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

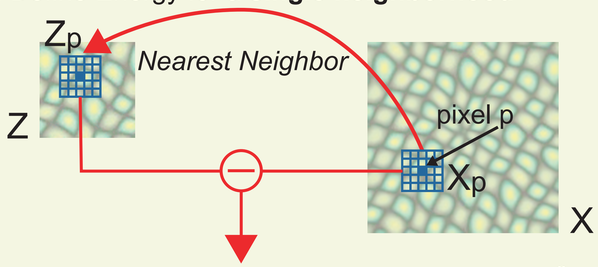
Explicit improvement of texture quality

Controllable synthesis: Flow-guided texture animation

Texture Energy

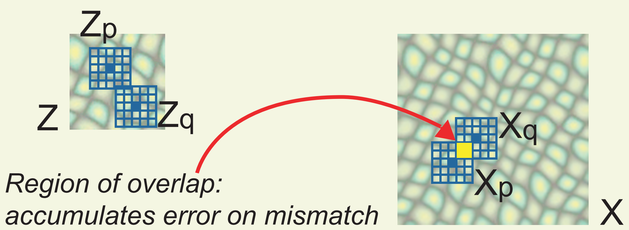
Texture Energy measures quality of the synthesized texture w.r.t. a given input sample

1. Define Energy for a **single neighborhood**



Single Neighborhood Energy = $||X_p - Z_p||^2$

2. **Total Energy** = Sum over single neighborhood energies

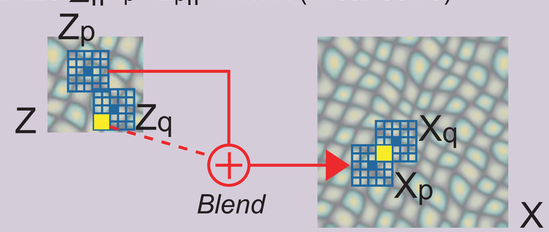


Region of overlap: accumulates error on mismatch

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)

