SIGGRAPH 1996

Course Notes

Implicit Surfaces for Geometric Modeling and Computer Graphics

Co-Chairs

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Implicit Surfaces for Geometric Modeling and Computer Graphics

Welcome to Implicit Surfaces for Geometric Modeling and Computer Graphics.

In this course we will survey implicit surfaces, discuss their usefulness, describe their advantages and disadvantages relative to other modeling techniques, and present the latest techniques for their design. Until recently, implicit surfaces have received little attention, partly due to the difficulties in visualizing them interactively. From the moment one realizes that it is easier to draw a circle with $(r\cos\theta, r\sin\theta)$ than it is with $(x^2 + y^2 = r^2)$, one is slowly led away from the world of implicit surfaces.

Welcome back!

Implicit surfaces are different from parametric surfaces: the latter, in use in many commercial modeling systems, are familiar to most of the computer graphics community. Implicit surfaces aren't necessarily less practical; they are simply different. They require different techniques for their creation, modification and visualization and have different properties and applications from their parametric counterparts.

The speakers in this course will discuss their current work in developing techniques to make implicit surfaces practical in modeling and animation. By definition, implicit surfaces embrace an extremely large set of surfaces. Undoubtedly, as they receive increased use in computer graphics, concepts will be developed that unify and distinguish various implicit forms. We hope the variety of approaches, applications and results presented in this course will stimulate interest in this exciting branch of modeling.

Courses on Implicit Surfaces were previously offered at SIGGRAPH in 1990 and 1993, co-organized by Jules Bloomenthal and Brian Wyvill.

Jai Menon, *IBM T.J. Watson Research Center*
Brian Wyvill, *University of Calgary*
1996

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Speaker Biographies

Chandrajit Bajaj

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Chandrajit Bajaj graduated from the Indian Institute of Technology, Delhi in 1980 with a Bachelor's Degree in Electrical Engineering. Subsequently he received his M.S. and Ph.D. degrees in Computer Science from Cornell University, Ithaca, New York in 1984. Bajaj is currently a Professor in the Computer Science Department of Purdue University, West Lafayette, Indiana and directs the Collaborative Modelling and Visualization Laboratory which houses the SHASTRA projects. He also directs the Purdue Center of Computational Image Analysis and Data Visualization. His research are in the areas of Computational Geometry, Geometric Modeling, Computer Graphics, Scientific Visualization and Distributed and Collaborative Synthetic Environments.

Jules Bloomenthal

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Jules Bloomenthal studied computer graphics at the University of Utah, and recently received his Ph.D. from the University of Calgary. Dr. Bloomenthal has conducted research at the New York Institute of Technology and at Xerox PARC, and has taught computer graphics at George Mason University and UC Santa Cruz. He is presently with Microsoft Corporation.

Contending that implicit blends usefully represent natural forms, Dr. Bloomenthal has published on several implicit surface topics, including uniform and adaptive polygonization methods, polygonization of non-manifold surfaces, convolution of skeletons, bulge elimination in implicit blends, specification of volume/surface blends, definition of branching structures, interactive design and display techniques, and procedural methods.

Baining Guo

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Baining Guo is currently an assistant professor in the Computer Science Department at York University in Toronto (CANADA). He received his B.S. from Beijing University (PRC) in 1982 and his M.S. and Ph.D. from Cornell University in Ithaca, New York (USA) in 1989 and 1991. Prior to joining York, he worked for France Telecom (FRANCE) and The University of Colorado (USA). Guo was a visiting assistant professor at the University of Toronto, in the Department of Computer Science, where he still actively participate research activities.

Guo's research interests include volume visualization, geometric modeling, and computer vision. In geometric modeling, his work addresses issues in modeling with low degree implicit surfaces for CAD/CAM applications. In volume visualization, he is developing structure-based volume rendering techniques that combine volume rendering with feature extractions. Recently, he has started to construct direct solvers for early vision problems. Guo is a member of ACM.

John Hart

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John C. Hart is an Assistant Professor in the School of Electrical Engineering and Computer Science at Washington State University. Hart received his B.S. in Computer Science from Aurora University, and his M.S. and Ph.D. in Computer Science in the Electronic Visualization Laboratory at the University of Illinois at Chicago. He also interned in Alan Norton's group at the IBM T.J. Watson Research Center, and at AT&T Pixel Machines (R.I.P.).

