

Mixed Reality

Merging Real and Virtual Worlds

Edited by
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HIDEYUKI TAMURA



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Mixed Reality — Merging Real and Virtual Worlds

Edited by: Yuichi OHTA

Hideyuki TAMURA

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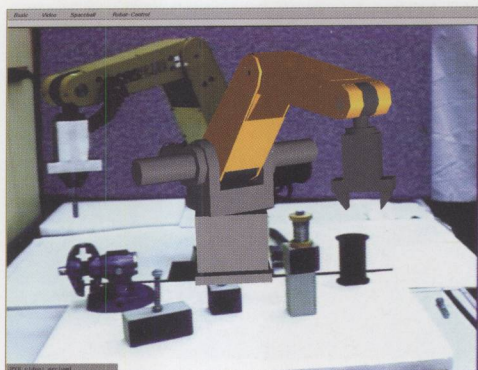


Figure 1.3

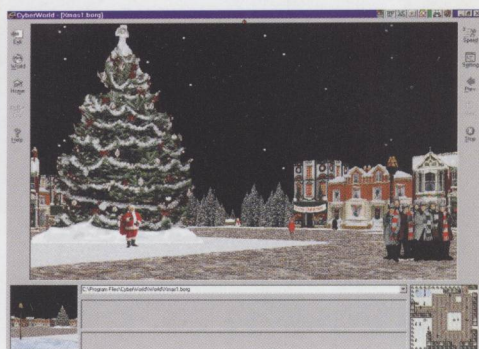


Figure 1.4



Figure 1.6

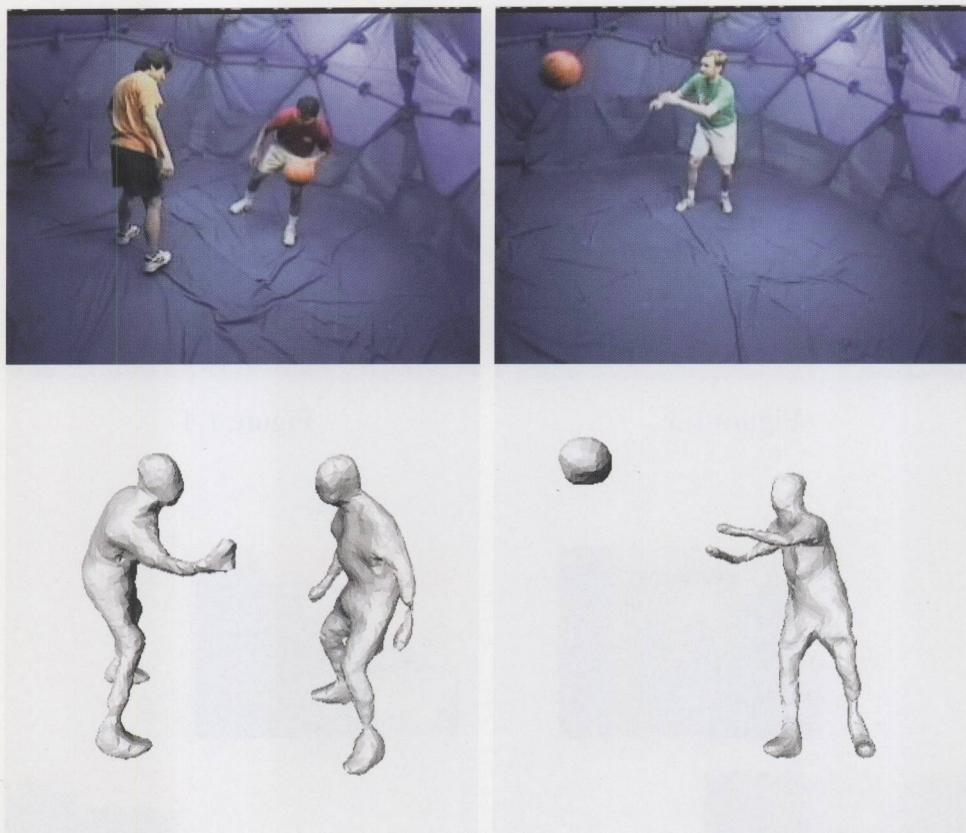


Figure 3.7



Figure 3.10



Figure 4.2

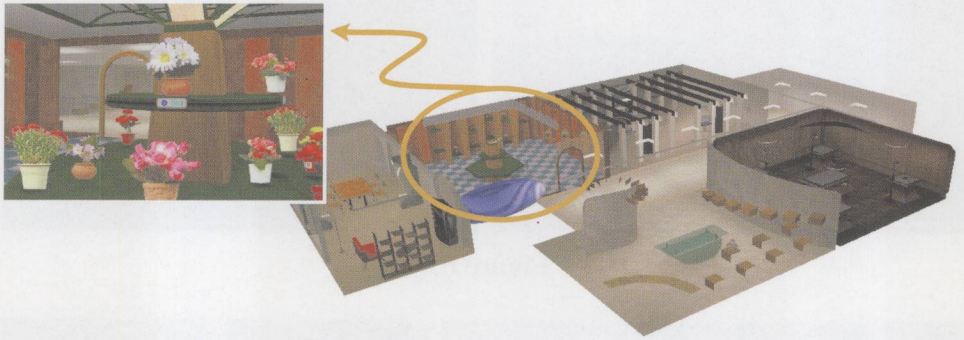


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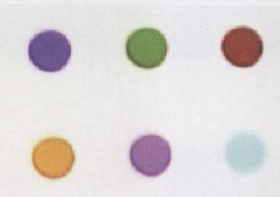


Figure 6.1

	Proportional width ring fiducials		
Constant width ring fiducials			
	First level	Second level	Third level

