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February 6, 1996

Ralph Wachter
ONR 311
Ballston Tower One
800 N. Quincy Street
Arlington, VA 22217-5660
SUBJECT: quarterly report on ONR Young Investigator Award number N00014-95-1-0728

Dear Ralph:

I've been very busy this last quarter. In addition to completing the manuscript, *Wavelets for Computer Graphics: Theory and Applications*, with co-authors Tony DeRose and Eric Stollnitz, to be published by Morgan-Kaufmann this spring, I also submitted 8 papers to SIGGRAPH and one more to AAAI. I'll include the titles, authors, and abstracts below (in no particular order):

1. Rendering Free-Form Surfaces in Pen and Ink

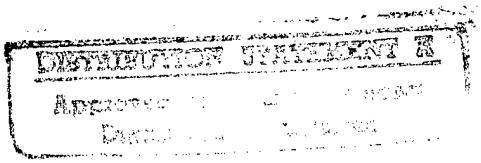
   Georges Winkenbach (grad student)
   David Salesin

   This paper presents new algorithms and techniques for rendering free-form surfaces in pen and ink. In particular, we introduce the concept of ``controlled-density hatching" to convey tone, textures, and shapes. We also show how a planar map, a data structure central to our rendering algorithm, can be constructed for curved surfaces. The planar map is used to clip strokes and to generate outlines. In addition, we show how to handle the casting of curved shadows onto curved objects. Finally, we introduce the use of traditional texture mapping techniques for controlling the tone of the illustration.

2. Reproducing Color Images as Duotones

   Joanna L. Power (grad student)
   Brad S. West (undergrad)
   Eric J. Stollnitz (grad student)
   David H. Salesin

   We investigate a new approach for reproducing color images. Rather than mapping the colors in an image onto the gamut of colors that can be printed with cyan, magenta, yellow, and black inks, we choose the set of printing inks for the particular image being reproduced. In this paper, we look at the special case of selecting inks for duotone printing, a relatively inexpensive process in which just



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Subj: RETURNED GRANTEE/CONTRACTOR TECHNICAL REPORTS

1. This confirms our conversations of 27 Feb 97 and 11 Jul 97. Enclosed are a number of technical reports which were returned to our agency for lack of clear distribution availability statement. This confirms that all reports are unclassified and are "APPROVED FOR PUBLIC RELEASE" with no restrictions.

2. Please contact me if you require additional information. My e-mail is *silverr@onr.navy.mil* and my phone is (206) 625-3196.

ROBERT J. SILVERMAN

two inks are used. Specifically, the system we describe takes an image as input, and allows a user to pre-select 0, 1, or 2 inks. It then chooses the remaining ink or inks so as to reproduce the image as accurately as possible and produces the appropriate color separations automatically.

3. A Resolution-Independent Representation for Pen-and-Ink Illustrations

Mike Salisbury (grad student)
Corin Anderson (undergrad)
Dani Lischinski (postdoc)
David H. Salesin

This paper describes a compact resolution- and scale-independent representation for pen-and-ink illustrations. The proposed representation consists of a low-resolution grey-scale image, augmented by a set of discontinuity segments. We also present a new reconstruction algorithm that magnifies the low-resolution image while keeping the image sharp along the discontinuities. By storing pen-and-ink illustrations in this representation, we can produce high-fidelity illustrations at any scale and resolution by generating an image of the desired size and filling that image with pen-and-ink strokes.

4. Hierarchical Image Caching for Accelerated Walkthroughs of Complex Environments

Jonathan Shade (grad student)
Dani Lischinski (postdoc)
David Salesin
Tony DeRose (professor)
John Snyder (Microsoft Research)

We present a new method for accelerating walkthroughs of geometrically complex static scenes. As a preprocessing step, our method constructs a BSP-tree that hierarchically partitions the geometric primitives in the scene. In the course of a walkthrough, images of nodes at various levels of the hierarchy are cached for reuse in subsequent frames. A cached image is applied as a texture map to a single quadrilateral that is drawn instead of the geometry contained in the corresponding node. Visual artifacts are kept under control by using an error metric that quantifies the discrepancy between the appearance of the geometry contained in a node and the cached image. The new method is shown to achieve significant speedups for a walkthrough of a complex outdoor scene, with little or no loss in rendering quality.

5. Interactive Multiresolution Surface Viewing

Andrew Certain (grad student)
Jovan Popovic (grad student)
Tony DeRose (professor)
Tom Duchamp (professor, Math)
David Salesin
Werner Stuetzle (professor, Statistics)

Multiresolution analysis has been proposed as a basic tool supporting compression, progressive transmission, and level-of-detail control of complex meshes in a unified and theoretically sound way.