In 1993, Dr. Hart received an NSF Research Initiation Award to explore new modeling, rendering and animation techniques for implicit surfaces. This research resulted in new techniques for rendering skeletal models, volume visualization, implicit modeling of geometric detail and the interactive modeling of implicit surfaces. His implicit surface rendering algorithm was used to demonstrate the removal of a 720° twist in a ribbon in the SIGGRAPH '93 Electronic Theater animation "Air on the Dirac Strings." Dr. Hart is a co-chair of Implicit Surfaces '96 — the 1996 Eurographics/SIGGRAPH Workshop on Implicit Surfaces. He is also a member of ACM, SIGGRAPH and the IEEE Computer Society. At the time of this writing, he serves on the SIGGRAPH Executive Committee as a Director-at-Large, and is a candidate for Director of Communication.

Jai Menon

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Jai P. Menon is a Project Leader at the IBM T.J. Watson Research Center, where he currently manages R&D on geometry-based and image-based graphics systems – the *(IBM 3D Interaction Accelerator)* and *(IBM SurroundVR)* respectively – with a focus on PC platforms. Menon received his B.Tech. from the Indian Institute of Technology (Delhi), his M.S. and Ph.D. from Cornell University, and joined IBM Research immediately after. He is also an Adjunct Professor at the New York Polytechnic University. He serves on an industrial advisory board at the University of Wisconsin (Madison), and is a member of a doctoral thesis committee at SUNY (Stony Brook).

Menon's research interests lie in four broad areas. His work on "implicit surfaces" has focused on algebraic patches, where he has pioneered their use in exact CSG schemes. In his work on "massively parallel processing" for solid modeling, he has developed (in collaboration with Cornell and Duke Universities) custom-VLSI RayCasting Engine (RCE) and ray-rep technologies to support hitherto intractable applications, such as general sweeps, and Minkowski operations. His work in "manufacturing" has produced the P2NC automatic verification system (from Cornell) for Numerical Control (NC) machining programs. His work on "polyhedral graphics" (at IBM) has resulted in two releases of the IBM 3D Interaction Accelerator (3DIX) product for real-time visualization of and communication with complex (multi-million polygon) databases. He has authored several patents and has received several IBM awards for his work on the 3DIX system. He has participated in the production of IBM TV Olympic commercials aired on ABC, NBC, and so forth.

Menon has published a number of papers in all these areas. He serves as an area chair at the 1996 ASME Design for Manufacturing Conference, and is general co-chair at the 1997 conference. He has been invited to the editorial board of the *International Journal of Manufacturing Engineering* and will be a guest editor for the *Computer-Aided Design* journal. He serves on an ASME Executive Committee, and is a member of Phi Kappa Phi, ACM, SIGGRAPH and the IEEE Computer Society.

Brian Wyvill

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Brian Wyvill is a full professor in the Department of Computer Science at the University of Calgary where he heads the GraphicsJungle research group. After gaining his PhD in the UK in 1975, he worked at the Royal College of Art as a post doc. in London to produce a computer animation system. Since coming to Calgary in 1981, Brian's research has concentrated on building the Graphics and Animation and visualization system. Brian has directed several animations (two shown at SIGGRAPH) that feature implicit surfaces. Recent work is in the areas of implicit surface modeling, animation techniques and scientific visualization. Currently he is interested in very efficient adaptive tiling algorithms for implicit surfaces and CSG, as well as new techniques for warping, blending and collision detection using implicit surfacs. Brian is a member of ACM, SIGGRAPH, and on the editorial board of the Visual Computer as well as the Journal of Animation and Scientific Visualization.

Geoff Wyvill

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Geoff Wyvill is an Associate Professor at the University of Otago, New Zealand and Director of Animation Research Limited. He is known for pioneering work in polygonizing implicit surfaces and ray tracing, especially the efficient ray tracing of CSG systems. He is an Executive editor of 'Virtual Reality' and serves on the editorial boards of 'The Visual Computer', 'Computer Graphics Forum' and 'Vizualisation and Computer Animation'. He contributed to the films 'Soft' (1985) 'Great Train Rubbery' (1988) and 'Fashion Show' (1992) as well as numerous TV commercial and channel animations. His company, ARL, has won eleven national and international awards for animation all of which has been produced using 'Katachi' Geoff's CSG, ray tracing and animation software. He has a BA in physics from Oxford University and MSc and PhD degrees in computer science from the University of Bradford.

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