Integrated System of Augmented and Virtual Reality for Ruins Tourism

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***Abstract*—For ruins tourism, we employ indirect augmented reality (AR) to virtually reproduce and show the buildings of the past that do not exist now. In addition, by taking advantage of indirect AR, we develop an integrated system that seamlessly transitions the AR experience to the VR experience. We evaluated the system through an actual local government event.**

***Index Terms*—indirect augmented reality, virtual reality**

I. Introduction

Kudara Temple Ruins in Hirakata City, Osaka, has been designated as a Special Historic Site of Japan. However, it is not well known due to the lack of any notable buildings. For this issue, reproducing and presenting scenes at that time using augmented reality (AR) is one of the approaches to increase the visibility of the site.

one type of AR that is suitable for historical sites is indirect AR [1], in which virtual objects are pre-composed in a pre-captured omnidirectional image, and an image is cropped out from it according to the orientation of the user's device obtained by its internal sensor and presented to users as AR.

In this study, we focus on a practical application of Indirect AR, rather than solving its technical issues [2], [3]. We also propose a system that enables enjoyable sightseeing of ruins by adding virtual reality (VR) functions that are seamlessly connected from Indirect AR.

II. Integrated System of AR and VR

A. Construction Method

We first captured omnidirectional images at the point where the system is to be experienced with RICOH THETA X and a tripod with a maximum height of 7.5 meters, as shown in Fig. 1. Next, we removed unwanted objects from the images and corrects the luminance to represent different weather conditions. The 3D models created based on archaeological materials were aligned with the omnidirectional image, and rendered together as shown in Fig. 2. Using the rendered images, we developed the system with Unity that runs on a tablet PC as an Android application. In the system, particle objects were added for snow, rain, spring, and autumn scenes.

B. System's Functions

Figure 3 shows the system interface. The field of view in the screen is linked to the rotation of the mobile device using its internal sensor. The icons on the right side change weather conditions and seasons. The up and down icons on the left side move the viewpoint between the ground and a height of 7.5 meters. The icon on the lower left side switch between displaying and not displaying virtual objects. The top-left icon displays a map of the entire Kudara Temple.

(a) From the ground (b) From a height of 7.5 meters

Fig. 1: Captured omnidirectional images.

Fig. 2: Rendered omnidirectional image with 3D models.

Fig. 3: System interface.

III. Use in a Local Event

Twenty people experienced the proposed integrated system with LAVIE T1295/DAS at an event hosted by Hirakata City on November 12, 2022, at Kudara Temple Ruins. Through this event, we confirmed that multiple people could experience the system at the same time without being affected by the surrounding people, and enjoyed VR of various weather conditions, seasons, and viewpoints that are seamlessly connected from AR by tapping the icons without any problems.

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References

[1] J. Wither, Y.-T. Tsai, and R. Azuma, "Indirect augmented reality," *Computers & Graphics*, vol. 35, no. 4, pp. 810–822, 2011.
[2] F. Okura, T. Akaguma, T. Sato, and N. Yokoya, "Addressing temporal inconsistency in indirect augmented reality," *Multimedia Tools and Applications*, vol. 76, pp. 2671–2695, 2017.
[3] F. Okura, Y. Nishizaki, T. Sato, N. Kawai, and N. Yokoya, "Motion parallax representation for indirect augmented reality," in *Proc. ISMAR*, 2016, pp. 105–106.