Shape-based analysis on component-graphs for multivalued image processing

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The extension of mathematical morphology to multivalued images is an important issue. In this context, connected morphological operators based on hierarchical image models have been increasingly considered to provide efficient image segmentation and filtering tools in various application fields, e.g. (bio)medical imaging, astronomy or remote sensing.

We propose a preliminary study that describes how component-graphs (that extend the component-tree from a spectral point of view) and shaping (that extends the component-tree from a conceptual point of view) can be associated for the effective processing of multivalued images.

### Previous works

**Component-graphs [1]:** Component-trees and multivalued images

A (discrete) image $I: \Omega \rightarrow V$ (canonically equipped with an order relation $\leq$) can be modeled as a **valued graph** $(G, \mathcal{V}, \mathcal{I})$. If $(\mathcal{V}, \leq)$ is no longer a total order, the Hasse diagram associated to $I$ is no longer a tree:

- We extend the notion of connected component to **valued connected component** $\Theta = \bigcup_{v \in \mathcal{V}} C(v) \times \{v\}$
- We define an **order relation** $\preceq$ on $\Theta$ as
  $$(X_1, v_1) \preceq (X_2, v_2) \iff \begin{cases} (X_1 \preceq X_2) \lor \ (X_1 = X_2 \land v_2 \preceq v_1) \end{cases}$$
- The **component-graph** $CG$ of the valued graph $(G, \mathcal{V}, I)$ is the Hasse diagram of the partially ordered set $(\Theta, \preceq)$.
- Each node of $CG$ can contain an **attribute value**, interpreted as a function $A : \Theta \rightarrow \mathbb{R}$. Such enriched component-graph is also interpreted as a valued graph $(CG, \mathbb{R}, A)$.

![Component-graphs](image)

**Advantages of the framework**

- Avoids the complex selection of nodes directly in $CG$.
- Extends the initial shaping approach to multivalued images.
- Inherits the good properties of space-filtering from increasing attributes: real-time and interactive node selection at higher semantic level.

### Introduction

**Component-graphs [1]:** Component-trees and multivalued images

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### Application to PET/CT image filtering

**Illustrative proof of concept:** We illustrate the potential usefulness of this framework by filtering coupled PET and CT images. The criterion considered for filtering is the compactness factor $\gamma$, defined as the ratio between the extremal eigenvalues of the matrix of inertia.

![Application to PET/CT image filtering](image)

**References**