Ryan Larkin
Psychorealism and Ryan
Projection

- Nonlinear
- Parallel
- Perspective

Nonlinear
Parallel
Perspective
Nonlinear Projection
Linear Perspective

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

Femme nue accroupie
Pablo Picasso

Tetrahedral Planetoid
M. C. Escher
Motivation

*Pearblossom Hwy. No. 2*
David Hockney

*Still Life with Fruit Basket*
Cézanne
Nonlinear Perspective

- Extend visual range
- Avoid disjoint images for complex scenes
- Artistic expression
The Problem...

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

Linear Perspective

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

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
Related Work

- **Image Processing** (Max 83, Zorin & Barr 95, Seitz & Dyer 96, Collomosse & Hall 03)
- **View-Dependent Deformation** (Rademacher 99, Martín 00)
- **Multi-Perspective Panoramas** (Wood et al. 97, Rademacher & Bishop 98, Peleg et al. 00, Seitz & Kim 02)
- **Nonlinear Ray Tracing** (Wyvill & McNaughton 90, Glassner 00, Weiskopf 04)
- **Multiprojection Rendering** (Agrawala et al. 00, Glassner 04, Yu 04)
- **Nonlinear Projection** (Singh 02)
Our Approach

• Combine linear perspective views (Singh 02)
• Extend weight computation from Singh 02
• New deformation approach for complex scenes and animated camera
• New constraint formulation with local control
• Shading from multiple points of view
Workflow

• Animate the *boss* camera as a normal CG camera
• Incrementally add *lackey* cameras to locally manipulate perspective
• Edit lackey weight functions
• Add constraints and edit viewport transformations
Defining projection weights

- Directional
  - Vertical falloff

- Positional
  - Radial falloff

Feature based, User Painted
Example
Nonlinear Projection Model

- $C, M,$ and $V$ are the eye-space, perspective, and viewport matrices for a linear perspective camera.

- A point in the scene $P$ linearly projects to $<x, y>$ in the image at depth $z$ where, $<x, y, z> = PCMV$. 
Boss and lackey cameras

Lackey cameras induce projection deformations to scene geometry as seen by the boss camera.
Deformation from a lackey camera

For $P'$ to appear in boss camera $b$, as $P$ appears in lackey camera $i$:

$$P' = PC_iM_iV_i(C_bM_bV_b)^{-1}.$$  

$$A_i = C_iM_iV_i(C_bM_bV_b)^{-1}.$$
Combining cameras

Given weight $w_i(P)$ for lackey camera $i$, point $P$ deforms to $P'$:

$$P' = P + P(w_i P(A_i - I))$$

...and for many lackey cameras

$$P' = P + \sum_{i=1}^{n} P(w_i P(A_i - I)).$$
Two Camera Example

\[ P' = P + \sum_{i=1}^{n} P(w_i P(A_i - I)) \]
Constraints

No Constraints  With Constraints
Constraints

Local control of composition

Independent of projection

(a) Pillar, $R_l$ (lackey view)  
(b) Constraint deformed pillar, $R_l, R_f$ (boss view)
Constraints

To see constraint frame $R_f$ in lackey as $R_t$ in boss camera:

$$Con = (\text{Cartesianize}(R_fC_iM_iV_i))^{-1}\text{Cartesianize}(R_tC_bM_bV_b)$$

...where $Con$ is a constraint matrix such that

$$A_i = C_iM_iV_i(Con)(C_bM_bV_b)^{-1}.$$  

...in general $Con$ is defined as an RBF interpolation of multiple constraints per scene object, per camera.
Multiview Illumination

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

Wrong shadows  
Corrected shadows
Multiple Linear Projections
Nonlinear Projections
Ryan Test
Ryan
Conclusions

• Interactive nonlinear projection of complex scenes with animated camera

• Global and local composition and relative depth control

• Illumination and shading from multiple viewpoints
Future Work

• Full unwrapping
• High level artist control
• Automatic camera specification
Hierarchical nonlinear projections
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