Figure 6.5

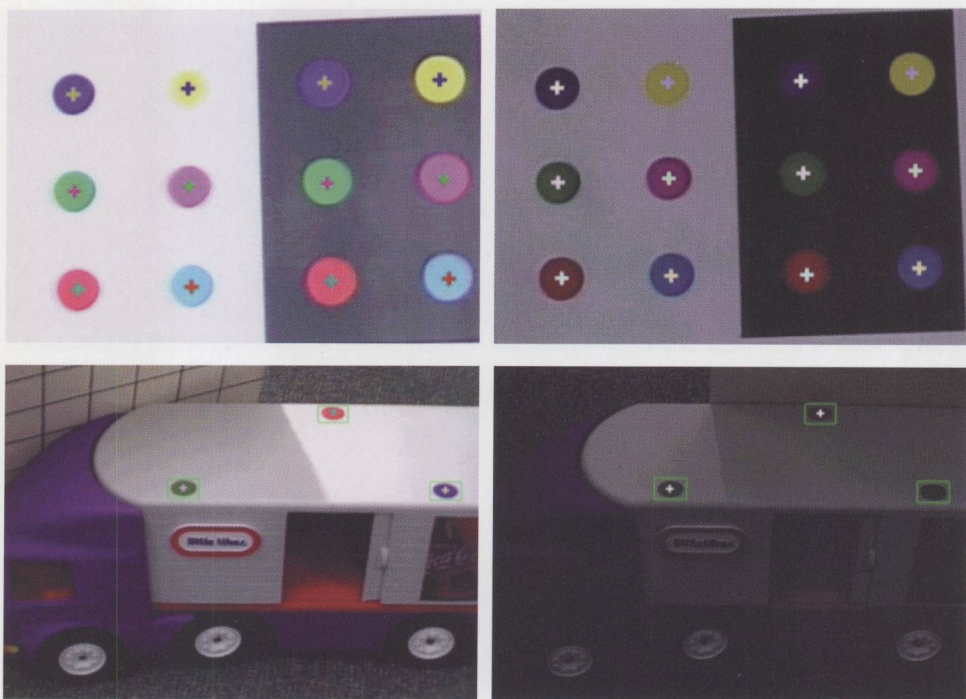


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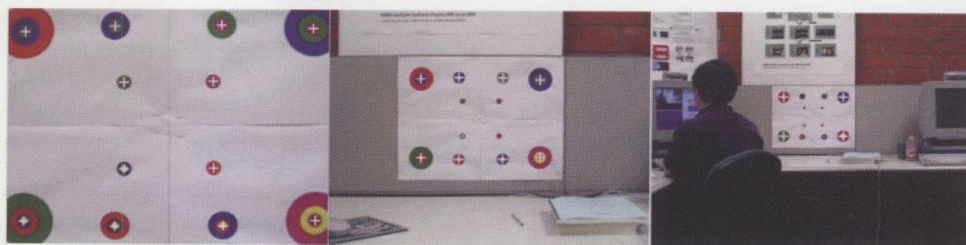


Figure 6.8



Figure 6.13

