Texture Optimization for Example-based Synthesis

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http://www.cc.gatech.edu/cpl/projects/textureoptimization/

**Goals**
- Optimization-based approach for texture synthesis: Energy Minimization using a simple iterative algorithm
- Explicit improvement of texture quality
- Controllable synthesis: Flow-guided texture animation

**Texture Energy**
Texture Energy measures quality of the synthesized texture w.r.t. a given input sample

1. Define Energy for a single neighborhood
2. Total Energy = Sum over single neighborhood energies

**Synthesis Algorithm**
Alternate between X and \( \{Z_p\} \) as optimization variables
1. Initialize output texture X randomly
2. Find input neighborhoods \( \{Z_p\} \) nearest to output neighborhoods \( \{X_p\} \)
3. Minimize \( \sum ||X_p - Z_p||^2 \) w.r.t X (linear solve)
4. Repeat until convergence

**Flow-guided Texture Animation**
Animated texture sequence: Texture appears to follow given flow field. Sub-goals:
1. Flow Consistency: Perceived motion should be similar to flow
2. Texture Similarity: Shape, size, orientation of texture elements should be similar to input texture

**Results**
Multi-resolution synthesis: Full, Half, Quarter scales 32x32, 16x16, 8x8 nbd sizes
3-5 iterations per level
7-10 min. for 256x256 textures

Flow Energy and Optimization
Optimize Total Energy = Flow Energy + Texture Energy

**Flow Energy**
\[ \text{Flow Energy} = ||X_1 - W_0||^2 \]

**Results**
Each frame synthesized at single resolution
20-60 seconds per frame