Poisson Image Editing

Authors:
Patrick Pérez
Michel Gangnet
Andrew Blake

Microsoft Research UK

Presentation By:
Charles Robertson

Overview

- Introduction
- Related Work
- Poisson solution to guided interpolation
- Seamless Cloning
- Selection Editing
- Conclusion
- Additional Questions

Introduction

- Local Change Image Editing
- Driving forces
  - Human psychology.
  - Unique solution to Poisson equation with known boundary values and a Laplacian over the interior of that boundary.
- The relationship between the Laplacian and guidance vector fields
- Gradient mixing.

Related Work

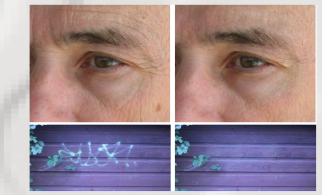
- High Dynamic Range. Fattal et al.
- Edgels. Elder and Goldberg.
- Spot Removal. Lewis.
- Adobe© Photoshop© 7 Healing Brush.
- Multiresolution Blending. Burt and Adelson.
- PDE interpolation.
- Example-based interpolation

Poisson solution and guided interpolation

- Why use guided interpolation?
  - Standard Minimizer
    - $\min_f \iint_\Omega |\nabla f|^2$ with $f|_{\partial\Omega} = f^*|_{\partial\Omega}$
    - $\Delta f = 0$ over Ω with $f|_{\partial\Omega} = f^*|_{\partial\Omega}$
  - Guidance Field Minimizer
    - $\min_f \iint_\Omega |\nabla f - \mathbf{v}|^2$ with $f|_{\partial\Omega} = f^*|_{\partial\Omega}$
    - $\Delta f = \mathrm{div}\mathbf{v}$ over Ω, with $f|_{\partial\Omega} = f^*|_{\partial\Omega}$
    - $\Delta \tilde{f} = 0$ over Ω, $\tilde{f}|_{\partial\Omega} = (f^* - g)|_{\partial\Omega}$
- How does it work?

Poisson solution and guided interpolation

- Breaking continuous into discrete.
  - $\min_{f|_\Omega} \sum_{\langle p,q\rangle \cap \Omega \neq \emptyset} (f_p - f_q - v_{pq})^2$, with $f_p = f_p^*$, for all $p \in \partial\Omega$
  - for all $p \in \Omega$, $|N_p| f_p - \sum_{q \in N_p \cap \Omega} f_q = \sum_{q \in N_p \cap \partial\Omega} f_q^* + \sum_{q \in N_p} v_{pq}$
  - $|N_p| f_p - \sum_{q \in N_p} f_q = \sum_{q \in N_p} v_{pq}$
- Common Solvers
  - Gauss-Siedel
  - V-cycle Multigrid



Seamless Cloning

- Standard gradient
  - Take the gradient of the source, so
    - $v = \nabla g$
    - $\Delta f = \Delta g$ over Ω, with $f|_{\partial\Omega} = f^*|_{\partial\Omega}$
    - forall <p,q>, $v_{pq} = g_p - g_q$
  - Easy from user standpoint
  - Only uses the source image.
  - What does this mean?

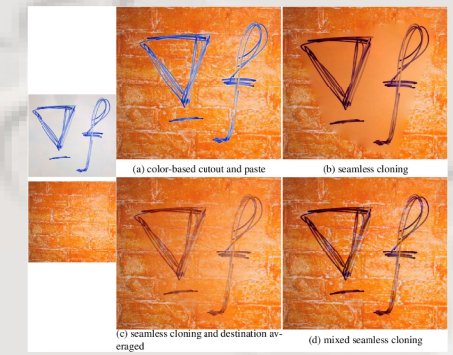
Seamless Cloning

sources/destinations | cloning | seamless cloning

Mixed Seamless Cloning

- Mixed gradient
  - Mix transparent or holey objects with from source to destination.
  - Linear interpolation of destination and source gradients does not work well.
  - Look at the Laplacian at a point in both the source image and the destination image and take whichever one is stronger.
  - What does this do?

Mixed Seamless Cloning



Selection Editing

- Texture Flattening
  - Gradient field put through edge detector.

Selection Editing

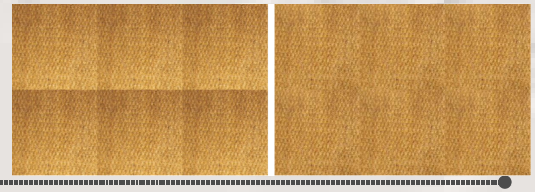
- Local Illumination Changes
  - Discussed before in HDR paper by Fattal et al.
  - $v = \alpha^{\beta} |\nabla f^*|^{-\beta} \nabla f^*$

Selection Editing

- Local Color Changes
  - By changing the attributes of the source or destination image we can change how they are combined in the end.

Selection Editing

- Seamless Tiling
  - Essentially we enforce periodicity on the borders by setting opposite border Dirichlet conditions to be equivalent.
  - $f_{north} = f_{south} = 0.5(g_{north} + g_{south})$



Conclusions

- Quick interpolation method
- No need to precisely select object to be worked on.

Questions?