Visualization '02 Course Proposal

full-day course on Sunday

1. Title:

State of the Art in Data Representation for Visualization

2. Course Presenters' Information:

Arie Kaufman (Course Organizer)
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Arie E. Kaufman is the Chairman of the Computer Science Department, the Director of the Center of Visual Computing (CVC), a Leading Professor of Computer Science and Radiology, and Co-Director of the Program in Biomedical Engineering at the State University of New York at Stony Brook. He further directs the Visualization Lab and the volume visualization projects there supported by the National Science Foundation, National Institute of Health, Department of Energy, Office of Naval Research, Naval Research Lab, Brookhaven National Lab, Mitsubishi Elactric Research Lab, Japan Radio Co., Hughes Aircraft Company, Hewlett-Packard Company, Intel, Silicon Graphics Company, Howard Hughes Medical Institute, Center for Biotechnology, the State of New York, and many others. His research interests include computer graphics and specifically computer graphics architectures, algorithms, and languages; visualization including volume visualization and scientific visualization; user interfaces; virtual reality; and multimedia; with specific applications in biomedicine.

Kaufman was the founding Editor-in-Chief (1995-1998) of the IEEE Transaction on Visualization and Computer Graphics (TVCG). He has lectured widely and published numerous technical papers in his research areas, including the pioneering IEEE tutorial book on Volume Visualization. He has given several courses on Volume Visualization for SIGGRAPH, Visualization, Visualization in Biomedical computing, CGI, EUROGRAPHICS, GI, and IBM. He has been the co-founder and member of the steering committee of the IEEE Visualization conference series, the Papers Chair and Program co-Chair for Visualization '90-'94 and co-Chair for several SIGGRAPH/EUROGRAPHICS Graphics Hardware Workshops and ACM Symposia for Volume Visualization, and the co-founder of the Volume Graphics Workshop series, and the General Chair of Volume Graphics 2001. He has previously chaired and is currently a director of the IEEE Computer Society Technical Committee on Visualization and Computer Graphics.

He is a Fellow of IEEE, and the recipient of a 1995 IEEE Outstanding Contribution Award, 1996 IEEE Computer Society's Golden Core Member. 1998 ACM Service Award, and 1999 IEEE Computer Society's Meritorious Service Award.

He received a BS in Mathematics and Physics from the Hebrew University of Jerusalem, in 1969, an MS in Computer Science from the Weizmann Institute of Science, Rehovot, in 1973, and a PhD in Computer Science from the Ben-Gurion University, Israel, in 1977.

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Baoquan Chen is an assistant professor of Computer Science and Engineering at the University of Minnesota at Twin Cities. He is also a faculty at the Digital Technology Center. His research interests generally lie in computer graphics and visualization, focusing specifically on volume visualization, real-time rendering/visualization by hardware and software (including image-based and point-based rendering and multi-resolution techniques), 3D data acquisition, large display, and virtual reality. Chen is a regular contributor to Visualization conference by presenting technical papers, serving as paper session chair and conference committee of VolVis ’02. He was also on organizing committee of Volume Graphics 2001. Chen received a BS in Electronic Engineering from Xidian University, Xi’an (1991), an MS in Electronic Engineering from Tsinghua University, Beijing (1994), and a second MS (1997) and then PhD (1999) in Computer Science from the State University of New York at Stony Brook.

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Klaus Mueller is currently an Assistant Professor at the Computer Science Department at the State University of New York at Stony Brook. His current research interests are computer graphics (including volume rendering, scientific visualization, and image-based rendering), medical imaging (in particular 3D reconstruction from cone-beam data), and virtual and augmented reality. He has authored or co-authored more

than 10 conference and journal papers on point-based volume rendering (or splatting), covering an array of rendering issues, both parallel and hardware implementations, and theoretical topics, such as filter design. One of these papers won the Visualization "Best Paper" award in 1997. He has also won the Visualization "Best Hot Topic" award in 1999 and the NSF CAREER award in 2000. He has recently co-chaired the International Volume Graphics Workshop in 2001 and will serve as a co-chair for the 2002 Symposium on Volume Visualization and Graphics.

