Novel View Telepresence Using Multiple Omni-directional Live Videos

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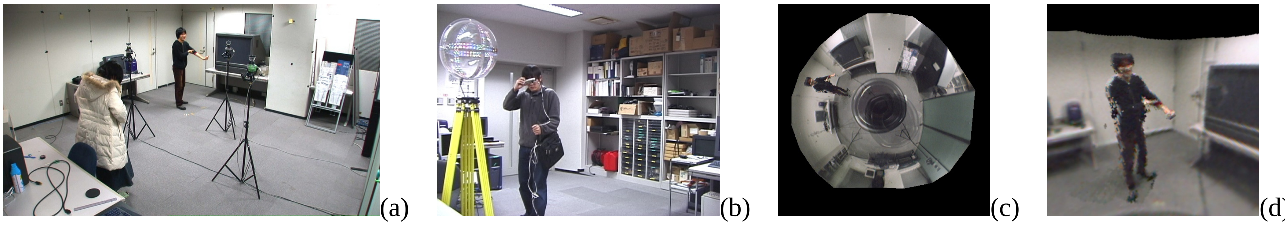

Figure 1: Novel view telepresence: (a, b) remote and user's sites and (c, d) generated omni-directional and planar perspective images.

1 Introduction

With high-speed network and high-performance PC, networked telepresence, which allows a user to see a virtualized real scene in a remote place, has been investigated. Uyttendaele et al.[2004] have proposed a system which enables a user to change the viewpoint and view-direction interactively like walk-through in a real scene. However, the viewpoint is restricted onto the camera path. Kanade et al.[1997] have proposed a method which generates novel view images in the 3D dome. Their system needs the assumption that the positions of objects are limited within the area covered by the outside-in cameras. Therefore, it is suitable for 3D modeling, rather than telepresence. We propose a novel view telepresence system which enables a user to control the viewpoint and view-direction freely by virtualizing real dynamic environments. Our system uses multiple omni-directional cameras for virtualizing both inside-out and outside-in observations from camera positions in a real scene simultaneously. Furthermore, it can generate novel view images in real-time from omni-directional live videos transferred on network. The example is shown in Figure 1.

2 Novel View Telepresence System

Figure 2 illustrates a configuration of a prototype telepresence system as well as the flow diagram. The prototype system enables a user to see a virtualized remote scene at arbitrary viewpoint and in arbitrary view-direction interactively.

The novel view generation is based on using multiple omni-directional cameras for obtaining both inside-out and outside-in observations from camera positions in a real scene simultaneously. Furthermore, for supporting dynamic scenes, the acquired images are segmented into static and dynamic regions by using a robust background subtraction technique. Novel view images are generated for each region in real-time. See [Ishikawa et al. 2005] for the detail of novel view generation for static and dynamic regions.

We have implemented the proposed method and incorporated it into a server-client system. We use three omni-directional cameras connected to a PC for transmission of multiple video streams. The PC as a video stream server transfers not only the captured video streams but also the binary silhouette images made by background subtraction. The background subtraction process does not depend on user's viewpoints, so the server executes this process before transmission. The acquired video streams and the silhouette images are transferred to another PC as a novel view generator in the user's site via network.
The novel view generator is connected with a magnetic sensor for measuring user's viewpoint and view-direction and an HMD for displaying novel view images. The magnetic sensor measures the receiver's 6DOF data. The novel view generator computes a novel view image according to the user's viewpoint and view-direction and display the image on the HMD.

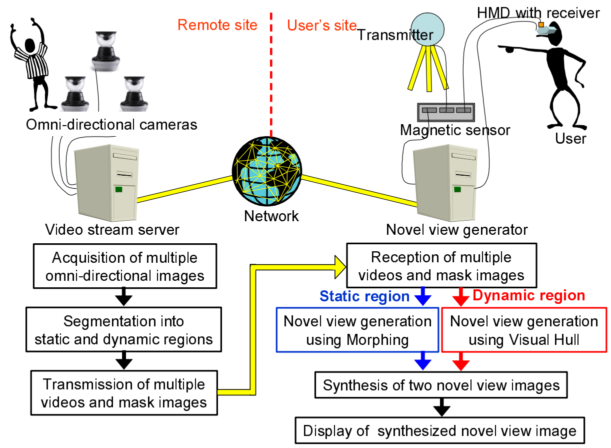

Figure 2: Configuration of prototype system and flow diagram.

3 Experiments

Figure 1 shows appearances of both remote and user's sites and generated omni-directional novel view image as well as planar perspective images. Planar perspective image is presented to an HMD mounted on a user. The user can change the viewpoint and view-direction freely and sense the feeling of being in a remote site. Each frame of novel view is generated in about 200[ms] by a PC (Pentium4-3.2GHz); that is, the frame rate is 5[fps]. Note that, the calculation time is not constant because the time required depends on the size of dynamic objects. When the user's viewpoint is near the cameras, the quality of novel view becomes high.

We have confirmed that our system can provide a user with the feeling of being in a remote site. The system can be applied to virtual sightseeing, remote conference, and so on. In future work, we will improve the generated image quality, especially one of dynamic regions by improvement of background subtraction and so on.

References

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