Line Drawings from 3D Models

SIGGRAPH 2008 Class

Tuesday, 12 August, 8:30 AM – 12:15 PM

Organizer

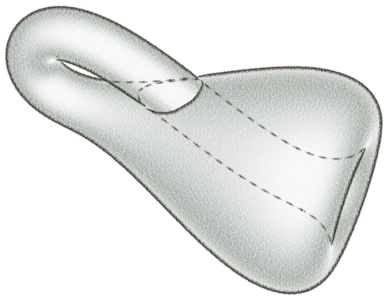
Szymon Rusinkiewicz
Princeton University

Lecturers

Forrester Cole
Princeton University

Doug DeCarlo
Rutgers University

Adam Finkelstein
Princeton University



Course Description

Nonphotorealistic rendering techniques, including line drawings, can be remarkably efficient at conveying shape and meaning with a minimum of visual distraction. This class will describe techniques for automated rendering of 3D models using a number of sparse line drawing styles, for both artistic and illustrative purposes. We will mathematically define lines such as silhouettes, contours, creases, suggestive contours and highlights, and apparent ridges and valleys. We then describe algorithms for finding lines efficiently, including object- and image-space methods, and discuss methods for stylization and level-of-detail control. Finally, we provide a brief introduction to concepts of visual perception, including the information content of line drawings and the effects of abstraction and detail on attention.

Prerequisites

Basic familiarity with the graphics pipeline and some knowledge of calculus and linear algebra.

Instructor Bios

Forrester Cole is a fourth-year Ph. D. student in the graphics group at Princeton University. His research interests are mainly in non-photorealistic rendering, particularly interactive NPR algorithms and algorithms for artistic stylization and abstraction. He is currently investigating improved algorithms for interactive, stylized line drawing. Prior to coming to Princeton, Forrester was a programmer at Pandemic Studios, where he wrote engine code for PlayStation 2 and Xbox games.

Doug DeCarlo received BS degrees in computer science and computer engineering from Carnegie Mellon in 1991, and his Ph. D. in computer science from the University of Pennsylvania in 1998. He is currently an associate professor in the Department of Computer Science with a joint appointment in the Center for Cognitive Science at Rutgers University. His research in computer graphics explores how accounts of human perception and communication can inform the design of computer systems that engage in effective visual communication.

Adam Finkelstein is an associate professor in the Computer Science Department at Princeton University. His current research focuses on non-photorealistic rendering and animation. Adam received a doctorate from the University of Washington in 1996. From 1987 to 1990, he worked at Tibco developing software for people who trade stock. He received a BA in 1987 from Swarthmore College.

Szymon Rusinkiewicz is an associate professor of Computer Science at Princeton University. His work focuses on acquisition and analysis of the 3D shape and appearance of real-world objects, including the design of capture devices and data structures for efficient representation. He also investigates algorithms for processing complex datasets of shape and reflectance, including registration, matching, completion, symmetry analysis, and sampling. In addition to data acquisition, his research interests include real-time rendering and perceptually-guided depiction. He obtained his Ph. D. from Stanford University in 2001.

Acknowledgements

Thanks to Rob Kalnins, Lee Markosian, Anthony Santella, and especially Mike Burns. Partially supported by the National Science Foundation through grants HLC 0308121, CCF 0347427, and CCF 05041185. Some photographs in slides for Part VII courtesy `http://philip.greenspun.com`.

Course Syllabus

I. Introduction to the study of lines (:15 — Finkelstein)
- Non-photorealistic rendering
- What is conveyed? (shape, markings, material, shading)
- Approaches to the study of line drawings

II. Artists' line drawings (:20 — Cole)
- Studying what lines artists draw
- Evaluation

III. Mathematical description of lines (:45 — Rusinkiewicz)
- Silhouettes and occluding contours
- Basics of differential geometry for surfaces in 3D
- Suggestive contours and highlights; principal highlights
- Surface ridges and valleys
- Apparent ridges and valleys
- Ridges and valleys of illumination
- Other lines (creases, surface markings, material boundaries, topo (isoelevation) lines, principal curvature lines, etc.)

IV. Perception of line drawings (:25 — DeCarlo)
- How much information is there in drawings?
- Ambiguities (bas-relief, line labeling, etc.)
- Psychophysical studies (gauge figures, etc.)

— Break — (:15)

V. Algorithms for extracting lines (:30 — Rusinkiewicz)
- Image-space algorithms
- Brute force, "marching triangles"
- Randomized methods
- Hierarchical methods
- Methods based on the Gauss map and other mappings
- Determining line visibility

VI. Stylization of line drawings (:25 — Finkelstein)
- Parameterization
- Temporal coherence
- User interaction

VII. Abstraction and evaluation (:30 — DeCarlo)
- Abstraction in NPR
- Evaluation using eye tracking

VIII. Controlling detail and attention (:20 — Cole)
- Control of line density
- Stroke simplification
- Stylized focus