

*SIGGRAPH 93
20th International Conference
on Computer Graphics and
Interactive Techniques*

*Anaheim Convention Center
1 to 6 August 1993*

COURSE NOTES 41

Volume Visualization

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Preface

Volume visualization is emerging in the nineties as a key field of visualization, computer graphics, and computer imaging. It encompasses an array of techniques, a technology, and a nomenclature, and it holds substantial challenges. The techniques provide the mechanisms that make it possible to reveal and explore the inner or unseen structures of volumetric data and allow visual insight into opaque or complex datasets. Volume visualization, as a technology, brings a revolution to computer graphics and promises important breakthroughs in the diverse applications of volume visualization.

Volume visualization is concerned with the tasks of representing, manipulating, and rendering volumetric data. This tutorial provides an overview of the technology, the nomenclature, and the techniques for these tasks, emphasizing algorithms and applications. The tutorial covers and compares different approaches in volume representation, volume and surface viewing, volume shading, software, and applications of volume visualization.

These tutorial notes contain many of the text slides that will be presented during the tutorial. In addition, numerous color slides and video segments of volume visualization images and animations will be presented. These tutorial notes supplement the tutorial book *Volume Visualization*, by Arie Kaufman (IEEE Computer Society Press, 1990 (ISBN 0-8186-9020-8)). This tutorial book contains landmark papers, classical articles, reviews, and up-to-date contributions to the field of volume visualization. It promises to be a reference book for researchers, developers, and programmers of volume visualization systems, as well as users or potential users of these systems. The book is available at the IEEE Computer Society booth for a special reduced price.

Acknowledgements

The work on 3D volume visualization at Stony Brook has been supported by the National Science Foundation under several grants including IRI-9008109 and CCR-9205047, and grants from the Department of Energy, Hughes Aircraft Company, Hewlett Packard, Silicon Graphics, the Center for Biotechnology, and the State of New York.

Speaker Biographies

Arie E Kaufman is a Professor of Computer Science at the State University of New York at Stony Brook. He is the director of the Cube project for volume visualization supported by the National Science Foundation, Hughes Aircraft Company, Hewlett-Packard Company, Silicon Graphics Company, the Center for Biotechnology, and the State of New York. His research interests include volume visualization, computer graphics architectures, algorithms, and languages, user interfaces, and multimedia. Professor Kaufman has lectured widely and published numerous technical papers in these areas, including the IEEE tutorial book on Volume Visualization. He has given several courses on Volume Visualization for SIGGRAPH, EUROGRAPHICS, CGI, GI, and IBM. He is the chairman of the IEEE CS Technical Committee on Computer Graphics, and has been the Papers co-Chair and Program co-Chair for Visualization '90-'93 Conferences, and co-Chair for several EUROGRAPHICS Graphics Hardware Workshops. He received a BS in Mathematics and Physics from the Hebrew University of Jerusalem, an MS in Computer Science from the Weizmann Institute of Science, Rehovot, and a PhD in Computer Science from the Ben-Gurion University.

Scott Dyer is Vice President of Lamb & Company in Minneapolis, Minnesota. Lamb specializes in high quality three dimensional computer graphics for advertising, entertainment, and simulation, and produces visualization software solutions. Prior to that he was an Associate Director of the Ohio Supercomputer Graphics Project, where he directed the three year effort to construct the apE visualization software. He has also been on the staff of Cranston/Csurfi Productions and worked in visuals for flight simulation at Evans and Sutherland in Salt Lake City. He received his BS in Math from Carnegie Mellon.

William E. Lorensen is a Graphics Engineer in the Information Systems Laboratory at General Electric's Corporate Research and Development Center in Schenectady, New York, and is currently working on algorithms for 3D medical graphics and scientific visualization. His other interests include computer animation, color graphics systems for data presentation, and object-oriented software tools. He is the author or co-author of more than 50 technical articles on topics ranging from finite element pre/postprocessing, 3D medical imaging, computer animation and object-oriented design. He is a co-author of "Object Oriented Modeling and Design" published by Prentice Hall. Prior to joining General Electric in 1978, he was Mathematician at the US Army Benet Weapons Laboratory, where he worked on computer graphics software for structural analysis. He holds a BS in Mathematics and an MS in Computer Science from Rensselaer Polytechnic Institute.

Lisa Sobierajski is currently a PhD student at the State University of New York at Stony Brook. Her research interests include global illumination models and rendering algorithms for voxel-based data, animation, and visualization systems. She is currently working on a visualization system which incorporates several data types into a single, consistent global illumination model. She received her BS Cum Laude (1989) and MS (1990) from the Department of Computer Science at the State University of New York at Stony Brook.

Ulf Tiede is a research assistant at the Institute of Mathematics and Computer Science in Medicine at the University Hospital Eppendorf, Hamburg, Germany. He is working on image processing, computer graphics algorithms, and user interface design for 3D medical workstations. Especially he designed the visualization kernel of the VOXEL-MAN / Atlas project. His research interests include display techniques and data structures for the manipulation of voxel-based data. Tiede received his MS in computer science from the University of Hamburg in 1988.

William L. Van Zandt is the Director of Business Development and a founder of Vital Images, Inc. He holds a BS in physics (summa cum laude) and a MS in neuroscience from Maharishi International University (MIU). His past research experience includes participation in Stanford University's Gravity Wave Project and in MIU's Laboratory for Advanced Biological Cell Imaging where he helped develop the core volume rendering technology of Voxel View. In addition to his work with volume visualization software, Mr. VanZandt has also served as a technical consultant to Vital Images' corporate clients in the fields of medical imaging, seismic analysis, non-destructive industrial testing, and volume microscopy. He has co-authored several papers on applications of volume visualization in the life sciences and has spoken at numerous scientific conferences and meetings.

Roni Yagel is an Assistant Professor in the Department of Information and Computer Science at The Ohio State University. He received his PhD in 1991 from the State University of New York at Stony Brook where he was also a researcher in the Department of Anatomy and in the Department of Physiology and Biophysics. He received his B.Sc. Cum Laude and M.Sc. Cum Laude from the Department of Mathematics and Computer Science at Ben Gurion University of the Negev, Israel, in 1986 and 1987, respectively. His research and technical publications deal with both hardware and software aspects of volume visualization. His research interests also include algorithms for voxel-based graphics, imaging, and animation, three dimensional user interfaces, and visualization tools for biomedical applications.

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- R Avila, L Sobierajski, and A Kaufman "Towards a Comprehensive Volume Visualization System," *Visualization '92 Proceedings*, IEEE Computer Society Press, October 1992, pp 13-20 164
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