The patch transform
and its applications to image editing
Taeg Sang Cho¹, Moshe Butman², Shai Avidan³, William Freeman¹,³
CSAIL-MIT¹, Bar-Ilan Univ². Adobe Inc.³

The image model
\[ P(x) = \frac{1}{Z} \prod_{i=1}^{N} \prod_{j \in \mathcal{N}(i)} p(y_i|x_i)p(x_i|x_j)p(x_j)E(x) \]

- Adjacent patches should plausibly fit next to each other.
- Each patch should not be used more than once (we name it the exclusivity term.)
- The image structure and user’s constraints should be maintained.

The inverse patch transform
Belief propagation is used to solve for patch assignments

Pair-wise compatibility
\[ \psi_{ij}(k,l) = \frac{1}{\prod_{l,m=1}^{L} \{ \frac{\exp(-w^T x_m(k,l))}{q} \} } \]

Exclusivity term
\[ m_{ij}(x_i = l) = \prod_{l \in \mathcal{N}(i)} \sum_{x_l} \psi_{ij}(x_i|x_j = l)m_{ij}(x_l) \]
\[ = \prod_{l \in \mathcal{N}(i)} (1 - m_{ij}(x_i = l)) \]

The factor node tells others not to use the patch already claimed by another node.

Image editing applications
Subject reorganization
Texture control
Image retargetting
Photomontage

Extensions
The patch transform using overlapping patches can reduce artifacts.

Object Removal
Multiscale Patch Transform
The reconstructed image using coarse patches is refined with smaller patches.

Seam-based compatibility measure
User input
Reconstructed image