

Getting a Morphological Tree of Shapes for Multivariate Images: Paths, Traps, and Pitfalls

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At a Glance

- Motivation. The Tree of Shapes (ToS) provides a *high-level representation of the image structure* and has *many applications* (here, grain filter = denoising).
 Objective. Extend the ToS computation on color images.
- Problem. A natural tree does not exist for color images (it requires a total order).
 Contribution. Review of standard approaches and new leads to extend the ToS on colors and get a single structure representing the image.

Approach 1. Total (pre)order based Tree of Shapes (Standard) Idea. Define a new total (pre)-order on colors.



Total (pre)order considered:

- Total order: lexicographical ordering
- Total pre-orders: luminance / chrominance in La*b*, RGB, HSL



Qualitative evaluation through denoising



Original image (corrupted). PSNR=36.46



Problems.

• Use an *arbitrary* choice of total ordering

• Many reconstruction policies with pre-orders that yield very different results (visible color artefacts)

Approach 2. Distance based Tree of Shapes (Standard)

Idea. Extend the ToS algorithm with a propagation to the closest level in the front.



Pros.

- Very natural extension of the gray-level algorithm
- Yield the same ToS in the gray-level case

 $\lambda_{\text{next}} = \arg\min_{\lambda_i} ||\lambda_{\text{current}} - \lambda_i||_2^2$

In gray level. $\lambda_{next} = \lambda_{current} \pm 1$

Distance-based approach.

• "Look" morphological and few color artefacts

Approach 3. The Graph of Shapes

Idea. Merge the individual ToS into a single structure based on the inclusion that yields a graph.

ToS \mathcal{T}_1



Approach 1. Pre-order based ToS. PSNR=38.23



Approach 2. Distance-based ToS. PSNR=37.88



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Approach 3. Graph of Shapes. PSNR=39.98

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