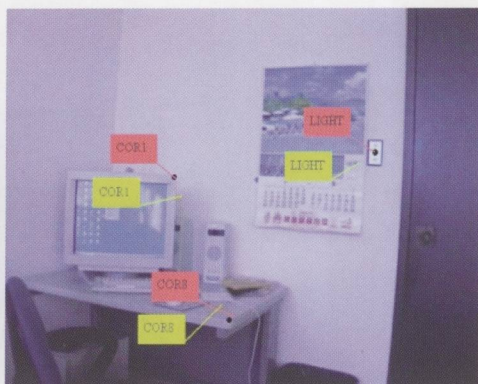
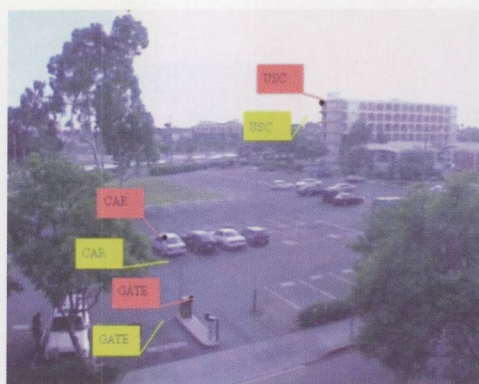


Figure 6.17

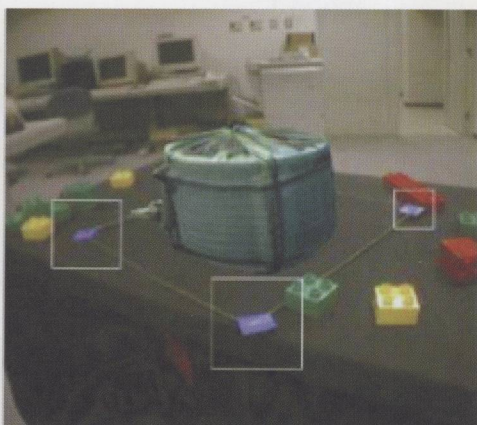
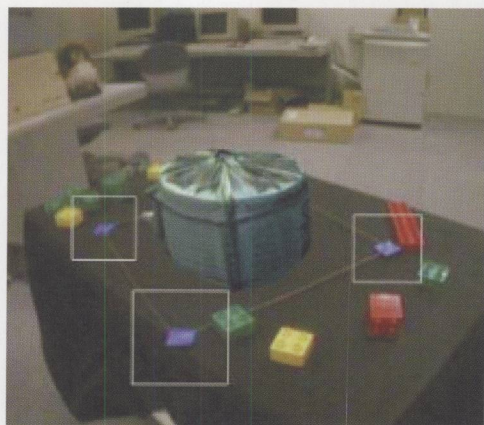


