Network Interaction Models for Remote Guiding

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Abstract

This paper addresses the research issue of network interaction models in the framework of networked virtual environment. Our research goal is toward a distributed virtual museum with 3D virtual heritage sharing and network interaction over the network. Compared with the conventional virtual museum, the main feature of our approach is the remote guidance within the virtual museum using mixed reality. This paper presents network interaction models for remote guiding. This paper also presents experimentations using VRPN for the networked interaction with the cultural heritage.

Key words: Network Interaction Model, Remote Guide, VRPN

1. Introduction

The network issue is one of the important research topics for distributed virtual environments, in which we can share and exchange virtual objects and contents while sharing the knowledge and experiences [1-4]. We can consider interaction models with regard to the coupling level between (among) objects, as follows, independent model, master/slave model, equal right model. The independent model has no common interaction on 3D objects and no 3D object synchronization. The master/slave model and equal rights model address the issue of object manipulation, object synchronization and control of object synchronization.
Fig. 1 shows a model for a distributed interaction test using audio/video streaming via IP unicast/multicast for the transmission of content, video conferencing for the discussion between participants, network interaction data for VRPN.

In case of 3D content navigation and interaction using interaction devices such as mouse, joystick and head tracker, the camera viewpoint coordinates and angle information can be exchanged through network. VRPN (Virtual Reality Peripheral Network) can be used as a base for implementing distributed interfaces.

In this paper, we presents the conceptual network interaction models while considering the remote guide through network. It should be noted that the remote guide concept is represented by avatar while considering the interaction rights relationship between partners. We show the network interaction system that is based on the master/slave concept. We also demonstrate the network interaction experimentation between Korea and Germany through TEIN (Trans-Eurasia Information Network). The interaction through network is implemented by VRPN while sharing 3D contents.

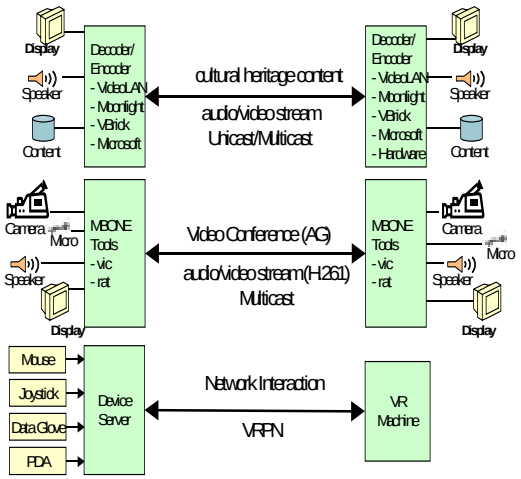

Fig. 1 Network interaction while using A/V streaming

2. Network Interaction Models

The concept of the DHX (Digital Heritage Exchange) project [5] allows museums to present copies of their exhibits at remote sides, to include virtual characters into scenes, to remotely guide observers through the presented scenarios and to support visible and audible human interaction.

A number of example models for remote interaction and communication will be presented and discussed. They build the base for the specification of the distributed DHX scenarios and the discussion of network requirements. These can be deduced according to the different forms of interaction and communication in the models. Each distributed presentation of a scenario starts with the distribution of the 3D objects for the scenes from the database to a VR middleware systems such as NAVER[6], AVANGO[7] , VR Juggler[8] at the exhibition locations.

Three models as shown in Table 1 for the manipulation and synchronization of 3D scenes can be distinguished.

Table 1. Network Interaction Models

Independent Model	Master-Slave Model	Equal Rights Model
No common interaction on 3D-objects	Manipulation of 3D objects by master	Manipulation of 3D objects by both sides
No 3D object synchronization	3D object synchronization	3D object synchronization
	Control of synchronization at the master side	Control of synchronization at both sides

A simple model allows treating the scenes at the two locations as independent ones. The 3D objects are distributed and the scenes are built up and manipulated totally independent.

Secondly, a master-slave model can be implemented. After the distribution of the 3D scenes the presentation and manipulation of the scenes are controlled by the master. The scenes at the remote side are synchronized with the master scene by transmitting synchronization data from the master to the slave side.

In the third, the equal rights model both locations are allowed to control the presentation and to manipulate the scene. The manipulating persons have to co-ordinate their actions in some way. Whenever the scene is changed by one side, synchronization data has to be sent to the other side to synchronize the scenes at both sides. In view of the implementation issue, we classify the master-slave model with no avatar, with avatar using video streaming, with remotely guided character, and with autonomous character.

With regard to the implementation issue, we classify the master-slave-model and the equal rights model with no avatar, with avatar using video streaming, with remotely guided character, and with autonomous character. The features of each model will be described in view of guide and audiences with avatar and character techniques.

Fig. 2 shows an example for in interaction model. Two groups of persons observe the same scene at their displays. The scene can be an exhibition in a museum that is explained and controlled by a person, the real guide. The speech of the guide is transmitted as audio stream to the remote side. If the technical preconditions are given (symbolized by the dashed line), the remote observers can ask questions to the real guide.

