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Mixed and Augmented Reality Research at Nara Institute of Science and Technology (NAIST)

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Abstract

This paper briefly describes recent activities in Mixed and Augmented Reality at Nara Institute of Science and Technology(NAIST), JAPAN. We especially introduce augmented reality and augmented virtuality research conducted at two laboratories in NAIST.

Categories and Subject Descriptors (according to ACM CCS): H.5.1 [INFORMATION INTERFACES AND PRESENTATION]: Multimedia Information Systems — Artificial, augmented, and virtual realities

1. Introduction

Nara Institute of Science and Technology (NAIST), which is a Japanese national university, is consisted solely of graduate schools. NAIST consists of three schools: Information Science, Biological Science and Materials Science. This paper introduces Mixed and Augmented Reality research at the following two laboratories in Graduate School of Information Science.

Interactive Media Design Lab.

Professor: Hirokazu Kato
Associate professor: Jun Miyazaki
Assistant professors: Toshiyuki Amano, Makoto Fujisawa

Research fields of this lab include media engineering, data engineering and human interface. Main topics are virtual/augmented reality and next generation interfaces. It is well-known that Prof. Kato produced ARToolKit which is a software library for building Augmented Reality (AR) applications.

Vision and Media computing Lab.

Professor: Naokazu Yokoya
Associate professor: Kazumasa Yamazawa
Assistant professors: Masayuki Kanbara, Tomokazu Sato

Research fields of this lab cover computer vision, computer graphics and human interface. In this lab, augmented reality and augmented virtuality based on computer vision technology have been investigated.

2. Augmented Reality

2.1. Desk-top AR Applications

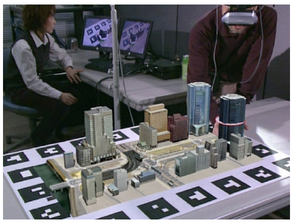
In a AR field, a tracking techniques are very important. We have developed and released the ARToolKit as open source library, which uses square markers for tracking. Many desktop AR applications based on the ARToolKit have been developed as shown Fig. 1(a). We also have been investigating registration method using the Texture Tracking method, which does not use markers, as shown in Fig. 1(b). For AR applications, new user interfaces are investigated. Instead of simply using AR to present information, it is also possible to use it as an input and output mechanism, and such possibility can be extended in large scale. We can provide the research guidance and technology for the design of such interfaces.

2.2. Projection Based AR Applications

We developed AR systems with projector instead of Head Mounted Display (HMD). Fig 1(c) shows a visual feedback system using a method to control the color and brightness of a dynamic object. In our experimental system, the appearance of the objects on printed materials in which the color has vanished or in which it is difficult for the naked eye to distinguish the objects is enhanced. Besides, it is possible to perform negative feedback, erasing the object. Using a mobile projector, AR guide system is also developed for large indoor environments as shown in Fig 1(d). The system measures user's position and orientation by using a localization method with invisible markers described in the next section and can provide a user with not only 2D but also 3D information by using a pair of projectors and polarized glasses.

2.3. AR Applications for Large Environments

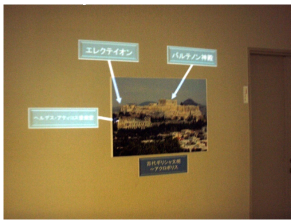
For large indoor environments, we proposed a novel registration method which is based on using an IR camera and invisible markers made from retro-reflective materials as shown in Fig 1(e). Since the wallpaper contains printed invisible markers whose color is similar to one of wallpaper and IR camera captures only reflection of infrared light, the user cannot see the markers. Fig 1(f) is an example of AR application in which user information is overlaid as annotations. For



(a) AR city modeling

(b) Virtual popup book

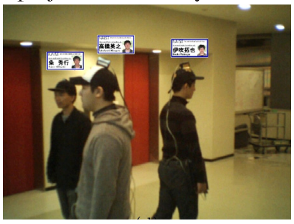
(c) Image enhancement using projector camera system



(d) Projection based AR guide system

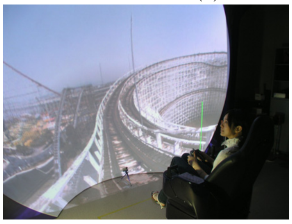
Without flash With flash

(e) Invisible markers

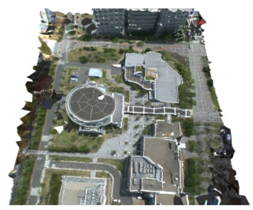


(f) Annotation overlay for users

(g) AR registration using feature landmarks



(h) MR teleplesence with dome screen



(i) 3D reconstruction in large outdoor environment

(j) Omnidirectional image captured by multiple camera system

Figure 1: *MR and AR activities at Kato and Yokoya labs. of NAIST*

AR registration in outdoor environments, extrinsic camera parameters of video images are estimated from correspondences between pre-constructed feature-landmarks and image features (Fig. 1(g)). In order to achieve real-time camera parameter estimation, the number of matching candidates is reduced by using priorities of landmarks that are determined from previously captured video sequences.

3. Augmented Virtualty

Fig. 1(h) illustrates an MR telepresence system which enables user to feel as if they are at remote site. The system consists of an immersive display and a motion chair and presents real images to users. In order to provide user with high realistic sensation, information of the real world should be acquired to virtual environment. We have investigated two approaches for acquisition of the real world.

3.1. 3D Modeling Based Acquisition of Real World

We proposed a dense 3-D reconstruction method that first estimates extrinsic camera parameters of a hand-held video camera, and then reconstructs a dense 3-D model of a scene. In the first process, extrinsic camera parameters are estimated by tracking a small number of predefined markers of known 3-D positions and natural features automatically. Then, several hundreds dense depth maps obtained by multi-baseline stereo are combined together in a voxel space. We can acquire a dense 3-D model of the outdoor scene accurately by using several hundreds input images captured by a handheld video camera, as shown in Fig. 1(i).

3.2. Image Based Acquisition of Real World

To acquire the real environment, we captured omnidirectional images by using a multiple camera system mounted on a vehicle or a roller coaster. The multiple camera system consists of six cameras and can capture high resolution images as shown in Fig 1(j). The stereoscopic view can be also generated from an omnidirectional image sequence by a light field rendering approach which generates a novel view image from a set of images.

4. Conclusion

This paper has briefly introduced Mixed and Augmented Reality research activities of Nara Institute of Science and Technology (NAIST). To get more information, please visit to our web pages. (**http://imd.naist.jp/** and **http://yokoya.naist.jp/**)