

Guest Editors' Introduction

Special Issue on Mixed Reality

The term *mixed reality* (MR) was first used in the mid 1990s (Milgram & Kishino, 1994), after the popularization of *virtual reality* (VR). VR refers to the experience of users immersed in a virtual computer-created world. Thus, the world of VR exists within the computer. In contrast, MR attempts to correlate the virtual world with the real world.

At one end of the spectrum of ways in which virtual and real worlds can be combined is *augmented reality* (AR), a term that was first used in the early 1990s (Caudell & Mizell, 1992). AR supplements the real world with information obtained from a virtual world; for example, a see-through head-mounted display (HMD) may be used to superimpose a computer-generated image on the user's view of the real world. *Augmented virtuality* (AV), in contrast, refers to augmenting a virtual world with information obtained from the real world. Using AV, a more realistic virtual world than that of VR can be realized; for example, complex shapes and actual images of naturally occurring objects can be incorporated into a virtual world.

In 1997, Mixed Reality Systems Laboratory Inc. was inaugurated in Japan as the founding body for a four-year joint project between the Ministry of International Trade and Industry (MITI) and Canon Inc. Three universities, the University of Tokyo, Hokkaido University and the University of Tsukuba, joined the collaboration, and an MR research group comprising industry, government and academia was established. The editors of this special issue, Ohta and Hirose, are collaborative researchers involved in the project, and Feiner participated as an international advisor.

As part of this project, the *International Symposium on Mixed Reality (ISMR)* was held twice, in 1999 and 2001, to encourage MR research worldwide. To compile this special issue, we selected some of the best papers presented at *ISMR 2001*, and asked their authors to submit revised versions for review. The following is a brief summary of the articles included in this special issue.

Sawada and colleagues report on one of the core AR

technologies: head tracking. Sawada's group describes a hardware solution based on miniature high-precision gyroscopes. Hedley and colleagues and Walairacht and colleagues present studies of user interface devices for freely manipulating the AR environment. Lee and colleagues introduce a system that allows the user to model physical objects within AR. Mann and Fung describe an approach to obscure visually undesirable objects to create diminished reality. Ohta and colleagues, MacIntyre and colleagues, and Sakagawa and colleagues report on methods for fusing the real world and virtual worlds. Ohta's group describes an augmented reality system that uses an interactively computed depth map of the real world. MacIntyre's group reports on software for embedding 2D video actors in 3D augmented reality, while Sakagawa's group presents hardware for incorporating 3D, real world, ray-space models into virtual reality.

When MR was first introduced, it dealt with the fusion of real and virtual worlds, accomplished, in principle, with VR technology. However, as MR research has progressed, it has become clear that a broader perspective is required to better take into account the real world. In particular, this has meant that MR researchers have begun to address the real world beyond the laboratory, exploring mobile and wearable computing technology. The MR field is progressing rapidly, and we hope that this special issue helps convey its vitality. Finally, we express our sincere thanks to Prof. Hirota of the University of Tokyo, who handled the administration work for the submitted manuscripts. We also thank Dr. Tamura of MR Systems Laboratory, and the members of the *ISMR* Committee.

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References

- Caudell, P., & Mizell, D. "Augmented reality: An application of heads-up display technology to manual manufacturing processes," *Proc. Hawaii Int. Conf. on Sys. Sci.*, January 1992, Hawaii, 659–669.
- Milgram, P., & Kishino, F. "A taxonomy of mixed reality visual displays," *IEICE Trans. on Information and Systems*, vol. E77-D, no. 12, December 1994, 1321–1329.