

Faking Visual Appearance

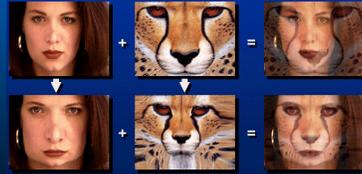
Richard Szeliski
Microsoft Research

SIGGRAPH Panel on Faux Physics
August 16, 2001

Image Morphing



- Warp + cross-dissolve = *morph*

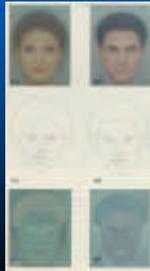


[Beier & Neely '92][Gomes *et al.* '99]

Manipulating Facial Appearance through Shape and Color

[Rowland and Perrett, IEEE CG&A, Sept.95]

- Compute *average faces* (color and shape)
- Compute *deviations* between male and female



Changing gender

- Deform *shape* and/or *color* of an input face in the direction of "more female"



Enhancing gender



more same *original* androgynous more opposite

Changing age

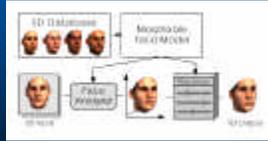
- Face becomes "rounder" and "more textured" and "grayer"



Morphable model of 3D faces

[Blanz and Vetter, SIGGRAPH'99]

- ◆ Start with 200 3D Cyberware scans



- ◆ Build a model of *average* shape and texture, and principal *variations*

Morphable model of 3D faces

- ◆ Adding some variations

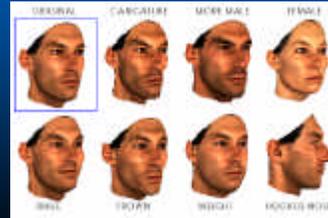


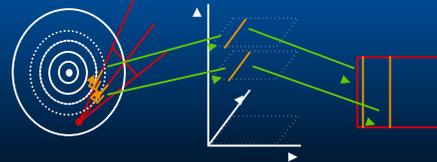
Image-based Rendering

New area of Computer Graphics, which uses images as rendering primitives

- Panoramic images, Concentric Mosaics
- View interpolation and view morphing
- Lightfield and Lumigraph
- Layered Depth Images
- Sprites with Depth

Concentric Mosaics

- ◆ Interpolate between several panoramas [Shum & He, SIGGRAPH'99]



Concentric Mosaics



Lumigraph

- ◆ Convert video into a solid 3D model based on silhouettes; re-render object from original images plus solid model



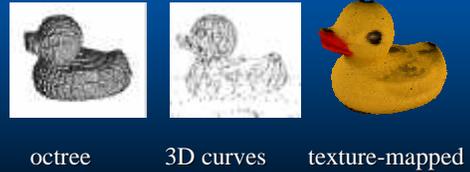
Image-Based Modeling

Computer Vision is the *inverse* of Computer Graphics:

- ◆ computer graphics:
 - given a 3D model, render it
- ◆ computer vision
 - given some images, create a 3D model (*geometry, texture, reflectance, lighting, ...*)

Image-Based Modeling

- ◆ 3D model building example



Voxel Coloring

- ◆ Carve away a 3D model based on color consistency



3D face model building

[Pighin *et al.*, SIGGRAPH'98]

- ◆ take photos of a face from different views
- ◆ identify key points in each image
- ◆ recover camera pose and geometry
- ◆ refine geometry



3D face model building

- ◆ animate by morphing between expressions



"neutral" ➤ "joy"

3D face model-based tracking

- ◆ Use "analysis by synthesis" to match 3D face model parameters to input video



3D model-based effects

- ◆ Change viewpoint, identity, illumination, or add special effects (scars, tatoos, ...)



Video-Based Rendering

- ◆ How can we generate *computer video* instead of *computer images* (stills)?
- ◆ A: analyze video and synthesize new *frames*
 - *Video Rewrite*
 - *Video Textures*

Video Rewrite

[Bregler *et al.*, SIGGRAPH'97]

- ◆ Train on associated *phonemes* and *visemes*
- ◆ Analyze new speech signal in triplets to select appropriate visemes



Video Clips



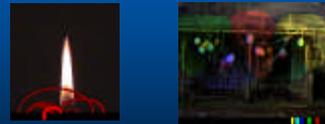
Video Textures

[Schödl *et al.*, SIGGRAPH'2000]

- ◆ Take a short *video clip* and turn it into an ∞ amount of continuous *video texture*
 - replace clips in Web pages and presentations
 - screen savers
 - alternative to 3D graphics animation?

Video Textures

1. find cyclic structure in the video



2. (optional) region-based analysis
3. play frames with random shuffle
4. smooth over discontinuities (morph)

Interactive fish



Composited animation



So, what's your point?

Data-driven simulation & machine learning

- ◆ Data-driven modeling is revolutionizing many aspect of computer science, e.g., trend from rule-based diagnosis to machine learning (Bayes Nets, neural nets...)
- ◆ Examples: junk e-mail filtering, medical diagnostics, recommendation systems...

Data-driven simulation

- ◆ 3 kinds of models:
 1. True physical simulation (accurate, predictive)
 2. Simple model + lots of data (data-driven)
 - [Bregler 97; Blanz & Vetter 99]
 - HMMs for speech recognition ≠ true language model
 3. Tons of data: sample-based rendering
 - sample-based music synthesis
 - concatenated speech synthesis
 - previous (pure) IBR & VBR examples

Modeling: pros. & cons.

- ◆ Advantages:
 - truer reality
 - easier to control and extrapolate
 - compactness (geometry + photometry)
- ◆ Disadvantages:
 - harder to achieve visual fidelity
 - longer development cycle
 - (but isn't that what science is about? ☺)

Faking Visual Appearance

- ◆ We can often *fake* visual appearance from samples (input images and video)
- ◆ To achieve acceptable realism, we sometimes *have* to use real source data
- ◆ Choosing the right level of model (data rich/poor, representation) is usually the *key*