Interactive Augmented Reality through Network

Jin-Woo Park, Tae-Sung Lee, Yong-Moo Kwon
39-1 Hawalgog-dong, Sungbuk-ku, Imaging Media Research Center
Korea Institute of Science and Technology, Seoul, 136-791, Korea
jwp@imrc.kist.re.kr, lts@imrc.kist.re.kr, ymk@kist.re.kr

Abstract

In this paper we designed networked AR (Augmented Reality) system that supports augmentation of remote real object with local virtual object. This makes AR system be possible with the situation that real world doesn't exist or cannot exist with local area. Furthermore, in the case that there are many locals with one remote of real world, we can have interaction with augmented virtual object at any of locals and share the interaction result with the other locals in the network. After describing each technique for the proposed system, we suggested applications of our interactive AR system.

Key words: Augmented Reality, Network Interaction, DVTS, VRPN

1. Introduction

The recent advance of Augmented Reality (AR) is remarkable. A freely-available software toolkit (the ARToolKit) is now available and the requirements of practical field of the AR system are becoming various and complex. So, new attempts have been made to use network to implement mobile AR on handheld devices, c.f. [1, 2]. However, such attempts using network are point to reduce computational complexity for handheld devices.

In this paper, we designed AR system which input of real world is from remote site. And then we had interaction with augmented 3D virtual object at the local using the marker of the real world. So we named it as interactive AR system. The advantages of this system are obvious. The basic goal of an AR system is to enhance the user's perception and interaction with the real world through supplementing the real world with 3D virtual objects that appear to coexist in the same space as the real world [3]. But most of research are not considering the case that the real world from remote. However if the real world is too far to go, or too dangerous to be existed with users, or moreover, the real world needs to be broadcasted to many others, the AR system cannot be working in the local by itself. We can solve this problem easily by receiving streaming data from the real world through network.

By augmenting 3D virtual object in the local independently, we can have interaction with the augmented virtual object in the local. So, many of users are able to share the virtual object with the same real world from the remote. And the users at the local can have interaction with the virtual object and share the interaction result with the others.

The main considerations of our system are these two:

- If it's working in real-time through network.
- How we handle the controlling of the 3D augmented virtual object while avoiding collision between the local interaction and the remote marker

There are many kinds of the interacting device that we can consider, such as joystick, mouse, tracker, and haptic devices, etc. Also, there are powerful tools to achieve our network interactive AR system, including ARToolKit, DVTS, and VRPN.

ARToolKit is a freely-available software toolkit for rapidly building AR applications and developed by Marc Billinghurst and Hirokazu Kato. It has many advantages such that, just a simple monocular camera is needed, the system is very simple and it works very fast. The DVTS (Digital Video Transport System) is developed by Akimichi Ogawa of WIDE project with the DVTS consortium. And the VRPN (Virtual Reality Peripheral Network) is developed by Russell M. Taylor II. The following explains about the DVTS and the VRPN briefly.

2. DVTS

The DVTS is an application for sending and receiving DV(Digital Video) streams using the internet [4]. We use DVTS to send streaming video of the real world and the marker from remote. DVTS enables us to send same streaming data to many of DVTS clients. DVTS server has the DV camera and sends streaming video to DVTS client. Using multi-cast, many of DVTS clients are able to receive the same streaming data from DVTS server. This is illustrated in Figure 2.1.

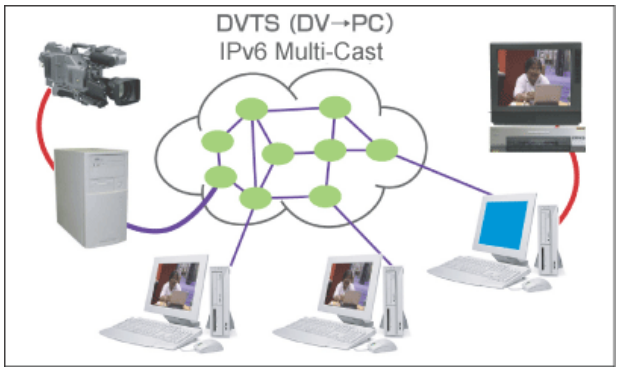

Fig 2.1 DVTS overview

The DV data is sent over the Internet using RTP (Real-Time Transportation Protocol). The DV/RTP packet format is shown in Figure 2.2. Original packet format is adopted. As shown in Figure 2.2, the isochronous stream packet of DV is simply encapsulated with RTP/UDP/IP [4].