We extend previous work on multiresolution analysis of meshes in two ways. First, we show how to perform multiresolution analysis of colored meshes by separately analyzing shape and color. Second, we describe efficient algorithms and data structures that allow us to incrementally construct lower resolution approximations to colored meshes from the geometry and color wavelet coefficients at interactive rates. We have integrated these algorithms in a prototype mesh viewer that supports progressive transmission, dynamic display at a constant frame rate independent of machine characteristics and load, and interactive choice of tradeoff between levels of detail in geometry and color. The viewer operates as a helper application to Netscape, and can therefore be used to rapidly browse and display large collections of complex geometric models stored on the World Wide Web.

6. Multiresolution Video

Adam Finkelstein (grad student)
Charles Jacobs (undergrad)
David Salesin

We present a new representation for time-varying image data, called multiresolution video. The representation allows for varying -- and arbitrarily high -- spatial and temporal resolutions in different parts of a video sequence. The representation is based on a sparse, hierarchical encoding of the video data. We show how multiresolution video supports a number of primitive operations: drawing frames at a particular spatial and temporal resolution; and translating, scaling, and compositing multiresolution sequences. These primitives are then used as the building blocks to support a variety of applications: video compression; multiresolution playback, including motion-blurred "fast-forward" and "reverse"; constant speed display; enhanced video scrubbing; and "video clip art" editing and compositing. The multiresolution representation requires little storage overhead, and the algorithms using the representation are both simple and efficient.

7. The Virtual Cinematographer: A Paradigm for Automatic Real-Time Camera Control and Directing

Li-wei He (Microsoft Research)
Michael Cohen (Microsoft Research)
David Salesin

This paper presents a paradigm for automatically generating, in real-time, complete camera specifications for capturing events in virtual 3D environments. We demonstrate a fully implemented system called the Virtual Cinematographer as it is applied in a virtual "party" setting.

The Virtual Cinematographer is implemented as a hierarchical finite state machine. Cinematographic expertise in the form of film idioms is encoded through a set of small finite state machines organized as a directed graph through call/return conventions and exception handling mechanisms. Each idiom is responsible for capturing a particular type of scene, such as three virtual actors conversing, or one

actor moving across the environment. The idiom selects shot types and the timing of transitions between shots to best communicate events as they unfold.

A set of camera modules shared by the idioms are responsible for the low level geometric placement of specific cameras for each shot type. The camera modules are also responsible for making subtle changes in the virtual actors' positions to best frame each shot.

We discuss some basic heuristics of filmmaking and show how these ideas are encoded in the Virtual Cinematographer. Results are shown in the accompanying video.

8. Declarative Camera Control for Automatic Cinematography (Submitted to AAAI)

David B. Christianson (grad student)
Sean E. Anderson (grad student, Stanford)
Li-Wei He (Microsoft Research)
David H. Salesin
Daniel S. Weld (professor)
Michael F. Cohen (Microsoft Research)

Animations generated by interactive 3D computer graphics applications are typically portrayed either from a particular character's point of view or from a small set of strategically-placed viewpoints. By ignoring camera placement, such applications fail to realize important storytelling capabilities that have been explored by cinematographers for many years.

In this paper, we describe several of the principles of cinematography and show how they can be formalized into a declarative language, called the "Declarative Camera Control Language" (DCCL). We describe the application of DCCL within the context of a simple interactive video game. Our prototype video game creates simulated animations in response to user input. Potential camera placements are generated by first segmenting the animations into individual scenes and then using a database of DCCL idioms to compile each scene into a set of possible films. Each potential film is then evaluated using domain-independent heuristics in order to select the best camera placements for filming the animation.

We argue that DCCL represents cinematic knowledge at the same abstraction level as expert directors by encoding 16 idioms from a film textbook. These idioms produce compelling animations, as demonstrated on the accompanying videotape.

9. Comic Chat

David Kurlander (Microsoft Research)
Tim Skelly (Microsoft Research)
David Salesin

Comics have a rich visual vocabulary, and people find them appealing. They are also an effective form of communication. We have built a system, called Comic Chat, that represents on-line communications in the form of comics. Comic Chat automates numerous aspects of comics generation, including balloon construction and layout, the placement and orientation of comic characters, the default selection

of character gestures and expressions, the incorporation of semantic panel elements, and the choice of zoom factor for the virtual camera. This paper describes the mechanisms that Comic Chat uses to perform this automation, as well as novel aspects of the program's user interface. Comic Chat is a working program, allowing groups of people to communicate over an on-line service. It has several advantages over other graphical chat programs, including the availability of a graphical history, and a dynamic graphical presentation.

I would be more than happy to furnish any or all of these papers, or discuss any of this work in more detail, upon your request.

Sincerely,

David Salesin
Assistant Professor

cc: Administrative Grants Officer
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