object made from range images has too many triangles to manipulate. To simplify the mesh - set of surface triangles, the level-of-detail (LOD) modeling is developed.

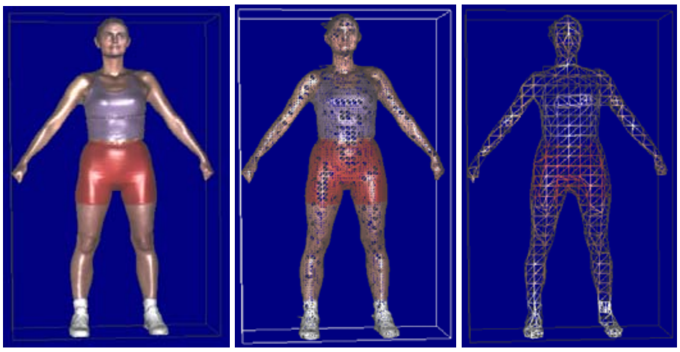

Figure 2. Level-of-detail modeling of 3D object from range images

The system performance is changed continuously in 3D graphic systems because the complexity of the scene (the number of objects) changed. 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 proposed a wavelet-based LOD modeling [14] and a new data structure called marching cube octree [15], which is based on the data structure of a Marching Cube algorithm used to generate mesh from range data. The example meshes of our modeling are shown in Figure. 2. Images in Figure 2 are wireframe view of 3D model of 100%, 60% and 20% LOD from left to right. (Dataset source: Cyberware™)

2.4. Background

For real image based background generation, we made the panoramic background images from the real environment using a digital camera and a panoramic tripod head. Then they were applied to the CAVE system to increase user's immersion. A virtual sphere surrounding CAVE was defined in graphic system and the panorama images were mapped into inside of the defined sphere as texture.

First, only one panoramic image is constructed using a digital camera and panoramic tripod head in [16] and the stereo background modeling is made by two panoramic images for left and right eye in [17]. The more efficient method for take picture of environment was proposed with 3D panorama sweep function in [16]. As an application, we used panorama background modeling to present mood of the Great East Japan Earthquake to users effectively in [19]. The example of CAVE system with real image based background modeling is shown in Figure 3. The left image of Figure 3 is the example of combination of dynamic object and background and the right image of the Figure 3 is background of the earthquake disaster.

Figure 3. Real image based background modeling

3. Vision Interface

We had used a game pad for interaction with VR contents before but more unaffected interface was needed. To make such interface, devices which are held or attached to body like game pad, glove and hat were excluded. So computer vision based interfaces were studied because they don't need hand-held or attached devices. Because of seamless feature of screens of CAVE, standalone system like wireless network connected notebook or tablet pc is preferred for interface processing as shown in the left image of Figure 4.

An interface of gesture recognition using motion templates method was proposed in [20]. A computer vision module recognizes predefined gestures and sends commands to master/render modules of CAVE system. Using this method, we could add unaffected user interface to our system. This interface was improved using blob detection to increase accuracy in [21]. The intermediate result of motion template method is shown in the center image of Figure 4 and of blob detection is in the right image of Figure 4. A new background extraction method using background color range matrix [12] was applied to our gesture recognition.

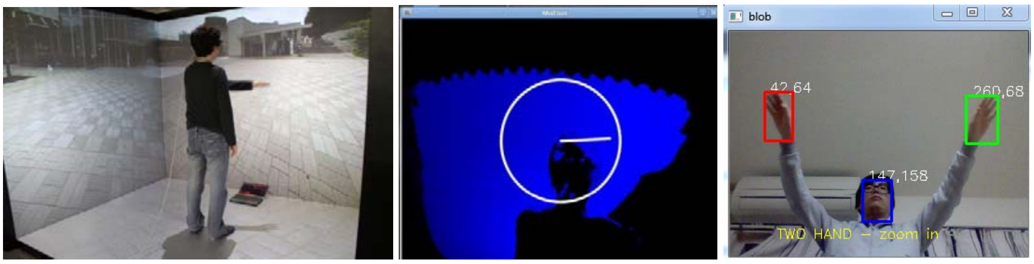

Figure 4. Computer vision based user interface for VR contents

4. Conclusion

In this paper, digital contents of VR system were generated using real image based approaches. They are divided into three categories - dynamic objects, static objects and background. Real image based approaches for them were studied and developed. For dynamic objects, video avatar system was developed and applied to various applications. We used 3D object level-of-detail modeling of mesh from range image for generating static objects. Image based backgrounds in VR system were obtained from panorama images of real environment. Using our real image based contents generation approaches, more realistic contents can be produced efficiently and rapidly.

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6. References

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