PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing

(a) Original (b) Inpainting (c) Retarget (d) Reshuffle

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Roadmap

Motivation PatchMatch Algorithm Interactive Editing

Traditional Photo Editing

(played back at 10x real-time)

Higher Level Editing

Retargeting [Avidan '07] Hole filling [Sun '05]

Reshuffling [Simakov '08], [Cho '08]
User Interaction

- Retargeting [Avidan '07]
- Hole filling [Sun '05]
- Reshuffling [Simakov '08], [Cho '08]

Non-Parametric Patch Sampling

- Image reshuffling/collage [Simakov et al. '08]
  (5 minutes per 256x256 input image)

Non-Parametric Patch Sampling

PatchMatch

Iterative Optimization Methods

- Retargeting and Reshuffling [Simakov '08]
- Texture Synthesis [Kwatra '05]
- Hole Filling [Wexler '04]

Hole Filling

- Initialize hole
- Find NN inside → out
- Update image
- Repeat

[Simakov et al. '08]

Texture Synthesis

(Wexler '04)
Hole Filling

Repeat

Initialize hole

Find NN inside → out

Update image

Slow

[Wexler '04]

Retargeting / Reshuffling

Repeat

Initial guess

Find NN A ↔ B

Update output

Slow

[Simakov '08]

Retargeting / Reshuffling

Repeat

Initial guess

Find NN A ↔ B

Update output

[Simakov '08]

Related Work

kd-tree with PCA
[Hertzmann '01]

Propagation
[Ashikhmin '01]

k-coherence
[Tong '02]

Problem

Intuition for PatchMatch
Intuition for PatchMatch

$A$ $B$

Nearest Neighbor Field

$A$ $B$

Random Initialization

$A$ $B$
After propagation:
\[ f(x, y) = \arg\min D \{ \text{current, left, above} \} \]

[Ashikhmin ’01]
Random Search

Box width: $\alpha^2 w$

Random Search

Box width: 1 pixel

Propagation and Search

After propagation and search:

$$f(x, y) = \text{argmin}_o \{ \text{candidate offsets} \}$$

Propagation Only

First Pass

Correspondence Vectors (red: x, blue: y)
Reconstruction of image A using patches from image B

Second Pass

Correspondence Vectors (red: x, blue: y)
Reconstruction of image A using patches from image B

Third Pass

Correspondence Vectors (red: x, blue: y)
Reconstruction of image A using patches from image B
Random Search Only

First Pass

Image A

Image B

Correspondence Vectors (red: x, blue: y)

Reconstruction of image A using patches from image B

Second Pass

Image A

Image B

Correspondence Vectors (red: x, blue: y)

Reconstruction of image A using patches from image B

Random Search Only

Third Pass

Image A

Image B

Correspondence Vectors (red: x, blue: y)

Reconstruction of image A using patches from image B

Convergence

First Pass

Image A

Image B

Correspondence Vectors (red: x, blue: y)

Reconstruction of image A using patches from image B

Convergence

Propagation

Random Search

PatchMatch

Ground Truth

Iteration 1

Iteration 3

Third Pass

Image A

Image B

Correspondence Vectors (red: x, blue: y)

Reconstruction of image A using patches from image B
Convergence

Correspondence Vectors (red: x, blue: y)

Reconstruction of image A using patches from image B

Fourth Pass

Convergence

Correspondence Vectors (red: x, blue: y)

Reconstruction of image A using patches from image B

Fifth Pass

Image Completion

Input

Hole

Output (enlarged)

Image Completion

Input

Hole + constraints

Output (enlarged)

Image Completion

(without constraints)

Input

Hole

Output (enlarged)

Image Completion

(with constraints)

Input

Hole + constraints

Output (enlarged)