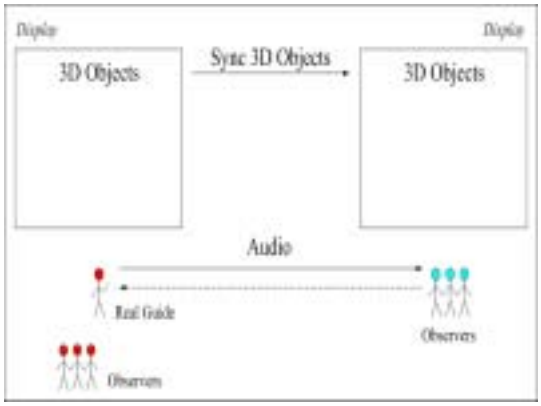

Fig. 2 Master-Slave model with no avatar

Fig. 3 shows two groups of persons that observe the same scene at their displays. A real guide leads the groups through a museum and explains and controls the scene. A live video of the guide is integrated in the scene. It can be integrated as a video avatar stream or as a video stream in a separate picture (PiP). The video avatar stream appears in the scenes at both sides. The video and the speech of the guide are transmitted as audio/video stream to the remote side and the video is integrated in the remote scene.

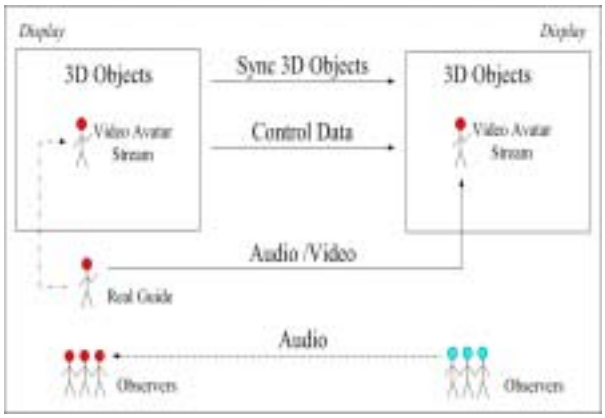

Fig. 3 Master-Slave / Video Avatar Stream

Fig. 4 shows two groups of persons that observe the same scene at their displays. A guide leads a group of person through a museum. He/she comments the scene and his/her representation as remotely guided character movements within the museum. The movements of real guide control the movements of the guided character. The remotely guided character is integrated in the scene and appears in the scenes at both sides. The voice of the guide is transmitted to the remote side. If the technical preconditions are given (symbolized by the dashed line), the remote observers can ask questions to the guide. A video of the remote observers can be displayed at the guide's side.

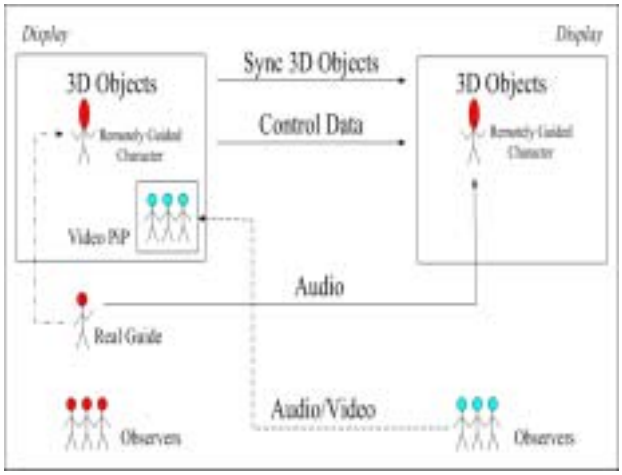

Fig. 4 Master-Slave / Remotely Guided Character

Fig. 5 shows two groups of persons that observe the same scene at their displays. Two real persons, they can be museum's guides or visitors of a museum, are integrated as video avatar streams into the displayed scene. The persons can communicate and control the scene in joint actions. The video and the speech of each person are transmitted as audio/video stream to the remote side and both videos are integrated in the scene.

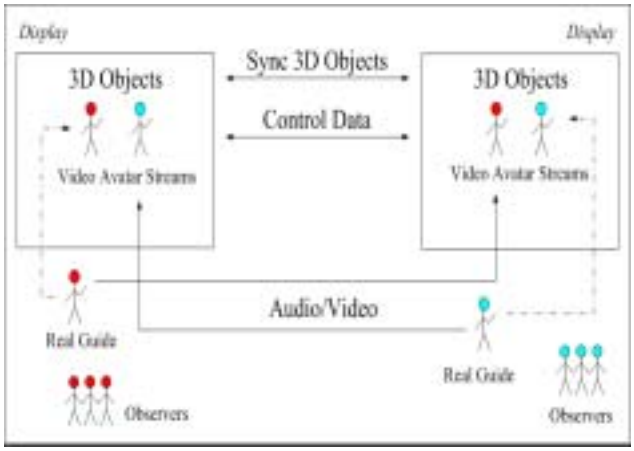

Fig. 5 Equal Rights / Video Avatar Streams

Fig. 6 shows two groups of persons that observe the same scene at their displays. On each side the scene is commented by a guide. Both guides are integrated in the scene as remotely guided characters. Each guide controls the movements of his/her representation as remotely guided character. The remotely guided characters can interact within the scene and appear in the scene at both sides. It is evident that in this scenario a visitor instead of the guide can be integrated by a remote user presentation. The speech of each guide is transmitted to the remote side so that the guides can discuss a scene and comment it on the basis of their personal expert knowledge.