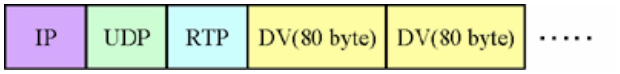

Fig 2.2 DV/RTP packet format

3. VRPN

The VRPN (Virtual-Reality Peripheral Network) system is a set of classes within a library and a set of servers that implement a device-independent, network-transparent interface between application programs and the set of physical devices (trackers, buttons, etc.) used in a virtual reality (VR) system [5]. The VRPN system overview is shown in Figure 3.1. We use the VRPN to control the augmented 3D virtual object in the DVTS server or client. The main advantage of using VRPN is that the interaction of 3D virtual object of VRPN server affects all the other's VRPN clients. And through this, the interaction result of VRPN server can be shared with all of VRPN clients.

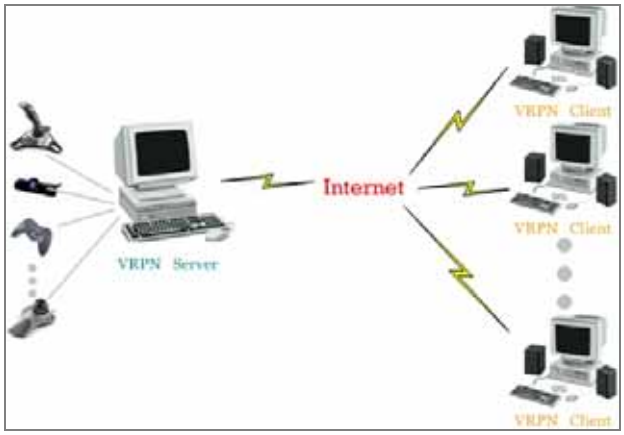

Fig 3.1 VRPN system overview

4. Interactive AR

Our interactive AR system basically uses the DVTS to send information of the real world and the marker. This is appropriate when the virtual object and the real world have a strong relationship with each other for example, construction, cultural assets, etc. The simple concept of interactive AR is shown in Figure 4.1. The 3D Buddha model is augmented using the ARToolKit.

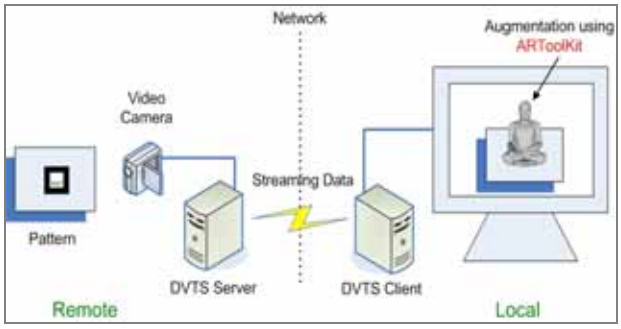

Fig 4.1. The simple concept of interactive AR system

The reason that we augment the 3D virtual object independently in the local rather than receiving the augmented object from the remote is that under the circumstance like teleconferencing or tele-education, it is needed to build an interactive AR system for supporting the interaction between the contents and the users. Having an interaction with the main contents among the clients will make the situation more efficient. So we augment virtual object using ARToolKit and then using VRPN, we have interaction with the augmented 3D virtual object.

There can be many scenarios of interactive AR system for instance the leader may have interaction with his virtual object, or the local participants may have interaction with the remote's virtual object. To avoid confusing, all of these scenarios have just one VRPN server in the network and the others are all VRPN clients which are only showing the interaction result. But if we make VRPN client to work independently, we can interact with the virtual object in the local independently.

The concept of interactive AR system is shown in Figure 4.2. The 3D Buddha model is augmented in the local and the joystick is used for the tool of interaction with the model. The real environment of the remote is a place where the Buddha model should have been sitting originally. Any of participants can have interaction with the virtual object as VRPN server. The interaction tool can be replaced to mouse, tracker, or haptic devices, etc.

