

Tangible 3D Communication

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Abstract. In our previous work, we developed the "Live 3D Scenography System and Tangible 3D Vision" system [1], which enables a user to easily utilize 3D images and creates new virtual experiences such as visual haptic images. We have expanded the Tangible 3D Vision to "Tangible 3D Communication." Tangible 3D Communication is a new form of remote communication, such as haptic 3D video phones. In this paper, we explain the application, which allows users to shake hands with remote users, one example of Tangible 3D Communication.

Keywords: Tangible, 3D, Haptic, Virtual Reality.

1 Introduction

Many fields have shown an increasing interest in 3D images [2]. By 3D images, we are referring to three dimensional videos, displayed in binocular vision. A lot of investment in 3D image technologies has been made in fields such as the entertainment and medical areas. However, it has not spread to general consumers because of the high cost of introducing 3D image technology. As such, 3D image technology is not seen in many areas. In the first phase of the history of 3D image technology, anaglyph three-dimensional films were expected to become the most common implementation. However, 3D image technology use has not become widespread. This is due to barriers which prevent the spread of 3D image technology. The major barriers for diffusion of 3D technologies are considered to be the very high cost of creating 3D applications, and the specialist knowledge required to utilize 3D applications. The failure of 3D image technology to spread has prevented general users from enjoying the advantages of 3D imaging.

On the other hand, content on the Internet has continually evolved in recent years. Moreover, Internet contents have changed dramatically from text to images, and then to video. Currently, improvement of video contents has concentrated only on high resolution and high frame rates. The evolution of contents has been restricted to 2D. "2D" imagery contains no perspective information, and the exact same images are seen by both eyes. Images or video that are rendered in 3D-CG are classified as 2D. New contents, with new presentation effects, are expected as contents continue to evolve.

Therefore, we had researched and developed a new 3D based system [1], based on the following: "3D images should be easy to use", and "there is a need for new media combining 3D presentation with a tactile interface." In this previous research work, users have become able to touch live-action images that are displayed on a 3D monitor [3][4][5]. While tactile interaction with 3D-CG already exists, touching live-action images is quite a new sensation.

In our current research, we have expanded this tactile experience to "Tangible 3D Communication." The main feature of Tangible 3D Communication is that the remote users can communicate with tactile live-action video. In this paper, we explain the application, which allows users to shake hands with remote users, one example of Tangible 3D Communication. The hand shaking application enables users to move a remote user's hands, as well as enabling the user to feel the touch of the remote user's hands. We also describe some basic functions of Tangible 3D Communication, such as the haptic process and delivery process, and the special function of the hand shaking application, the hand detecting process.

2 Exposition

2.1 Tangible 3D Communication

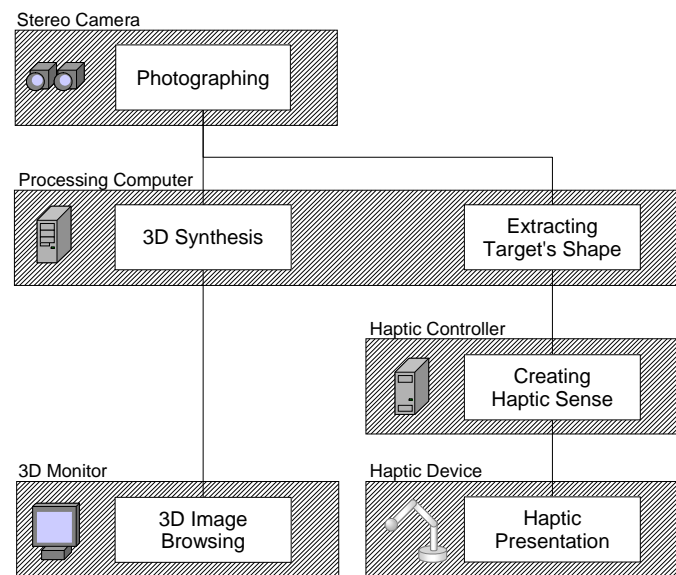


Fig. 1. System Diagram of the Tangible 3D Communication.

The system diagram of the Tangible 3D Communication is basically the same as the Tangible 3D Vision. It has two cameras, one processing computer to synthesize the

3D image and extract the shape of the target object, one haptic device controller to create haptic sensation from the shape of the object, one haptic device [6] to present haptic feedback to the user, and a 3D monitor, as shown in figure 1. The two cameras are connected with the processing computer via IEEE1394 or USB. In addition, the processing computer is connected with the 3D monitor via DVI-D. The processing computer also extracts the shape of the target from the stereoscopic images. The haptic device controller creates haptic sensation from the shape data created by the processing computer. Then the haptic device provides haptic sensation in the haptic 3D space placed in front of the 3D monitor, and the 3D monitor presents stereoscopic 3D space as real-time video. Those two types of 3D virtual space are synchronized, and the user physically feels the stereoscopic real-time video. The difference between the Tangible 3D Vision and the Tangible 3D Communication is whether the target's video is taken in real time. The tangible 3D Communication takes the target's video in real-time. The video is not 3D-CG, but actual video of a real object.