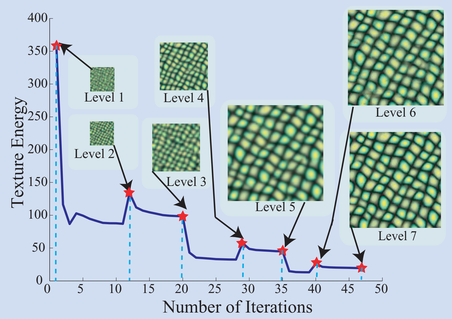


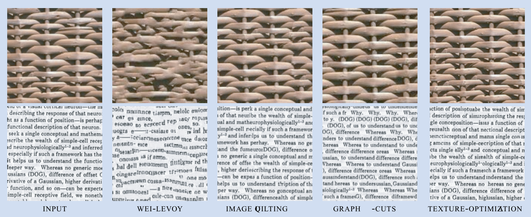
4. Repeat until convergence

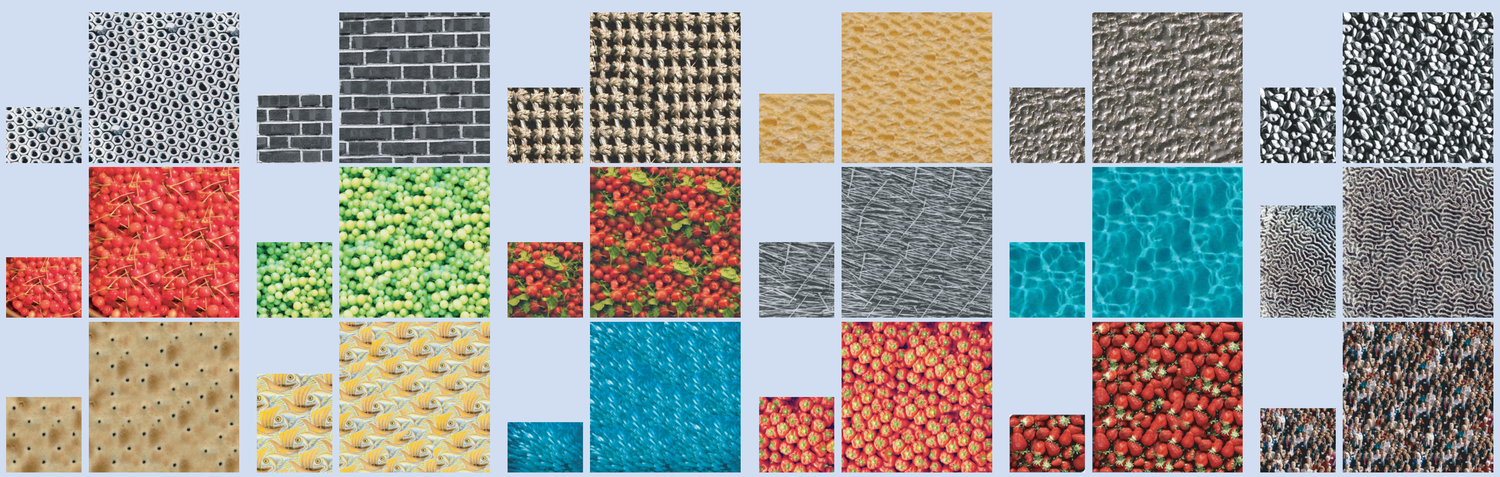
Results

Multi-resolution synthesis:
Full, Half, Quarter scales
32x32, 16x16, 8x8 nbd sizes

3-5 iterations per level
7-10 min. for 256x256 textures



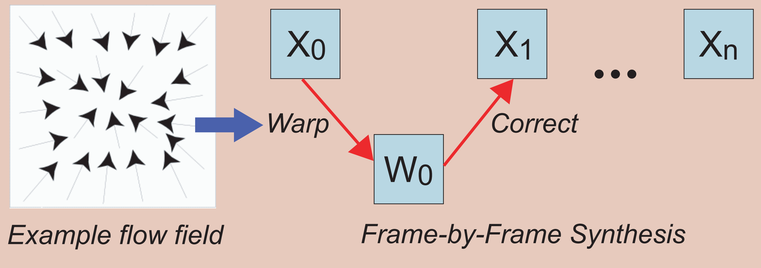




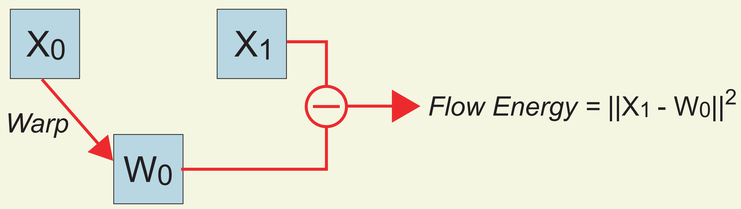
Flow-guided Texture Animation

Animated texture sequence: Texture appears to follow given flow field. Sub-goals:

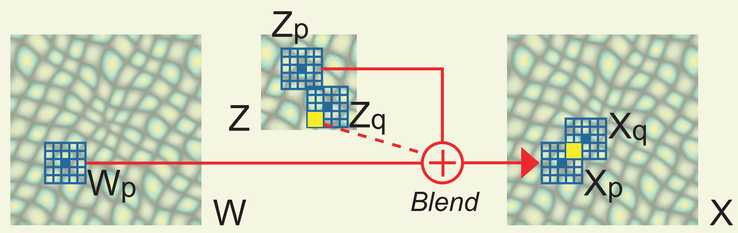
1. **Flow Consistency:** Perceived motion should be similar to flow
2. **Texture Similarity:** Shape, size, orientation of texture elements should be similar to input texture



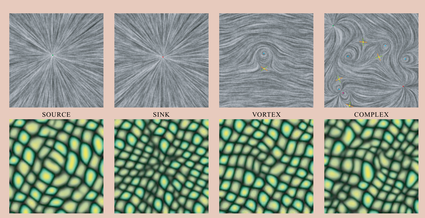
Flow Energy and Optimization

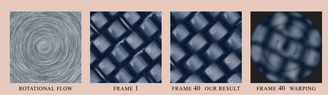


Optimize **Total Energy = Flow Energy + Texture Energy**



Results





Each frame synthesized at single resolution

20-60 seconds per frame