Texture Modulation-Constrained Image Decomposition

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1. Outline - Contributions
   • Novel approach for image decomposition in structure-texture combinad and with texture modeling
   • New variational decomposition scheme, involving an explicit texture reconstruction constraint term formed by the responses of selected frequency-tuned linear filters
   • u+v image model of K+1 components
   • Additional features:
     • Texture image reconstruction
     • Potential for multiple texture subcomponents (scale & orientation selective)

2. Image decomposition
   • Structure + texture image models, \( f = u + v \)
     - ‘Cartoon’ u (geometry, objects, contours, edges, plateaus)
     - Texture v (oscillations, details)

3. Formulation for \( u+v \)
   \[ E(u,v) = \left| f - u - v \right|_2^2 + \lambda \mu \int |\nabla u| + |\nabla v| \, dx \, dy + \rho |\nabla f|_2^2 + \lambda \mu \int |\nabla u| + |\nabla v| \, dx \, dy \]
   - Texture-wise mapping f \( \rightarrow u + v \)
   - \( t_j = y \frac{1}{|\mathcal{G}_j|} \) projection to \( \mathcal{G}_j \) (1 \( \leq j \leq K+1 \))

4. Texture AM-FM modeling
   • Narrowband texture components (AM-FM): \( t_j(x,y) = u_j(x,y) \sin(\theta_j(x,y)) \)

5. Texture reconstruction
   • Amplitude-weighted reconstruction
     \[ \sum_{j=1}^{K+1} \frac{1}{\mu_j + \lambda_j} \sum_{k \in \mathcal{G}_j} (f * g_k)_k \]
   • Automatic energy-based component selection
   • Approximated O(2), analysis:
     \[ \Psi \Psi = \sqrt{(\Psi \partial_x + \partial_x \Psi)(\Psi \partial_y + \partial_y \Psi)} \]

6. Example
   • Image f
   • Reconstruction term
   • Dominant component d

7. Comparisons

8. Extension to \( u+Kv \)
   \( K+1 \) components model
   \[ f = u + v \quad \sum_{k=1}^{K} \frac{1}{K} \sum_{k \in \mathcal{G}_j} (f * g_k)_k \]
   • PDE’s (steady-state solution):
     \[ u = \sum_{k=1}^{K} \frac{1}{K} \sum_{k \in \mathcal{G}_j} (f * g_k)_k \]
   • Summing subcomponents
     \[ v = \sum_{k=1}^{K} \frac{1}{K} \sum_{k \in \mathcal{G}_j} (f * g_k)_k \]

9. A color example

10. Applications
    • Edge detection
    • Restoration

Relevant work

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