Figure 7.2



Figure 9.13

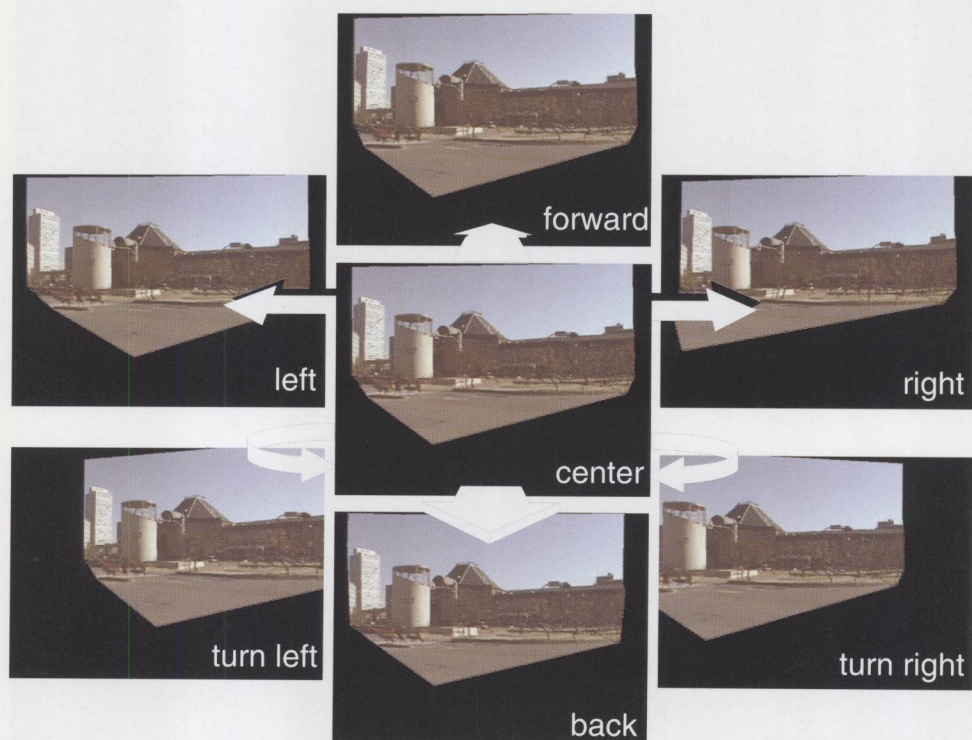
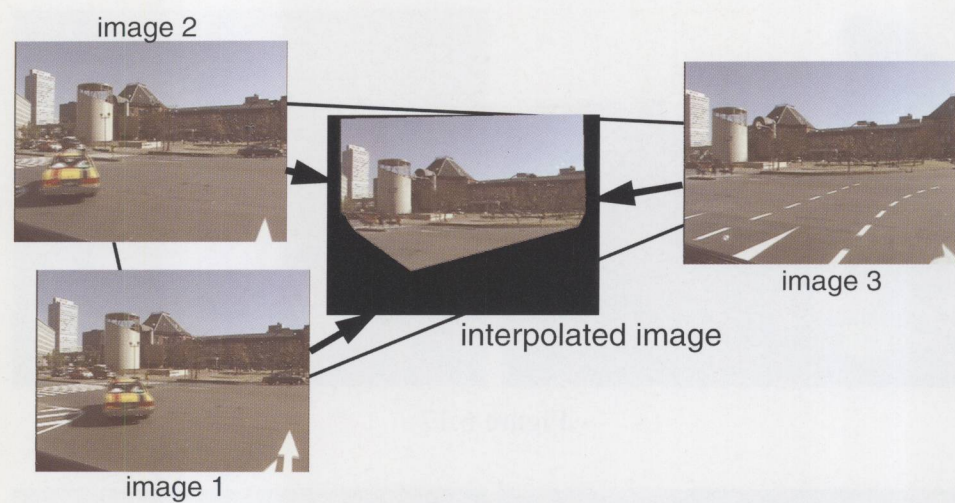


