BOOKSBOOKSBOOKS

Digital Geometry, 1st Edition
Geometric Methods for Digital Picture Analysis
by Reinhard Klette and Azriel Rosenfeld

Morgan Kaufmann, 2004

Reviewed by Jovisa Zunic (University of Exeter, UK)

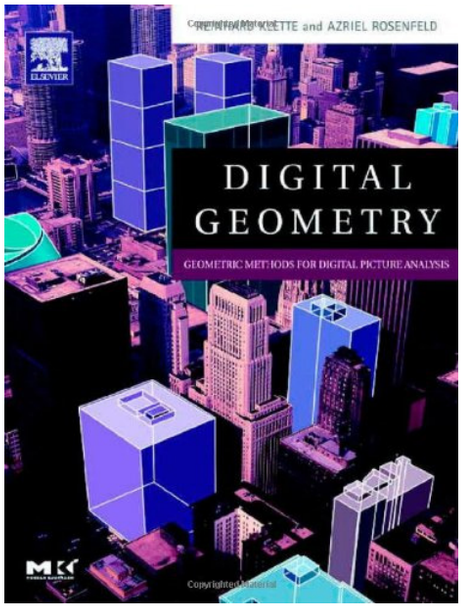
This is a self-contained book that presents and explains the main approaches and achievements in the area of digital geometry. It defined this field of research in 2004, and has been used since then frequently by researchers and students as a reference. The book is on the reading list of the Intelligent Image Understanding module, taught by me here, at the University of Exeter, for postgraduate computer science students. This review may also serve as a reminder that Azriel Rosenfeld, one of the founders of IAPR, had passed away 10 years ago (*Editor's note: please see "IAPR Then and Now" on Page 11 for the announcement of Azriel Rosenfeld as the first recipient of the prestigious King Sun Fu Award*), and the book documents also his great passion for the discussed subjects.

The book is also a general, very readable introduction to basic and advanced concepts in graph theory, geometry and topology, normally not expected in a book on an image analysis subject. It includes a comprehensive theoretical framework supporting the understanding of relevant concepts, theoretical observations, and analysis of results, algorithms and methods presented in various graph-theoretic, geometric and topologic disciplines.

Digital geometry is a relatively new scientific discipline, mostly related to the geometry and geometric properties of objects presented in digital images. It emerged in the 1960s in response to a strong demand for tools and theoretical foundations of tasks caused by developments in image technologies and applications related to digital image analysis and image synthesis (i.e. computer graphics). Even though there is a consensus that digital geometry, as a scientific discipline, was established in the second half of the 20th century, the evidence provided in the book reminds us that the roots of the discipline date back as far as the ancient times of Archimedes or Euclid. The authors have done a very extensive study of historic sources and have provided links, for example, to the work of Listing in topology, Gauss in combinatorial geometry, and Jordan in measurement theory (just to cite a few – there are many more in the book) for the first time to the digital geometry community.

Due to its completeness, complexity and the diversity of the material presented, the book is a recommended reading for a wide audience: from undergraduates to experts in the imaging technology field, but also, by several fundamental chapters, to others whose research and work relies on a use of graph-theoretical, geometric, or topologic concepts in other areas of science and technology.

The structure of the book supports reading by such a diverse audience.



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There are 17 chapters in total. More or less, the different chapters allow independent reading, possibly with a relatively minor limitation due to the background of the reader, because the presentations are mostly completely covering and explaining the discussed subjects, including consistent notation throughout the book.

The first nine chapters, apart from the introductory observations and comments, provide all the necessary theoretical (mainly mathematical) foundations necessary to understand the selected topics presented in the remaining eight chapters. The selected topics might be understood as the most attractive and most fruitful ones studied so far (by 2004) in the area of digital geometry. Planar digital objects (lines and curves) and their properties and features are studied in Chapters 9 and 10.

Chapters 11 and 12 consider 3-dimensional objects and their properties and features. Hulls and diagrams are studied in Chapter 13, while Chapter 14 is related to transformations in the digital geometry domain. Morphologic operations and deformations are in Chapters 15 and 16, respectively. Picture properties (local and global ones) and spatial relations are observed and analysed in Chapter 17.

A lot of knowledge, expertise, experience and effort were preconditions to enable such a precise and comprehensive selection of the material that covers the discipline's essentials and puts aside details that can be easily found somewhere else. Precise sources and links to where such additional material can be found are provided, mainly under subsections named `Commented Bibliography' given at the end of every chapter.

Proofs provided are precise and supported by nice illustrations. A number of proofs are omitted. This enables a good balance between the book size (measured in terms of the number of pages) and the material covered (measured in terms of theoretical results, algorithms and problem solutions described and analysed). For interested readers, references to the relevant literature are provided whenever proofs are omitted.

Each chapter concludes with exercises whose complexity and difficulty levels vary. Simpler exercises and the experimental ones are more suitable for undergraduates, while more advanced ones are designed and intended for graduates and experienced researchers.

The book includes several additional features that make a read very pleasurable. I appreciated very much the comments and information that put the presented material in a wider context in computer science, mathematics and science in general. Some of them remind us that the roots of our current research were established many years, decades, or even centuries ago. This presents a nice and big picture of mutual connections between scientific disciplines dating back from ancient times till today. If we consider these presented observations as a vertical scan (i.e. through time), then we can see the horizontal scan as a discussion about relationships between disciplines, which meet and overlap over solutions for some particular problems. The book also emphasizes such horizontal scans for a number of problems discussed in digital geometry. These different levels of detail, from very deep and specific observations (related to a specific problem) to illustrations of very global inter-connections of different scientific disciplines, differentiate this book.

A recent online-review by Ralph Reinhold says "I think anyone working in the field of computer vision should read this or better yet take a course in it." I fully concur with this; the book is highly recommended for educational and academic enlightenment for many more years to come.

We are looking forward to reports on the following books under review:

1. *Airborne and Terrestrial Laser Scanning* by George Vosselman, Hans-Gerd Maas (Whittles Publishing, 2010). Reviewer: Giuseppe Maino. Under review since February 2010.
2. *Guide to Medical Image Analysis* by Klaus D. Toennies (Springer, 2012). Reviewer: Alexandra Branzan-Albu. Under review since June 2012.
3. *Support Vector Machines for Pattern Classification, 2nd Ed.*, by Shigeo Abe (Springer, 2010). Reviewer: Huthaifa Abderahman. Under review since July 2013.
4. *Concise Computer Vision* by Reinhard Klette (Springer 2014). Reviewer: Tayyab Naseer. Under review since February 2014.
5. *Euclidean Shortest Paths* by Fajie Li, Reinhardt Klette (Springer, 2011). Reviewer: Arindam Biswas. Under review since March 2014.
6. *Decision Forests for Computer Vision and Medical Image Analysis* edited by Antonio Criminisi and Jamie Shotton (Springer 2013). Reviewer: Zeeshan Zia. Under review since April 2014.
7. Person Re-Identification by Shaogang Gong et al. (Springer 2014). Reviewer: Donatello Conte. Under review since May 2014.