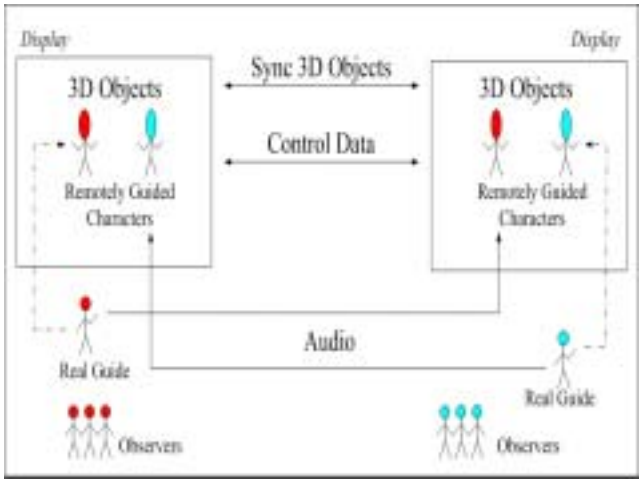

Fig. 6 Equal Rights / Remotely Guided Character

3. VRPN based network interaction

We implemented network interaction environment using the VRPN Library for the share of virtual heritage models and interaction through the network. Fig. 3 shows the Configuration of a Network Interaction Experimentation based on the network interaction model shown in Fig. 1.

Fig. 7 shows a screenshot of network interaction experimentation, King's Emile Bell, Chumsung Pagoda based on the network interaction model shown in Fig. 1.

As shown in Fig. 8, we can have the network interaction to the shared 3D objects and at the same time a conversation exchanging explanations and questions with an audio/video conferencing system. During the experiments we measured the network delay between Asia and Europe. The experimentation results show the acceptable real-time network bidirectional interaction with 3D cultural heritage contents and VRPN.

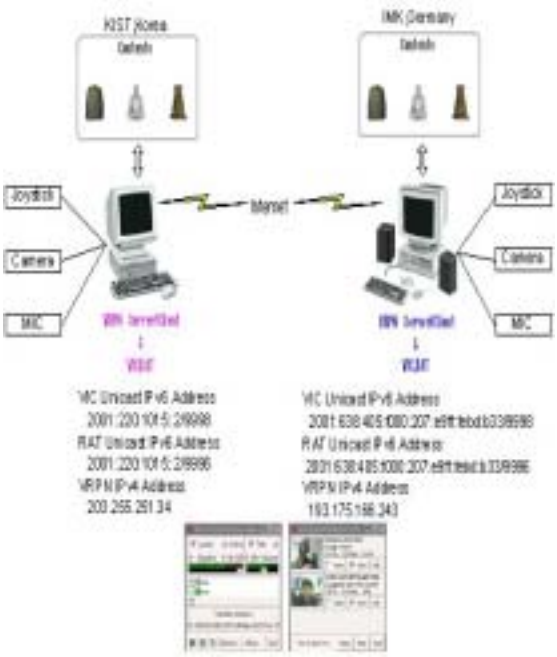

Fig. 5 Network interaction environment

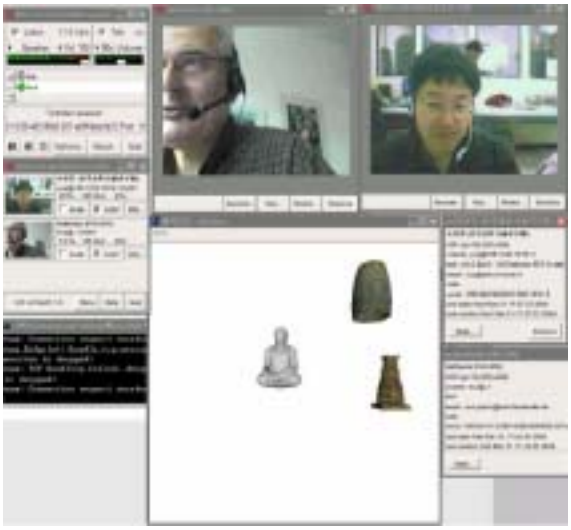

Fig. 6 Network Interaction Experimentation with A/V conferencing

4. Conclusion

This paper presents interaction models for the remote guiding concept that can be implemented in distributed virtual museum applications. As a starting point of distributed interaction, the VRPN-based network interaction system is implemented supporting the share of 3D virtual heritage objects and collaborative interactions through the network.

The results of network interaction tests using audio/video conferencing and VRPN object sharing for network interaction within the context of cultural heritage are shown.

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