Figure 10.8

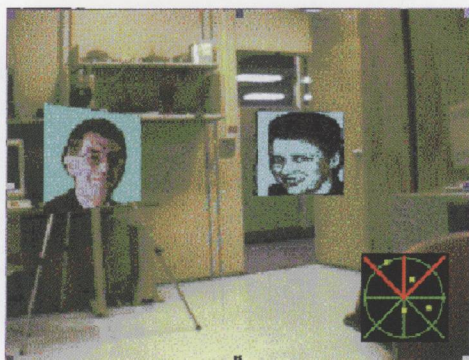


Figure 15.6



Figure 18.2

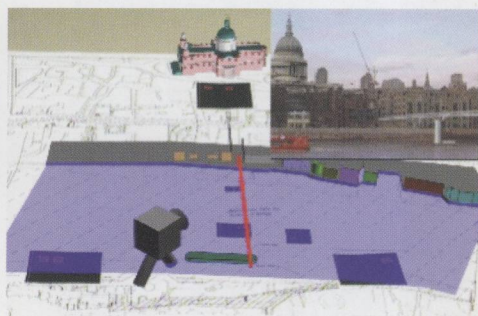


Figure 18.3



Figure 18.4

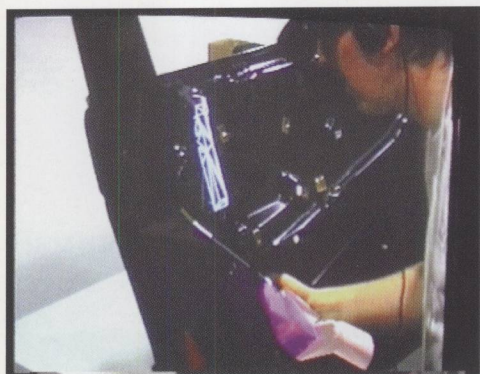


Figure 18.5

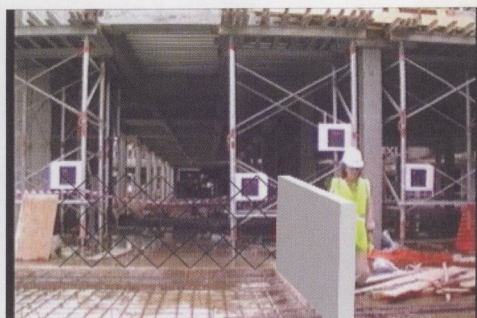


Figure 18.6

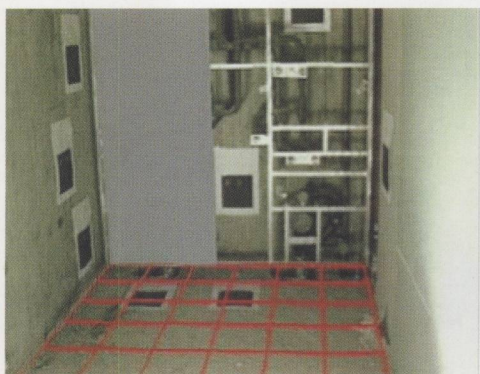


Figure 18.7

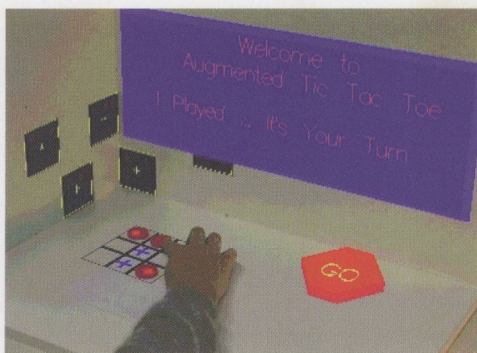


Figure 18.9

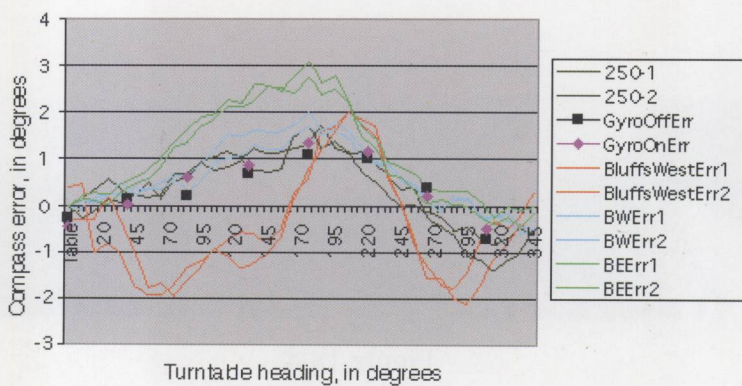


Figure 21.2

Preface

The past ten years have seen the popularization of virtual reality (VR) systems, which enable participants to interact with virtual environments synthesized by a computer. Most of the VR systems we have experienced in this decade, however, have conveyed a poor sense of reality, primarily because the environments are synthesized entirely within a computer. Due to this limitation, people started to incorporate the rich information available in the real world into their VR systems. It therefore became essential to identify a technology that deals concurrently with the virtual synthesized world, as well as with the real physical world. Mixed reality is just such a technology, in that it realizes environments that seamlessly integrate both real and virtual worlds.

