Preface

Volume 1 of these Proceedings is divided into eight parts containing the full papers accepted for oral presentation to the 8^{th} International Symposium on Mathematical Morphology, held in Rio de Janeiro from October 10^{th} to 13^{th}, 2007.

Each part is dedicated to a specific theme of interest. The distribution of the 38 articles along these themes gives an idea of the current trends in Mathematical Morphology (MM).

Lattice theory

Coincidently, MM and Fuzzy Sets were both born in 1965 and during the first few decades, both communities independently made important contributions. Nowadays, we observe some convergence between them.

Bloch extends the traditional skeleton by influence zones (SKIZ) to fuzzy sets and shows a possible method of interpolation between fuzzy sets. Hirata et al. present algorithms for the computation of the basis of binary and gray-scale translation-invariant and locally-defined operators in the presence of incomplete information about the kernel. Kiselman introduces upper and lower inverses of mappings between complete lattices, analyzes their properties and links with Galois connections, and gives a thorough characterization of them, as well as an extension to upper and lower quotient of two mappings. Based on the concept of adjoint conjunctor-implicator pairs, Popov discusses fuzzy dilation-erosion adjunctions on fuzzy sets, interval arithmetic with fuzzy numbers, and a fuzzy hit-or-miss transform. From a partial-order relation defined on tree representations of images, which provide a complete inf-semilattice structure, Vichik et al. derive self-dual morphological operators that can be used as filters for noise reduction.

Geometry and topology

Despite the fact that discrete geometry is a separate field of research, it has a large intersection with MM whenever one considers the applications of MM to digital image processing.

After recalling the definitions and properties of smallest-neighborhood spaces and the Khalimsky topology on $\mathbb{Z}^n$, Melin introduces a binary operation on topological spaces called join, and shows that under local finiteness theses spaces can be uniquely decomposed as a join of indecomposable spaces. Serra investigates the conditions for generating granulometries on $\mathbb{Z}^n$ using Steiner sets, as well as conditions on these sets for them to be convex or connected. In a second article, Serra proposes a new random closed set model, combining the generation of random germs and random

sets, and applies this model to the analysis of data on fires that occurred in Malaysia.

Signal processing

MM based on lattice theory is a powerful approach to solve nonlinear problems in signal processing. At the heart of this approach are the nonlinear operators of dilation and erosion as illustrated in a few of the contributions below.

Dorini and Leite introduce a scale-space toggle operator, prove some of its properties, and illustrate its usefulness for image segmentation. Karantzalos compares the construction of nonlinear scale space image representations derived from multiscale levelings constrained by four different markers. Maragos and Evangelopoulos introduce alternative approaches based on levelings and texture energy for decomposing an image into cartoon and texture components.

Image processing

The main application of MM is Image Processing. The success of MM in this field comes from the fact that, diferently from the linear approach, it is able to manage the finiteness of the digital image range. The contributions below include content-based image indexing and retrieval, texture classification, image simplification, crest line regularization, and image interpolation for computer-aided animations.

Andaló et al. introduce a new shape descriptor based on tensor scale, show how it can improve content-based image retrieval and provide a faster computation of tensor scale by exploiting the Euclidean Image-Foresting Transform. Aptoula and Lefèvre combine the complementary information extracted by morphological covariance and granulometry in order to improve texture classification, and propose an extension to color data introducing an ordering based on luminance and saturation. Meyer and Angulo introduce the so-called bilevelings of an image defined on an hexagonal grid, prove that they can be characterized in term of so-called micro-viscous operators that appear to form adjunctions between set of functions defined on vertices and edges, and verify that they lead to higher levels of simplification than with ordinary levelings. Retornaz and Marcotegui present a robust technique using morphological numerical residues for automatic localization of textual information in general image database through connected component extraction. Vachier and Meyer enlarge the concept of viscous transform to increasing operator, introduce three viscous dilations and show how dotted thin crest lines in gray-tone images may be reconnected and smoothed using these transformations. Vidal et al. extend to mosaic images their previous work on an interpolation technique for binary images based on morphologi-

cal median sets, by processing all the levels of the hierarchical region-based tree that represents the region structure of the mosaic image.

Connectivity

Among the major developments in MM in the last two decades are the interrelated subjects of connectivity classes and connected operators. Connectivity classes, in their general lattice-theoretical formulation, not only unify in a single axiomatic framework useful but disparate notions of connectivity, but also include new interesting definitions of connectivity not previously possible. Connected operators, on the other hand, have become very popular in image analysis applications due to the fact that these operators can preserve edge information by working at the level of the image flat zones, which are defined using connectivity criteria.

Crespo examines in detail the equivalence between two important classes of connected operators, namely, set levelings and adjacency-stable operators. Dimiccoli and Salembier propose the use of image inpainting to improve the appearance of images processed by connected operators. Naegel et al. propose a general definition of vector-attribute filters for gray-level images and describe its application in detection and segmentation tasks.

Watershed segmentation

The watershed method represents a powerful paradigm in image segmentation. Ever since its introduction three decades ago, it has attracted the interest of many investigators and practitioners, and research activity in this area continues unabated today.

Alléne et al. study the links that exist between the watershed and minimum cuts, minimum spanning forests, and shortest-path forests. Angulo and Jeulin propose a watershed-based stochastic segmentation methodology. Audigier and Lotufo use the Image Foresting Transform and the Tie-Zone concept to establish the relationship between several discrete watershed transforms. Ten Caat et al. address the visualization of electroencephalography (EEG) data by means of a watershed-based clustering method. Cousty et al. study several properties of watersheds in edge-waited graphs. Papa et al. present a classification method based on optimum-path forests. Stawiaski et al. present a technique to compute approximate geodesics and minimal surfaces.

Texture and geometrical segmentation

The articles in this part further examine the segmentation problem, by using geometric and texture criteria, within or without a watershed framework.

Angulo presents a method to calculate texture gradients and use them for joint color and texture segmentation. Consularo et al. present an efficient method for interactive image segmentation based on inexact graph matching. Cord et al. propose morphological and linear approaches to the characterization and segmentation of random textures. Noyel et al. introduce new connectivity classes that are able to improve flat-zone segmentation of hyperspectral images. Sofou and Maragos investigate problem of image segmentation via PDEs, focusing on a generalized flooding procedure using geometric and textural information.

Algorithms and architectures

The last, but not by any means least, part of this volume is devoted to an aspect of MM that allowed it to become widespread and popular in both research and practice, namely, efficient algorithms and architectures for implementation of MM operators.

Bergo and Falcão introduce an algorithm that expresses any Imaging Foresting Transform operator as a series of independent computations, facilitating thus parallel implementations of such operators. Menotti et al. present a linear time and space algorithm to compute the component tree of one-dimensional signals, from which they derive an efficient gray-level image multithresholding method. Ouzounis and Wilkinson present a concurrent implementation of a previously developed Max-Tree algorithm, which implements anti-extensive attribute filters based on second-generation connectivity. Vaz et al. describe an efficient method to implement MM operators using convex and symmetric structuring elements, including Euclidean discs and spheres.

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