TELEPRESENCE SYSTEM FOR OUTDOOR SCENE WITH GLASSLESS STEREOSCOPIC DISPLAY

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ABSTRACT

Telepresence is a virtual reality technology that enables users to feel as if they are at a remote site. A telepresence system is expected to be given high realistic sensation. This paper describes a high realistic telepresence system for outdoor environments by using a glassless stereoscopic display. In general, the glassless stereoscopic display requires multiple parallax images which are captured from different viewpoints to realize stereoscopic view at multiple viewpoints. In this work, the multiple parallax images are generated from omnidirectional image sequences by image-based rendering approach which synthesizes a novel view image from a set of images. In our demonstration, user can view stereoscopic image in outdoor environments with a glassless stereoscopic display.

***Index Terms*—** Telepresence, Glassless stereoscopic display, Novel view generation

1. INTRODUCTION

The technology that enables users to feel as if they are at a remote site is called telepresence [1]. It is important for telepresence to provide a user with a highly realistic sensation. Image-based rendering (IBR) approach can render a scene consisting of complicated shapes and reflectance properties because synthesized images are generated from captured images. Therefore, the IBR approach is often used for the telepresence in outdoor environments. Some researchers [2] have attempted to change the direction of user's view by employing omnidirectional video with the IBR approaches. In the method, the omnidirectional video is captured by an omnidirectional camera or omnidirectional multi-camera units. However, since the method provides a user with monocular images, a user can not feel enough realistic sensation.

Our goal is development of telepresence system which can change the direction of user's view and realize stereoscopic view by using a stereoscopic display which does not need special glasses. To realize stereoscopic view, we have to prepare parallax images which are observed from both user's left and right view points. Our previous work [3] has proposed stereoscopic view image generation already. The method also takes a look around by generating user's left and right view images from omnidirectional image sequences. In our demonstration, we apply the method to glassless stereoscopic display.

The glassless stereoscopic display such as lenticular display needs multiple parallax images in order to see stereoscopic images at multiple viewpoints. In this research, the multiple parallax images for the stereoscopic view are generated by IBR approach from omnidirectional image sequences captured in outdoor environments. Although stereoscopic view is essentially possible by generating parallax images using IBR, it is difficult to look around freely [4].

Our research realizes to see stereoscopic view and to look around simultaneously by generating the stereoscopic images of the various direction of view from omnidirectional image sequences by using extended our previous technique [3]. Our method employs a light field rendering approach [5] to generate a novel view, and tries to generate multiple parallax images. In order to generate multiple parallax images correctly, dense depth maps are required because novel view images are generated from a set of images which are captured from different viewpoints. In this research, the multiple parallax images are generated from omnidirectional image sequences by rendering with depth information which is estimated by a stereo matching approach.

2. GENERATION OF STEREOSCOPIC IMAGES

(1) Acquisition of Omnidirectional Images

For the purpose of this research, it is necessary to acquire a lot of images which are required for the generation of multiple parallax images. We use omnidirectional image sequences for generating multiple parallax images. The omnidirectional image sequences are acquired by using a car mounted omnidirectional multi-camera system.

(2) Setting of novel view points

The novel viewpoints are set so that a user can look around freely in telepresence. The glassless stereoscopic display needs multiple parallax images to realize stereoscopic view at multiple view points. Each viewpoint of multiple parallax images is the approximation of user's binocular viewpoints. Since the images of all viewpoints are not captured, the multiple parallax images is generated by IBR.

(3) Image Selection for Stereoscopic View Generation

In this research, multiple parallax images at novel viewpoints are generated from precaptured omnidirectional images by using extended our previous technique [3]. When there is no light ray information to generate stereoscopic images because omnidirectional images are captured at discrete positions, the omnidirectional image that is captured at the nearest position is used.

(4) Rendering with Depth Information

When a novel view is rendered without depth information, image distortions occur at the boundary between subimages selected from different camera images. The distortion appears in the generated image when the distances from an object to the cameras differ from each other, because the cameras capture the object from different positions. We reduce the distortion of the generated image by rendering with depth information which is estimated by a stereo matching approach between edges in two images that are captured at different positions and contain the same scene. We use template matching which is based on a robust similarity measure (the normalized cross-correlation) for stereo matching.

Fig. 1. Example of nine parallax images for stereoscopic display

Fig. 2. Telepresence system using stereoscopic display

3. CONSTRUCTION OF TELEPRESENCE SYSTEM

In demonstration, to see stereoscopic view and to look around are realized simultaneously by generating the stereoscopic images of the various directions of view from omnidirectional image sequences. Omnidirectional image sequences are captured by Ladybug2 (PointGreyResearch). As a stereoscopic display, we use SynthaGram404 (StereoGraphics Inc., size: 39.6inch, stereoscopic type: TFT-LCD active matrix, resolution: 1280×768). This stereoscopic display can present nine parallax images simultaneously by using a lenticular screen. A user can realize stereoscopic view by looking the images which have a binocular disparity. We generated multiple parallax images by off-line processing when the view direction is rotated in steps of 1 degree. Examples of multiple parallax images are given in Figure 1. In this figure, nine parallax images have a binocular disparity respectively and the disparity become large from the upper left image to the lower right image gradually. A user can see a stereoscopic view without special glasses and look around in arbitrary directions interactively by using the generated images, as shown in Figure 2. In the experiment, we confirmed that these images could correctly show a stereoscopic view interactively.

4. CONCLUSION

In this demonstration, the technique of presenting stereoscopic view for an outdoor scene using a glassless stereoscopic display is proposed. In telepresence, to see stereoscopic view and to look around were realized simultaneously. As a future work, we need to evaluate a generation quality of the generated stereoscopic images.

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5. REFERENCES

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