This is the first book that includes “Mixed Reality” in its title. It will also serve as the proceedings of the First International Symposium on Mixed Reality (ISMR '99), scheduled in March 1999 in Yokohama, Japan. Let us explain the background and circumstances that compelled us to edit and publish this book.

The Key-Technology Research Project to investigate the next generation of VR technology was conceived in Japan in 1996. We, the members asked to participate in this project, decided to adopt the name “Mixed Reality” (MR), which is broader than the term “augmented reality”, as the project’s main theme. The MR project was started in early 1997 by obtaining financial support from the Ministry of International Trade and Industry, and the Mixed Reality Systems Laboratory Inc. (MR Lab) was established. Soon after that, the Special Interest Group on Mixed Reality was formed within the Virtual Reality Society of Japan. Various Japanese academic societies have also made MR the theme of a number of special sessions at their annual conventions and periodic meetings.

People came to realize the importance of position sensors and computer vision technology in this field. On the other hand, wearable computers have more recently begun to acquire popularity and special attention has begun to be paid to MR systems in which the observer wears a see-through head-mounted display. At the current time, representatives of a large variety of organizations are visiting the MR Lab in Yokohama on a continuing basis, including broadcasting stations, video production companies, electrical power and gas companies, construction companies, city planning agencies, and museums. Among these, video game companies and medical instrument manufacturers are at the forefront, seeking the most direct route towards practical applications of this technology.

As an extension of our original proposal, we, the editors of this book and promoters of the MR project, decided to combine the demonstration of our intermediate

research results with an international symposium on the topic of MR. Our objective was not that the workshop would necessarily be a place only for presenting original papers, but also a forum in which people from various fields having an interest in this technology could get together and talk freely about its essential elements and the potential for future advances. With this in mind, we have endeavored to identify a variety of participants renowned for their farsighted opinions and outstanding research results in this field and invite them to talk about the MR theme. During our selection of these invited speakers, we realized that the contents of the invited talks would likely be too valuable merely to be a conference proceedings presented only to the symposium participants. We therefore decided to collect these papers and arrange them as a book, to be published widely through an international publisher.

We believe that the authors are well selected and that the book will stand on its own merits. A significant amount of important material is presented throughout the book, which we hope will become a valuable resource for people who want to acquaint themselves with the current orientation of emerging MR technology.

We also draw the reader's attention to the fact that various events have been planned to be held at ISMR '99 to demonstrate the breadth of MR technology and applications, such as a media art gallery, a panel discussion on future entertainment, and technical demonstrations of late-breaking results. We regret that we can not report on all of those events in this book.

Finally, the editors want to express our gratitude to many people for their devotion and cooperation in the creating and publishing of this book. We especially offer our thanks to Prof. Heitou Zen and Dr. Takeshi Naemura, the ISMR '99 Publication Chairs, for their good instructions and suggestions, to Ms. Yuko Wakatsuki, Mr. Mahoro Anabuki, Mr. Tomotaka Kanamori, Mr. Daisuke Kotake, Mr. Noriyuki Sugai, Mr. Masahiro Suzuki, and Ms. Rika Tanaka of MR Lab for their patience in the face of annoying tasks and complicated challenges, and to Dr. Haruo Takemura, who is currently on leave at the University of Toronto, for his voluntary cooperation from abroad. The editors also express their special thanks to Prof. Paul Milgram and Prof. Steven Feiner for their careful proofreading of the editorial introductions. Last but not least, we thank all the authors for their invaluable contributions.

January 1999

Yuichi Ohta
Hideyuki Tamura

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