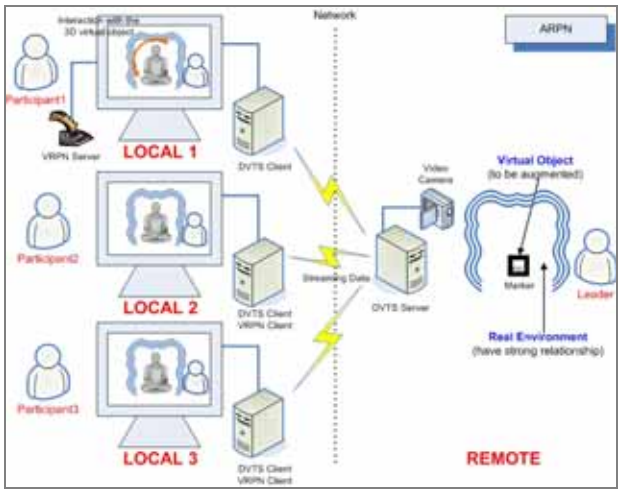

Fig 4.2 Interactive AR system overview

5. Experimental Result

In our experiments, we test with Sony DCR-PC115 digital camcorder with 17 frames/sec of frame rate which was enough to augment the 3D model in real-time. In the interactive AR system demonstration illustrated in Figure 5.2 and Figure 5.3, a marker and the DV camcorder is placed in the remote and the figure shows augmented 3D virtual object in the local. The real environment surrounding the Buddha has been removed for convenience sake. The participant in the local is rotating the Buddha model.

Fig 5.1 Interactive AR demonstration

Fig 5.2 Interactive AR demonstration

Fig 5.3 Interactive AR demonstration

6. Applications

Our interactive AR system can be easily applied to network historical, cultural education systems. If we augment 3D building model with the real environment where the building is going to stand in real-time, it would be helpful to imagine after construction. Another idea for interactive AR is network handshake. If we track the other's hand through network and augment with 3D virtual hand model of the user at local, we can design the network handshake system. Clearly we should augment the user's hand in the local with video from the remote because each point of view is different. We can apply haptic devices for this system such as the DataGlove or the PHANToM to make it immerse. This concept is illustrated in Figure 6.1.

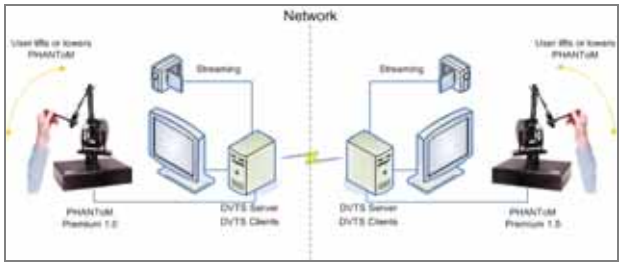

Fig 6.1 Network handshake system overview

Under the circumstance like teleconferencing using our interactive AR system, the participants are able to augment the main contents in the remote real environment at each of the local by receiving the video and audio streaming including marker information. So whatever the main content is, we can augment it in the local with the appropriate real environment without visiting some places. This system consists of a leader who is the main speaker and one or more participants who are distant from the leader and from each other as well. The conceptual figure of this system is shown in Figure 6.2.

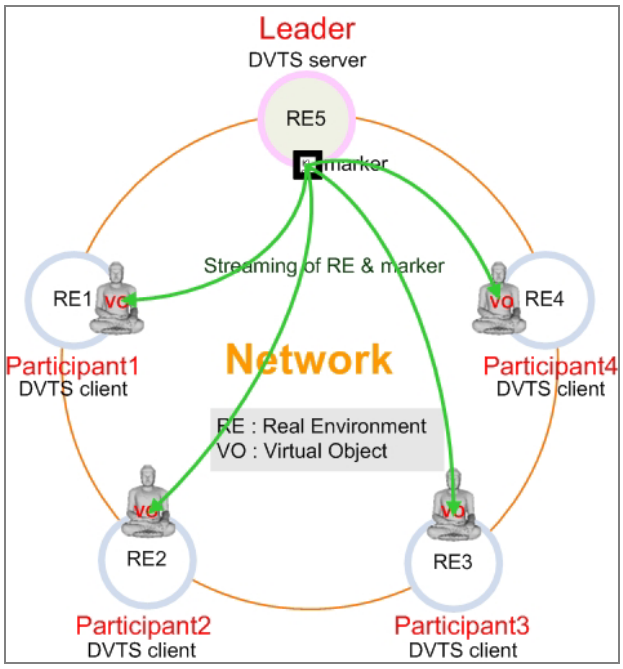

Fig 6.2 The concept of teleconferencing using interactive AR

7. Conclusion

In this paper, we addressed the limitation of AR systems and expand it using network. First we described the basic technologies, the DVTS and the VRPN, to implement to our system. Next we suggested interactive AR system and its possible applications. We are currently developing our interactive AR system and new scenarios so we can further explore the new applications of interactive AR system.

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