Object/Defect Removal via SR-based Inpainting and Sparse Coding

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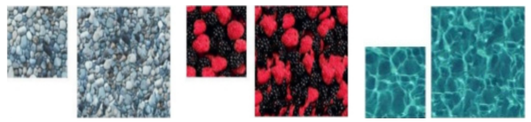
Motivation

- ✓ Object removal is a topic highly involved in a wide range of image reconstruction applications: restoration of corrupted or defected images, scene reconstruction, film production, etc.
- ✓ We strive to develop advanced methods and enhance the existing pixel-filling framework, referencing textural/structural inpaint approaches
- ✓ Further refinement of the restored image is needed in order to create better visual experience for the viewer

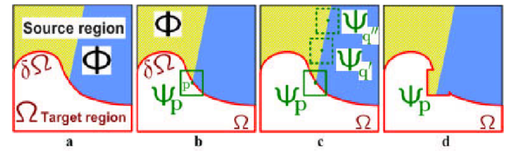


Related Work

1. "Texture Synthesis" by Ashikhmin and de Bonet
   - Heuristic approach to edge-stitch cut-out region by similar textures with moderate stocasticity



2. "Priority-based inpaint" by Criminisi and Perez
   - Isophote-drive region sampling



3. "Super-resolution on low-res inpaint" by Le Meur, Guillemot
4. "K-SVD method for dictionary learning by sparse linear combination" by Aharon, Elad, Bruckstein

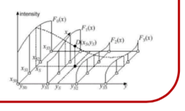
Proposed Methods

Single-Image Super-resolution based inpaint



Single-Image Super-Resolution

- 2x Down-sampling
- Exemplar-based Inpaint
  - Laplacian-based Edge Detection
  - Construct Fill-front Pixel Priority
  - Graduate inwards to Fill Entire Hole
- Bicubic Interpolation



- Sharpen w/ Unsharp Masking



output

Confidence term update:



$$C(p) = \frac{\sum_{q \in \Psi_p \cap (I-\Omega)} C(q)}{|\Psi_p|}$$

Data term update:
Apply Non-Local-Means method and L2-norm for pixel weight estimation

Sparse coding

$$\min_{D,A} \sum_{j=1}^{p} \|D\alpha_j - x_j\|_2^2 \quad s.t. \|\alpha_j\|_0^0 \le L$$

Dictionary | Sparse vector | Degraded image



- Find Dictionary
  - pre-defined dictionary: DCT coefficients, wavelet
  - learn dictionary: K-SVD
- Solve optimization problem (not convex!)
  - Relaxation: Basis Pursuit
  - Greedy: (Orthogonal) Matching Pursuit

K-SVD overview

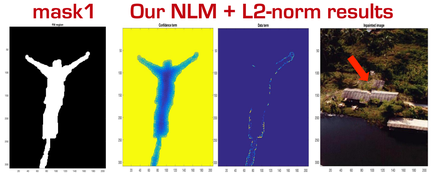
- Initialize D
- Sparse Coding: use any pursuit algorithm
- Dictionary Update: column by column svd computation

Experimental Results

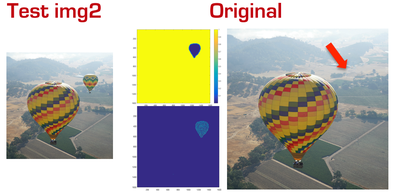
Test img1 | Original Exeplar-based Inpaint



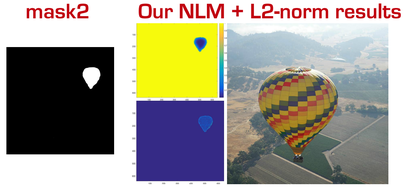
mask1 | Our NLM + L2-norm results



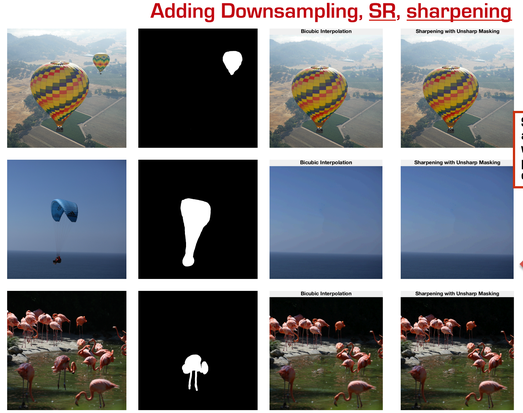
Test img2 | Original



mask2 | Our NLM + L2-norm results



Adding Downsampling, SR, sharpening



Smoothened abrupt edges while preserving details

Comparing w/ Patch Match

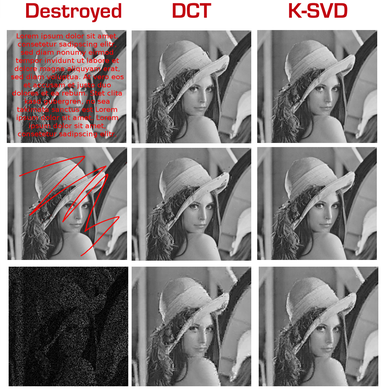


Unidirectional pixel-filling
Noticeable artifacts
Patchy visual effect

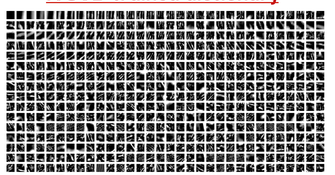
CSH

Left object remains

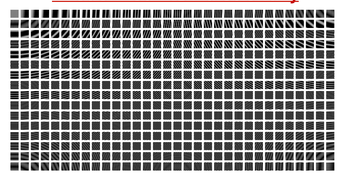
Destroyed | DCT | K-SVD



K-SVD trained dictionary



Predefined DCT dictionary



	destroyed	DCT	K-SVD
Text mask	14.03dB	30.9dB	33.09dB
Random mask	19.09dB	33.68dB	35.94dB
80% pixel loss	6.42dB	24.27dB	26.75dB

References

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