Fly-through Heijo Palace Site: Augmented Telepresence Using Aerial Omnidirectional Videos

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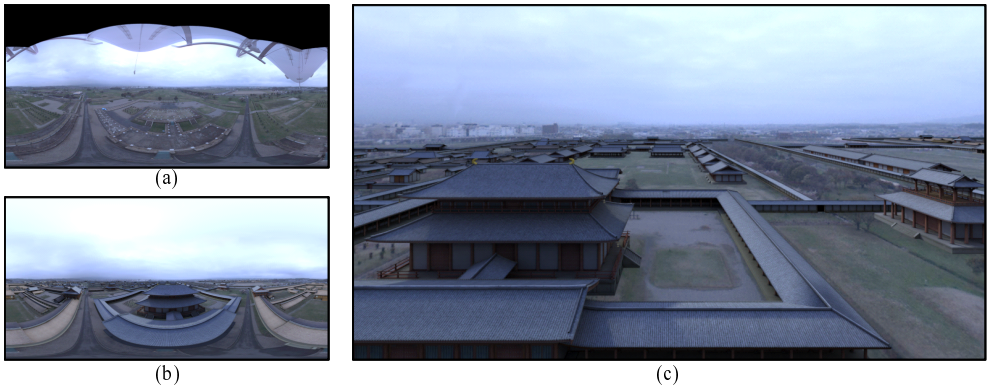

Figure 1: *(a) An omnidirectional image aligned by the posture of omnidirectional camera. An invisible area appears at the top of the image. (b) An augmented omnidirectional image with virtual constructs superimposed using camera position and posture under the illumination environment of the real world. Invisible areas are inpainted from the input image. (c) A view-dependent perspective image converted from the omnidirectional augmented image in real-time.*

1 Introduction

This study developed a virtual tourism system "beyond time and space" using augmented telepresence. Telepresence is a technique that provides a view of a remote site using immersive displays. In this paper, augmented telepresence (AT) refers to a kind of telepresence that provides a user with both a view of a remote site and related information using augmented reality (AR) techniques.

The 1300th anniversary of Nara Heijo-kyo capital, an ancient capital in Japan, was last year. The proposed system superimposes CG of the Heijo palace which was built 1300 years ago "beyond time" on recorded videos captured from an unmanned airship at the remote site "beyond space." Related AT works using recorded videos (e.g. [Ghadirian and Bishop 2008]) cannot resolve geometric and photometric registration problems, and/or they do not provide for immersive telepresence. This study handles geometric and photometric registration problems for automatic movie-quality registration. In addition, the proposed system uses omnidirectional videos captured by an omnidirectional multi camera system (OMS) equipped on an airship to increase the immersiveness of telepresence by providing looking-around behavior for the user. To render augmented scenes, we use image-based-lighting (IBL) and global illumination (GI) techniques with an omnidirectional environmental map. Invisible areas of the environmental map including areas which the OMS cannot capture and areas which the airship occludes a background scenery, are inpainted automatically.

2 Approach

To overcome the geometric registration problem, the proposed system estimates the camera position and posture. The proposed system uses non-realtime processing with a high-accuracy camera position and posture estimation method [Yokochi et al. 2006] with a video and position data measured by GPS. Each frame of the omnidirectional video is aligned using the position and posture of the OMS (e.g. Figure 1(a)).

Environmental maps for IBL are generated from an omnidirectional video to realize photometric registration. Environmental maps had to be generated without invisible areas. Such areas also decrease the immersiveness of telepresence. To inpaint invisible areas and generate a complete environmental map, other frames in the video are searched for an area corresponding to the invisible area using SSD, and the pixel intensities belonging to this area is copied to the pixels of the invisible area. The All-sky-model [Igawa et al. 2004] is used to inpaint areas having no corresponding areas, where the background scene is occluded in all the frames. The All-sky-model is a statistical model of various skies, with the intensities of pixels calculated from some parameters estimated from the whole sky.

Augmented omnidirectional video is rendered using the complete environmental maps and the estimated position and posture of the OMS (c.f. Figure 1(b)). Commercial software is used for the rendering process. The augmented omnidirectional video is converted to view-dependent perspective images (c.f. Figure 1(c)) in real-time [Onoe et al. 1998], and is presented to the user via a HMD. The user can freely look around the augmented scene. The proposed system was demonstrated at the Commemorative Events for the 1300th Anniversary of Nara Heijo-kyo Capital, and over a thousand people experienced the system.

References

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