# Guest Editor's Introduction to the Special Section on the IEEE International Symposium on Mixed and Augmented Reality 2014

Simon Julier, Rob Lindeman, and Christian Sandor

THE IEEE International Symposium on Mixed and Augmented Reality (ISMAR) is the leading venue for publishing the latest Mixed and Augmented Reality research, applications, and technologies. This special section presents significantly extended versions of the best papers from the IEEE ISMAR 2014 proceedings. Within the past few years, Augmented Reality (AR) has reached a critical mass in both research and commercial applications. It is now becoming truly feasible to use augmented reality to place graphics anywhere at any time. However, although the basic capabilities exist, many open research problems continue. This collection of papers considers underlying issues and technologies

The first paper, "Design and Error Analysis of a Vehicular AR System with Auto-Harmonization" by Eric Foxlin, Thomas Calloway, and Hongsheng Zhang, considers the problem of developing an AR system for aerospace and ground vehicles. Unlike many commercial applications where the registration merely has to be plausible, poor registration in these systems can jeopardize safety and mission criticality. Furthermore, the display is being worn by an operator who is inside a vehicle which is moving. The authors present a comprehensive and detailed analysis of the key system components including the development of a harmonization algorithm (which compensates for platform movement), the calibration of camera systems, and the effects of measurement latency. The system also provides estimates of registration error, which can potentially be used in displays which adapt to tracking errors. The resulting system is demonstrated in a high fidelity AR system which is used in a commercial road vehicle.

The next two papers consider the problems associated with rendering and the interaction of virtual content and the real world. The paper "SmartColor—Real-Time Color and Contrast Correction for Optical See-Through Head-Mounted Displays" by Juan David Hincapié-Ramos, Levko Ivanchuk, Srikanth Sridharan, and Pourang Irani, considers the problem that optical see through head-mounted displays cannot truly block the background environment. When graphics are overlaid in the user's field of view, the color of those graphics is a blend of what is rendered, and what is in the background, which can produce colors which are very different from those conceived by the application designers. To overcome this challenge, the authors develop a formalism, known as QuickCorrection, which models and adapts to the color blending challenge. User studies confirm the effectiveness of the approach, and real-time implementations designed to support a number of effects—including color correction and contrast—are developed. In contrast, the paper "Interactive Near-Field Illumination for Photorealistic Augmented Reality with Varying Materials on Mobile Devices" by Kai Romer, Wolfgang Buschel, Raimund Daschelt and Thorsten Grolsch, explores how to light virtual content on video see through AR systems so that the virtual content seamlessly blends with the real world. This is achieved by lighting of the virtual content in a physically realistic manner. It must also support multiple users on mobile devices. To address this problem, the paper introduces a novel distributed system. A server uses a set of high dynamic range cameras to construct a texture atlas of the environment, which encodes both geometry and appearance. This is encoded using a compact parameterization. With this system, frame rates of more than 25 fps are reported.

The paper "Monocular 3D Reconstruction and Augmentation of Elastic Surfaces with Self-occlusion Handling" by Nazim Haouchine, Jeremie Dequidt, Marie-Odile Berger and Stephane Cotin, investigates the 3D reconstruction of deformable and self-occluding objects. Many objects in the real world—including biological tissues and paper—can flex and deform and even fold back on themselves. The shape of these objects must be determined even if the objects are only partially visible. The paper introduces a new method for capturing surfaces using a single viewpoint. A non-elastic model is used as a prior in this construction step. The model used to fit the deformable surface to the model also can be used to predict the shape. Therefore, the authors show that this model can also be used to accurately predict the shape of the occluded region of part of an object when up to 60 percent of that object is not visible. The approach is demonstrated for both deformable objects, such as sheets of material, and in biological tracking applications.

The final paper, "Fidelity and Plausibility of Bimanual Interaction in Mixed Reality" by Gergory Hough, Ian Williams, and Cham Athwal, presents a framework for assessing the fidelity of humans and virtual object interaction in the context of virtual production. In particular, actors with no feedback as to the actual size, shape, and location of the virtual content they are supposed to be interacting with commit errors. These errors lead to loss of plausibility for the viewers. The framework analyzes the types of errors

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which are made, the effects these errors have on the viewing audience, and several mitigating strategies including the resizing of the virtual content to match an actor's hand separation.

