Computer Vision for Visual Effects

CVFX 2015
PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing

Barnes et al., SIGGRAPH 2009
Demo Video
PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing

- Key issue: how to search efficiently all patches in one image region for the most similar patch in another image region

- Recall texture synthesis
  - Efros and Leung, ICCV 1999
  - Wei and Levoy, SIGGRAPH 2000

[Barnes et al.]
Nearest-Neighbor Field (NNF)

› A function of offsets $f : A \mapsto R^2$

› Defined over all possible patch coordinates in image A, for some distance function D of two patches.

Given patch coordinate $a$ in image $A$ and its corresponding nearest neighbor $b$ in image $B$, $f(a)$ is simply $b - a$. The values of $f$ are referred to as offsets, and they are stored in an array whose dimensions are those of $A$.

Cf. optical flow
An Example of Offset Field

(a) originals    (b) random    (c) $\frac{1}{4}$ iteration    (d) $\frac{3}{4}$ iteration    (e) 1 iteration    (f) 2 iterations    (g) 5 iterations

Saturation $\rightarrow$ magnitude
Hue $\rightarrow$ angle
Approximate Nearest-Neighbor Field

(a) Initialization

(b) Propagation

(c) Search
Approximate NNF Algorithm

- **Initialization**
  - Assign random values to the field

- **Iteration (from left to right, top to bottom)**
  - **Propagation**
    \[ f(x, y) = \arg \min \{ D(f(x, y)), D(f(x - 1, y)), D(f(x, y - 1)) \} \]
    
    measure patch similarity
to copy the offset from neighbors
  - **Random search**
    \[
    \begin{align*}
    v_0 &= f(x, y) \\
    u_i &= v_0 + w\alpha^i R_i \\
    
    R_i \text{ is a uniform random in } [-1, 1] \times [-1, 1] \\
    w\alpha^i \text{ is a decaying search radius}
    \end{align*}
    \]
Interactive Editing

› Bidirectional distance measure

\[
d_{BDS}(S, T) = \frac{1}{N_S} \sum_{s \in S} \min_{t \in T} D(s, t) + \frac{1}{N_T} \sum_{t \in T} \min_{s \in S} D(t, s)
\]

› Adding constraints

› Search space constraints

› Deformation constraints
  » Model constraints

» Hard constraints (reshuffling, like "patch transform")
Bidirectional Similarity Measure

Source

(a) complete coherent

(b) complete coherent

(c) complete and coherent