Reviews

Understanding Virtual Reality—Interface, Application, and Design

William R. Sherman and Alan B. Craig
Morgan Kaufman. ISBN 1-55860-353-0. US$ 69.95

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My first introductory textbook to the field of virtual reality (VR) was Kalawsky's *The Science of Virtual Reality* (1993). I was pleased last year to obtain a copy of *Computer Graphics and Virtual Environments—From Realism to Real-Time* (Slater, Steed, and Chrysanthou), which provided a valuable update to the earlier work. I therefore wondered if there was a place so soon for another introductory reference book on VR. However, I enjoyed reading this new publication and found that Sherman and Craig provide much complementary material to Slater et al.'s book, and their own informative overview of the field.

The relatively short first part of the book introduces the topic of virtual reality: it provides definitions, identifies the key elements involved, and presents VR as a medium. The second part addresses VR systems and is the "meat" of the book. It covers the VR experience through chapters on the user interface, the technology components required, and the life experience of the participant. Comprehensive lists are given of all of the technology solutions and/or concepts that have been used to date for input to, output from, rendering, and interacting with a virtual world. The author's style of listing the main points and then following up with detailed explanations and examples of each point makes the chapters easy to read. The later chapter on how to design a VR application and apply this technology to a particular problem was well written. It contains many useful design considerations that are often overlooked by an application developer. Many of us will benefit from the consistent use of the design criteria advocated here. The final chapter addresses the future of VR (a difficult area to predict), but I believe the authors have succeeded in giving some good predictions of what we might expect. The book also includes four detailed case studies as appendices. These have been selected carefully to cover a wide spectrum of VR applications. I particularly enjoyed reading about the "Crumbs" tool for scientific visualization and would like to try this software out at my own university facility.

My main criticism of the book is that it is very USA-centric. Practically all of the case studies, software products, and other examples given come from U.S.-based groups. I know of many examples of work from Europe and Asia that could also have been referenced to give a slightly more balanced overview of the field.

A companion Web site is available for the book. At the time of writing this review, the Web site was still being fine-tuned, but it looks as if it will be a useful resource for instructors and students and includes further case studies, sample programming assignments, and exam questions. The URL is difficult to find in the book, however. It was not until I reached p. 418 that I found the address (www.mkp.com/understanding-vr).

Overall, I believe that Sherman and Craig have produced an excellent reference on the current state of the art of VR and related technology. The book should be easily accessible to noncomputer scientists and provide a useful introduction to new students interested in studying the field.

Level of Detail for 3D Graphics

David Luebke, Martin Reddy, Jonathan D. Cohen, Amitabh Varshney, Benjamin Watson, and Robert Heubner
Morgan Kaufmann, ISBN 1-55860-838-9, $69.95

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Sparkling with ideas, this new book provides a timely and long-needed treatment of both the practice and theory of level of detail. As a field within computer graphics, level of detail (LOD) addresses the balance between the ever-increasing complexity of virtual worlds and the requirement to produce images of them in real time.

The intended audience for the book includes both graphics researchers and developers of real-time graphics applications, and it succeeds in supporting this broad audience while requiring of the reader only the essentials of computer science and interactive computer graphics. Needed math background is limited to basic

linear algebra and three-dimensional geometry, and an informal approach is used throughout the book. The book could be used to support a graduate course in level of detail or as part of an undergraduate advanced graphics course. To help teachers, slides from the author's SIGGRAPH 2002 course appear on the companion Web site (http://LODbook.com).

LOD systems have to address two main technical problems: how to simplify complex polygon meshes and how to select the mesh with the fewest polygons at runtime without compromising image quality. To address these problems, the book is divided into three sections: Generation, discussing mesh simplification; Application, discussing mesh selection at runtime; and Advanced Issues, how understanding the performance of the human vision system can improve LOD results.

The Generation section begins with a summary of the history of LOD, stretching back to Clark's seminal 1976 paper "Hierarchical Geometric Models for Visible Surface Algorithms." This is followed by an introduction to the mathematics and terminology used in the book, which doubles as a good overview of the different approaches to level of detail.

Chapter 2 presents a high-level review of the different approaches to mesh simplification with simplification presented as an optimization process wherein the aim is to reach set goals of fidelity or triangle numbers by repeatedly applying a simplification operator to the mesh. The different approaches for removing triangles, edges, or vertices are described and compared. The high-level approach in this chapter does leave a thirst for more detail, but fortunately the authors have anticipated this and describe representative algorithms in detail in chapter 5 and provide working source code on the companion Web site.

Chapter 3 reviews the different error metrics that are available. At their simplest, error metrics measure the difference between a simplified mesh and the original mesh and are used to make choices on which edges can be removed with minimum disturbance to the mesh. Geometric error metrics have traditionally been used to guide the simplification process. Some of the most exciting recent research has begun to consider the visual effect of mesh simplification by comparing the image of the mesh before and after simplification to make visually better simplification choices. The Advanced Issues section covers this topic in more detail, relating error metrics directly to characteristics of the human visual system.

The Application section begins in chapter 4 with descriptions of the alternative runtime frameworks that implement the mechanism to select between LOD models. Selection between LOD models based on distance from the viewer is compared to selection by estimating computational load. This chapter also covers approaches to view-dependent LOD where the level of simplification applied depends on which parts of the model the user can see. Methods to avoid visible "popping" between LOD models are presented, including alpha blending and geomorphing.

Chapter 5 and 6 on computer games and terrain models show the application-dependent nature of the choice of simplification technique and runtime framework. In games, minimum memory use is often a high priority, almost equal to meeting a guaranteed frame rate target, whereas, in terrain modeling, the problem can be how to manage very large data sets that do not fit into main memory.

The Advanced Issues section moves from current practice towards topics associated with the latest research. It aims to provide a better basis for designing error metrics and selecting LOD models at runtime by presenting a detailed understanding of the human visual system. Some of this discussion can be found elsewhere in the human vision and computer graphics literature, but it is useful to have the information in context. Chapter 9 includes a discussion on the relative performance of LOD algorithms and results from comparative studies.

The book might be usefully extended in two areas for future editions. The first is to extend the quantitative comparison of different approaches begun in subsection 9.6, perhaps with the development of a definitive set of benchmarks representative of the key applications. The second is the discussion on the links between LOD methods and compression techniques for both meshes and images. For example, MPEG-4 devoted significant effort to supporting spatial and temporal scalability in coding meshes and images in a real-time framework.

To conclude on a personal note, I was recently undertaking research on a new LOD system at a games company, and I had to search the Internet for information on many of the topics in this book. Not only would Luebke et al. have saved me weeks of effort, but it also presents many more design alternatives than I was able to discover. If you are a developer or researcher working with LOD techniques, you need this book; go and order a copy before your next coffee break.