2.2 Hand Shaking Application



Fig. 2. Photo of the Hand Shaking Application.

Figure 2 shows actual use of the hand shaking application. The person on the right and the person on the left shake hands using the system. The user on the right can feel the sensation of shaking hands with the user on the left. And the user on the left also can move the hand of the user on the right.

We set and solved three problems to achieve "Handshake experience." The first is the pliant feeling. In the case of the hand shaking application, the pliant feeling of hands is very important information. But the haptic process that is described in the foregoing section cannot create pliant haptic sensations, even though it can create a haptic sense of shape. The second is how to adjust the position of the haptic modeled hand and the 3D viewed hand. Due to individual variations in binocular vision, the

position that the user thinks the partners' hand is at varies, independent of the space coordinates of each hand. The third is how to seamlessly achieve the experiences of having ones' palms meet, grasping the partner's hand, and moving the partner's hand.

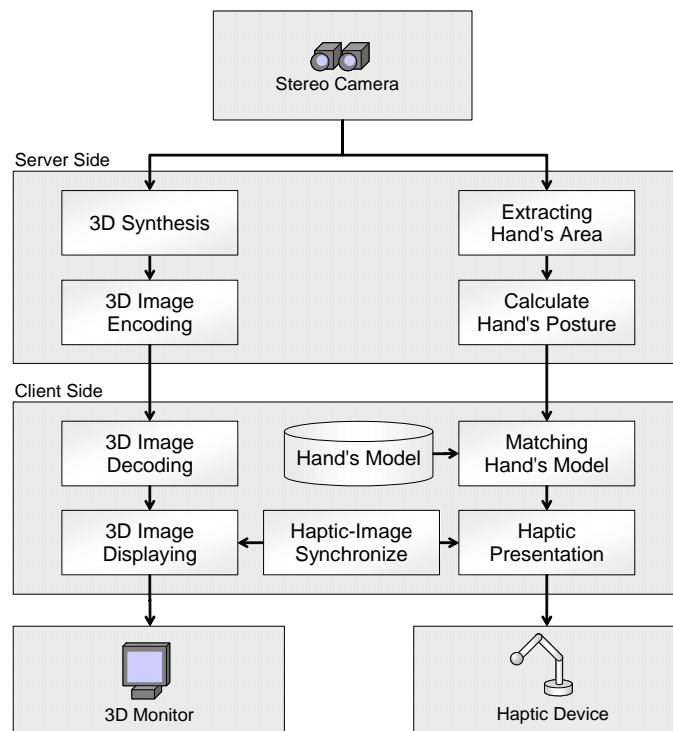


Fig. 3. System Diagram for Hand Shaking Application.

To solve the first problem, we have remodeled the system diagram as shown in figure 3. First, on the client side, the system prepares the elastic model data of human hands used in the VR field for medical treatment [7]. On the server side, the system extracts the hand's area from the stereo image to calculate the posture of the hand and fingers. Then the hand's posture is matched to the haptic hand's model. Finally, the pliant haptic information is synchronized to the 3D image of the hands, allowing the user to shake hands with a remote user, with a natural, soft feel. Moreover, the hand's posturing provides the exciting experience of having one's hand moved by the remote user's hand.

To solve the second problem, we have added the haptic hand's model approaching function to the system. The system watches the posture and the position of the user's hand, and if the system assesses that the user has started to shake hands, then the haptic hand's model approaches the user's hand. This function provides the ability to shake hands similarly to everyone.

To solve the third problem, we have added the user's hand status monitoring function. The function sets three statuses of user's hands: "approaching the haptic hand", "starting to get a hold" and "holding". The function determines the status based

on the posture of hand, the location of the palm, the angle of the palm, and the speed of the arm. This function selects and switches the handshake experience seamlessly and naturally using these status evaluations.

3 Conclusion

We have expanded our previous work in Tangible 3D Vision into Tangible 3D Communication by adding remote connectivity. Tangible 3D Communication enables remote users to communicate via tactile live-action video.

In this paper, the application can connect only one user with the remote user's hand because the hand shaking should be one-on-one. However, the application is easily extensible to a newer application that can connect many users with a target object. The newer expanded application is conceived for space and object sharing with 3D videophones and haptic sensation. The key point is that many users, who are in remote locations, can touch and watch the same object at the same time. It can be utilized in distance learning situations, such as remote ceramic arts classes. It can also be utilized in dangerous sites such as nuclear power plants to prevent accidents, etc., by providing virtual handling of dangerous materials.

Because the system in this paper is only unidirectional, we plan to develop a multidirectional system platform for the Tangible 3D Communication. Of course, it also will be applicable to the hand shaking application. However, this new platform has the possibility of extending into a remote collaboration system, with space and object sharing via 3D images and haptic sensation.

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