A Warped Perspective on Computer Graphics: Psychorealism and More

Patrick Coleman
Dynamic Graphics Project
Computer Science     University of Toronto
9 February 2004
Nonlinear Perspective for CG
Psychorealism and Ryan
Overview

• Perspective in Art and Science
• Nonlinear Projection of Animated Scenes
• Ryan
• Psychorealism and *Ryan*
Projection

Perspective

Parallel

Nonlinear
History of Perspective

Kauffmann Haggadah  
late 1300’s

Baptistry of San Giovanni  
Brunelleschi 1420
History of Perspective

Camera Obscura

Last Supper
Motivation

Femme nue accroupie
Pablo Picasso, 1959
Motivation

Tetrahedral Planetoid
M. C. Escher
Motivation

*Pearblossom Hwy. No. 2*
David Hockney, 1986
Linear Perspective

• Good approximation of human visual system
• Conceptually simple and predictable
• Aids depth perception
• Efficient graphics pipelines
Nonlinear Perspective

- Extend visual range
- Avoid disjoint images for complex scenes
- Artistic expression
Allow artists to explore, understand, and subsequently express complex 3D scenes.
The Problem…

Allow artists to explore, understand, and subsequently express complex 3D scenes

Linear Perspective

Nonlinear Projection
Nonlinear Projection
Nonlinear Projection Goals

- Interactive and incremental
- Use of common animated camera
- Local linear perspective
- Continuous nonlinear projections
- Artistic control of composition, projection
- Coherent shading, shadows, lighting
- Handle complex scenes
Model of Projection

• Interface

  Let $C_1, \ldots, C_n$ represent world to image space transformations of $n$ linear perspective cameras

• Control

  Let $w_i(p)$ be a per camera spatial weight function
  - Directional
  - Positional
  - Procedural
  - User-Painted
Conceptual Model

\[ P' = \left[ \sum_{i=1}^{n} w_i(p)C_i \right] P \]

\[ \mathbf{n} \mathbf{i} \mathbf{w} \begin{bmatrix} \mathbf{P}' \end{bmatrix} \]}
User Interface

• Animate the boss camera as a normal CG camera
• Incrementally add lackey cameras to locally manipulate perspective
• Add composition constraints as desired
Interface

$C_1$ Linear Perspective

Nonlinear Projection

$C_2$ Linear Perspective

Exploratory View
Weighting Projections

Directional

Vertical falloff
Weighting Projections

Positional
Weighting Projections

User Painted
Example
Constraints Conceptualized

Compose scene independently of projection
– Often only an image space translation
– Manipulate depth ordering
Constraints Example

No Constraints

With Constraints
Multiview Illumination

- Boss camera shading
- Virtual camera shading
- Blended shading
Stylized Multiview Shading
Shadows

Wrong shadows
Corrected shadows
Ryan Test
Another Ryan Test
Procedural Weighting
Automotive Visualization
Stylized Camera Motion
Ryan Larkin
Ryan Larkin
Psychorealism

Realism of the human psyche, expressed through art and animation.
Psychorealism in Art

*Guernica.* Pablo Picasso, 1937

*
Psychorealism in Art

Isabel Rawsthorne. Francis Bacon, 1965-1966
Psychorealism in Ryan
Nonlinear Projection
Nonlinear Projection
Nonlinear Projection
Nonlinear Projection
Nonlinear Projection
Psychorealism in *Ryan*
Psychorealistic Shader
Psychorealistic Shader
Psychorealistic Shader
Psychorealism in Ryan
Tying up the Animators
Tying up the Animators
Tying up the Animators
Tying up the Animators
Ryan: A (very) Short Teaser
Acknowledgements

Karan Singh
Chris Landreth

Alias, Pixar