

## Introduction

Mathematical morphology was initiated by George Matheron and Jean Serra in the early 1960's, but it is not until the publication of the 1975 seminal book *Random Sets and Integral Geometry* by Matheron and later of *Image Analysis and Mathematical Morphology* in 1982 by Serra that mathematical morphology really took off as an international field of research in applied mathematics and a powerful set of tools for image analysis.

Today mathematical morphology is an established discipline in the areas of image and signal processing, filtering, segmentation and image and signal coding, among others. It has strong links with more recent theories such as scale-space and level set methods. On the practical level most introductory books in image analysis and most available commercial imaging software include at least the most basic mathematical morphology operators.

Yet this field is still very much a work in progress, as this book hopes to demonstrate. Image capturing devices have become increasingly more sophisticated and more prevalent. At one end of the spectrum the capture of high-resolution, multispectral, 3D and time-dependent images is possible and at the other end simpler devices such as digital cameras and scanners are becoming more commonplace. As a result image processing and image analysis needs are increasing all the time. In particular faster, simpler and more powerful techniques are needed to analyse this data. At the same time the underlying theory is becoming better known, fostering progress.

The contributions of this book have been classified by the following themes:

**Regularisation.** The classical mathematical morphology methods for segmentation, such as the watershed and seeded region growing, are powerful methods with simple descriptions but can yield irregular contours, unlike other methods such as active contours or level sets. Solutions are presented to help solve this problem.

**Applications.** One of the main strengths of mathematical morphology is its practical aspect. Many applications are presented here in the areas of texture segmentation, image editing tools, 3D segmentation, image compression and more. Practical implementation of morphological operators is also discussed.

**Binary Mathematical Morphology.** Mathematical morphology has its

roots in binary image analysis. Even though the theory has evolved to include grey-level and multispectral images, advances in this important area are reported here, including efficient implementations, operator design and advances in the object splitting problem.

**Scale-space.** This area of research has become quite important and although its roots are in linear signal processing, the ideas of scale-space for filtering and segmentation have been exported to mathematical morphology with great effect. Papers in this area discuss the theory, including its symmetries and its unifying effect, as well as its implementation aspects and applications.

**Bridges.** This theme includes papers that build a bridge between mathematical morphology and other areas of image analysis.

**Granulometry.** Granulometries are an essential aspect of mathematical morphology that were developed early and are of great importance in applications.

**Simulations and models.** One of the main links between mathematical morphology and spatial statistics is in the areas of point processes and simulations. Inverse problems are common in this area as well.

**Implementations.** The practical and theoretical aspects of implementations are common problems in image analysis and particularly in mathematical morphology. Its success is undeniably due to the efforts of many researchers in the area of fast algorithms and hardware implementations, and this aspect of the domain continues to this day.

**Reconstruction.** Morphological reconstruction allows for the design of powerful filtering methods and has given rise to the notion of connected operators.

The invited and keynote papers open the book. The first paper is an historical paper on the birth of mathematical morphology, by Matheron<sup>1</sup> and Serra from the Centre de Morphologie Mathématique. The following paper describes the successful DjVu document compression scheme by Haffner, Bottou and LeCun from AT&T Research and Vincent from LizardTech. The third paper is on levelings and flattenings by Meyer – also from the Centre de Morphologie Mathématique. Levelings are among the more recent advances both from a theoretical and a practical point of view. The last paper is on the link between classical edge detection and geometric active contours by Kimmel and Bruckstein of the Technion.

We hope that the content of this book will be of interest to people working in the general areas of image and signal analysis, pattern recognition and computer vision.

Hugues Talbot

---

<sup>1</sup>The last paper Matheron co-authored before his death.