IEEE ISMAR 2014 had 89 paper submissions; each paper was reviewed by at least four experts in the field. An international program committee of 15 AR experts invited reviewers, led discussions, invited a rebuttal by the paper authors and prepared a consensus review. To select the final papers for publication, an online two-day PC meeting was held connecting three continents, where each paper was discussed. Thirty-five papers were accepted either as long or short publications, giving an overall acceptance rate of 40 percent.

An independent Award Committee reviewed the highest-ranked submissions again to determine the awards for Best Paper and Honorable Mention. For this special section, the authors of the award papers were invited to submit an extended version of their conference papers, with a clear focus on additional content that expands the scientific contribution of the original conference paper. A standard *TVCG* reviewing cycle was initiated in which all papers were reviewed, feedback was provided, and papers were revised to suit. Out of all submitted papers, less than 6 percent appear in this *TVCG* Special Section.

The authors would like to thank the General Chairs, Gudrun Klinker and Nassir Navab, for their excellent work in arranging the conference, the Awards Chair, Dr. Hirokazu Kato, for organizing the selection of the award papers and the members of the Award Committee for the additional reviews and final recommendations for the papers presented in this section. We would also like to thank all the authors—both successful and unsuccessful—for submitting their many ideas and visions to the conference. It has been a true privilege to see the creativity and imagination of so many people in one place at one time. Finally, we thank all the reviewers who have provided thoughtful and insightful comments through several iterations. The quality of ISMAR and its outstanding reputation could not have been achieved without all of their hard work and vision.

Simon Julier
Rob Lindeman
Christian Sandor
*Guest Editors*

**Simon Julier** received the DPhil from the Robotics Research Group, the University of Oxford, United Kingdo. He is a reader in the Department of Computer Science, University College London. During the DPhil, he assisted Jeff Uhlmann in the development of both the Unscented Kalman Filter and Covariance Intersection fusion algorithms. Between 1997 and 2006, he was at the Naval Research Laboratory, Washington DC, where he led a team to develop mobile augmented reality systems. Since 2006, he has been at UCL, where he has been developing algorithms for simultaneous localization mapping, augmented reality, and distributed data fusion. Recently, he has begun to study the use of negative information (lack of detections) in filtering and estimation problems. He has also been developing inertial navigation systems for camera-based tracking, and is developing self-calibration systems for cranes and robotic arms for camera calibration and film and TV production.

**Rob Lindeman** received the master's of science degree from the University of Southern California in 1992, and the Doctor of Science (ScD) degree from The George Washington University in 1999 in the areas of computer graphics and human-computer interaction. He has been doing research in the field of virtual reality since 1993. He is an associate professor in the Department of Computer Science, Worcester Polytechnic Institute (WPI) in Massachusetts. He is the director in the Human Interaction in Virtual Environments (HIVE) Lab, which focuses on immersive, multisensorial feedback systems for VR, AR, and gaming, as well as natural and nonfatiguing interaction. He joined WPI in 2005 as one of the first faculty hired in support of their program in Interactive Media & Game Development (IMGD), which he currently directs. He was the general chair for the IEEE 2010 Virtual Reality Conference, Program co-chair for 2014 & 2015 IEEE ISMAR Conference, and the co-chair for the 2015 & 2016 IEEE 3DUI Symposium. He is a senior member of both the IEEE and ACM.

**Christian Sandor** received the doctorate in computer science from the Munich University of Technology, Germany, under the supervision of Prof. Gudrun Klinker and Prof. Steven Feiner in 2005. Since the year 2000, his foremost research interest is augmented reality, as he believes that it will have a profound impact on the future of mankind. He is an associate professor at Nara Institute of Science and Technology (NAIST), where he is co-directing the Interactive Media Design Lab together with Professor Hirokazu Kato. Before joining NAIST, he directed the Magic Vision Lab (http://www.magicvisionlab.com). Together with his students, he received several awards including best demonstration at IEEE International Symposium on Mixed and Augmented Reality (ISMAR) in 2011. He presented several keynotes and received faculty awards from Samsung (2012) and Google (2014).