Lecture Notes in Computational Vision and Biomechanics

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Volume 2

The research related to the analysis of living structures (Biomechanics) has been a source of recent research in several distinct areas of science, for example, Mathematics, Mechanical Engineering, Physics, Informatics, Medicine and Sport. However, for its successful achievement, numerous research topics should be considered, such as image processing and analysis, geometric and numerical modelling, biomechanics, experimental analysis, mechanobiology and enhanced visualization, and their application to real cases must be developed and more investigation is needed. Additionally, enhanced hardware solutions and less invasive devices are demanded.

On the other hand, Image Analysis (Computational Vision) is used for the extraction of high level information from static images or dynamic image sequences. Examples of applications involving image analysis can be the study of motion of structures from image sequences, shape reconstruction from images and medical diagnosis. As a multidisciplinary area, Computational Vision considers techniques and methods from other disciplines, such as Artificial Intelligence, Signal Processing, Mathematics, Physics and Informatics. Despite the many research projects in this area, more robust and efficient methods of Computational Imaging are still demanded in many application domains in Medicine, and their validation in real scenarios is matter of urgency.

These two important and predominant branches of Science are increasingly considered to be strongly connected and related. Hence, the main goal of the LNCV&B book series consists of the provision of a comprehensive forum for discussion on the current state-of-the-art in these fields by emphasizing their connection. The book series covers (but is not limited to):

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Digital Geometry Algorithms

Theoretical Foundations and Applications to Computational Imaging

Springer

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Preface

Digital geometry is a modern mathematical discipline studying the geometric properties of digital objects (usually modeled by sets of points with integer coordinates) and providing methods for solving various problems defined on such objects. Digital geometry is developed with the explicit goal to provide rigorous mathematical foundations and basic algorithms for applied disciplines such as computer graphics, medical imaging, pattern recognition, image analysis and processing, computer vision, image understanding, and biometrics. These are in turn applicable to important and societally sensitive areas like medicine, defense, and security.

Although digital geometry has its roots in several classical disciplines (such as graph theory, topology, number theory, and Euclidean and analytic geometry), it was established as an independent subject only in the last few decades. Several researchers have played a pioneering role in setting the foundations of digital geometry. Notable among these is the late Azriel Rosenfeld and his seminal works from the late 60's and early 70's of the last century. Some authors of chapters of the present book are also among the founders of the area or its prominent promoters. The last two decades feature an increasing number of active contributors throughout the world. A number of excellent monographs and hundreds of research papers have been devoted to the subject. One can legitimately say that at present digital geometry is an independent subject with its own history, vibrant international community, regular scientific meetings and events, and, most importantly, serious scientific achievements.

This contributed book contains thirteen chapters devoted to different (although interrelated) important problems of digital geometry, algorithms for their solution, and various applications. All authors are well-recognized researchers, as some of them are world leaders in the field. As a general framework, each chapter presents a research topic of considerable importance, provides a review of fundamental results and algorithms for the considered problems, presents new unpublished results, as well as a discussion on related applications, current developments and perspectives. By its structure and content, this publication does not appear to be an exhaustive source of information for all branches of digital geometry. Rather, the book is aimed at attracting readers' attention to central digital geometry tasks and related

applications, as diverse as creating image-based metrology, proposing new tools for processing multidimensional images, studying topological transformations for image processing, and developing algorithms for shape analysis.

An advantage of the chosen contributed book framework is that all chapters provide enough complete presentations written by leading experts on the considered specific matters. The chapters are self-contained and can be studied in succession dictated by the readers' interests and preferences.

We believe that this publication would be a useful source of information for researchers in digital geometry as well as for practitioners in related applied disciplines. It can also be used as a supplementary material or a text for graduate or upper level undergraduate courses.

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Fredonia and Buffalo, NY, USA

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