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Amitabh Varshney is an Associate Professor of Computer Science at the University of Maryland at College Park. He received a B. Tech. in Computer Science from the Indian Institute of Technology, Delhi in 1989 and a M.S. and Ph.D. in Computer Science from the University of North Carolina at Chapel Hill in 1991 and 1994. During 1994 - 2000, he was an Assistant Professor in the Department of Computer Science at the State University of New York at Stony Brook. Varshney's research focus is on exploring the applications of virtual reality in engineering, science, and medicine. He has worked on the design and implementation of virtual walkthroughs of proposed structures, such as buildings, automobiles, and submarines. In the process he has developed new algorithms for automatically generating multiresolution object hierarchies, image-based rendering, parallel computation and simplification of radiosity meshes, and fine gesture recognition for virtual environments. His work on efficient and robust computation of smooth molecular surfaces is useful in the rational drug design process through the protein folding and docking problems. He has also consulted and collaborated with the industry including Honda, IBM, Daimler Chrysler, General Dynamics, and Reuters. Varshney received a NSF Career Award in 1995 and a Honda Research Initiation Award in 1997.

3. Expanded Statement

Over the years a number of representations to describe graphics objects has emerged. This multi-species evolutionary process has been driven by application domain constraints, available rendering hardware, and also academic force. We now have a choice to use polygons, points, volumes, images, or even free-form representations. Each paradigm comes with a large body of theoretical knowledge and practical optimizations, as well as strategies on how to convert one into the other. To address these diverse developments, this course seeks to achieve two goals: first, to provide a unified framework, based on principles from signal processing, in which all representations can be explained, compared, and contrasted; second, to provide the course attendees with a comprehensive overview of these representations and their hybridities using the unified framework. This will foster a deeper understanding of the advantages and disadvantages of the available representations,

stimulate "technology" transfer and tighter integration, and raise awareness of the challenges ahead. We will demonstrate several practical examples of major applications, available tools and techniques. We believe the course will provide a fresh look onto the subject and stimulate new research directions and challenges confronting the field of computer graphics and visualization.

4. Prerequisites

Course material is moderately difficult, due to the level of detail of the algorithms and methodologies. Basic knowledge of computer graphics rendering (including basic volume rendering), sampling theories and mathematics is recommended.

5. List of Topics

The course will include sampling theories and antialiasing techniques, volumetric splatting, point-based representation and rendering, polygon-based level-of-details techniques, differential points, hybrid methods combining image-, point- and polygon- based techniques.

6. Course Syllabus

Morning: Sampling Theories and Practice, Splatting Techniques

9:00 - 9:15. Welcome and Introduction (Kaufman)

8:15 – 9:45. Motivation and Overview (Chen)

9:45 - 10:30. 2D and 3D Sampling theory and Practice (Chen)

10:30 - 11:00. Coffee Break

11:00 - 11:45. Volumetric Splatting (Mueller)

11:45 - 12:30. Point-based Representation and Rendering (Mueller)

12:30 - 2:00. Lunch Break

Afternoon: Rendering and Manipulation

2:00 - 2:45. Polygon-based Level-Of-Details Techniques (Varshney)

2:45 - 3:30. Differential Points (Varshney)

3:30 - 4:00. Coffee Break

4:00 - 4:40. Hybrid Representation and Rendering Systems (Chen)

4:40 - 5:00. Q&A

5:00. Adjourn

7. Innovative Methods

We would like to use live demos on computer for illustrating techniques.

8. Course History

The course is a new course designed to cover emerging advances in new data representation and rendering techniques for graphics rendering and visualization. Most of the course materials are from course presenters' research in the related topics.

9. Course Notes Description

The course notes will be electronic and will contain:

* Complete set of slides used by all speakers.
  (This can and should be provided also in hard copy).
* Relevant papers from each speaker describing in more detail some of techniques discussed in class.
* Provide a rich set of references for further exploration.
* Additional reference material such as web resources, list of WWW and FTP sites for relevant software, additional manuscripts, images, animations, etc.

10. Special Notes Requirements

None.

11. Special Presentation Requirements

The course will include oral presentation with slides, videos, and web resources, along with live demos of various techniques presented in the course, tools, and web resources.
Several of the presenters will use their laptops for demonstrating techniques and software. A connection to the Internet is desired.