The Poisson Equation in Image & Shape Processing

Michael Kazhdan

(600.657)

Short Bio

- Undergraduate degree in mathematics
- Started Ph.D. in mathematics
- Switched to computer graphics

Short Bio

- Undergraduate degree in mathematics
- Started Ph.D. in mathematics
- Switched to computer graphics

My Interest:
   Mathematical analysis of methods
   in computer graphics

What are we studying?

- Calc., Linear Alg., and Numerical Methods
- Image Processing
- Mesh Editing
- Shape Matching

Calc., Linear Alg., and Num. Methods

Poisson Equation:

Given the function G, solve for F with the property:
$$\Delta F = G$$

Calc., Linear Alg., and Num. Methods

Poisson Equation:

Given the function G, solve for F with the property:
$$\Delta F = G$$

Use the fact that the Δ is a symmetric linear operator.

Calc., Linear Alg., and Num. Methods

Poisson Equation:

Given the function G, solve for F such that:
$$\Delta F = G$$

Use the fact that the Δ is a symmetric linear operator.

Use numerical methods for solving the system:
- FFT
- Jacobi/Gaus-Seidel Solvers
- Conjugate Gradients
- Multigrid
- Pre-Conditioning

Image Processing

HDR Compression:

Generating visualizations of images that have a dynamic range that is too large for standard display devices.

Fattal et al. 2002

Image Processing

HDR Compression:

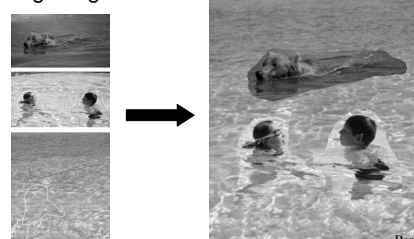Generating visualizations of images that have a dynamic range that is too large for standard display devices.

Fattal et al. 2002

Image Processing

Image Compositing:

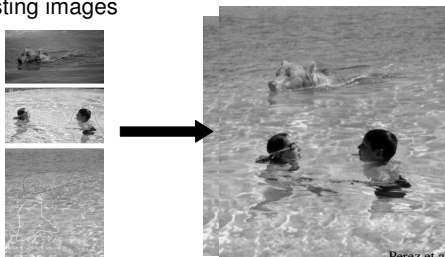Generating new images by combining parts from existing images

Perez et al. 2003

Image Processing

Image Compositing:

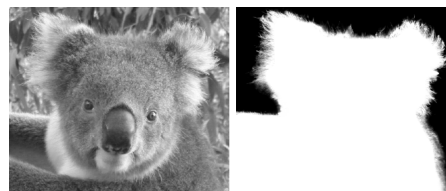Generating new images by combining parts from existing images

Perez et al. 2003

Image Processing

Image Matting:

Computing a (continuous) blending mask that indicates whether pixels are interior or exterior to a region of interest.
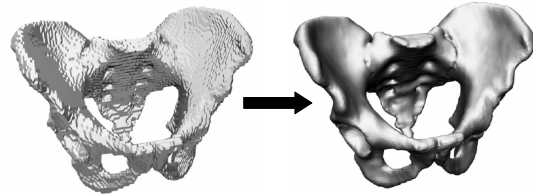

Sun et al. 2004

Image Processing

Image Matting:

Computing a (continuous) blending mask that indicates whether pixels are interior or exterior to a region of interest.

Sun et al. 2004

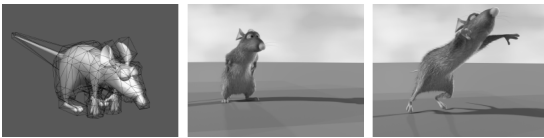## Mesh Editing

Smoothing:

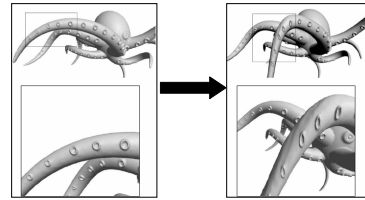Removing artifacts/noise from surface meshes.

Sun et al. 2004

Mesh Editing

Animation:

Extrapolating coarse animation constraints defined on the vertices of a "cage" to a smooth character articulation.

Joshi et al. 2007
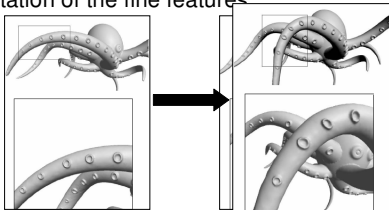
Mesh Editing

Editing:

Providing a way for applying large deformations to surfaces while retaining the appropriate orientation of the fine features.

Lipman et al. 2004

Mesh Editing

Editing:

Providing a way for applying large deformations to surfaces while retaining the appropriate orientation of the fine features.
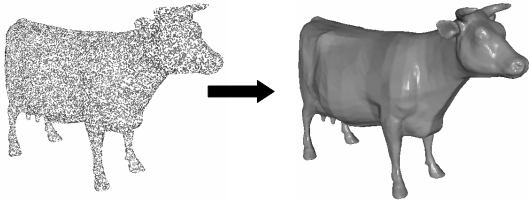

Lipman et al. 2004

Mesh Editing

Stitching:

Seamlessly combining parts of different 3D meshes to define a new model.

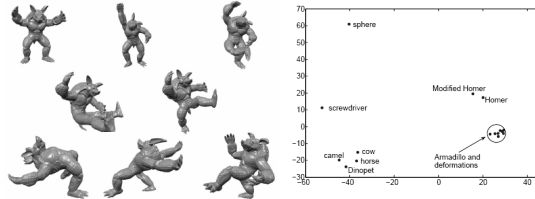Yu et al. 2004

Mesh Editing

Reconstruction:

Generating a continuous mesh from a set of discrete surface samples.

Mesh Editing

Matching:

Defining a representation of 3D shapes that is robust to non-rigid representations.

Rustamov 2007

What I Expect of You

Homework:
> There will be a paper assigned (almost) every class. You are to expected to have read it and be prepared to discuss it in depth.

Presentations:
> The papers will be presented (mostly) by you.

Projects:
> One independent project due at the end of the semester
> Project proposals due in the middle of the semester.

Exams:
> There will be no exams.

http://www.cs.jhu.edu/~misha/Fall07