

Myung-Soo Kim
Kenji Shimada (Eds.)

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Myung-Soo Kim

Seoul National University, School of Computer Science and Engineering

Seoul 151-742, Korea

E-mail: mskim@snu.ac.kr

Kenji Shimada

Carnegie Mellon University, Mechanical Engineering

Pittsburgh, PA 15213, USA

E-mail: shimada@cmu.edu

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Preface

This book contains the proceedings of Geometric Modeling and Processing 2006, the fourth in a biennial international conference series on geometric modeling, simulation and computing, which was held July 26–28, 2006 in Pittsburgh, USA. The previous conferences were in Hong Kong (2000), Tokyo (2002), and Beijing (2004). The next conference (GMP 2008) will be held in China.

GMP 2006 received 84 paper submissions, covering various areas of geometric modeling and processing. Based on the recommendations of 114 reviewers, 36 regular papers were selected for conference presentation, and 21 short papers were accepted for poster presentation. The authors of these proceedings come from Austria, Belgium, Canada, Chile, China, Colombia, Greece, Indonesia, Israel, Japan, Korea, Lebanon, Singapore, the UK, and USA.

We are grateful to the authors who submitted to GMP 2006 and to the many dedicated reviewers. Their creativity and hard work substantially contributed to the technical program of the conference. We would also like to thank the members of the Program Committee for their strong support. We also wish to thank David Gossard, GMP2006 Conference Chair, and past GMP Program Co-chairs Shimin Hu, Ralph Martin, Helmut Pottmann, Hiromasa Suzuki, and Wenping Wang, whose current and previous work has helped to establish this conference as a major event in geometric modeling and processing. Further, we wish to thank the members of the Computer Integrated Engineering Laboratory at Carnegie Mellon University, in particular Soji Yamakawa, for their invaluable assistance throughout the conference preparation.

We gratefully acknowledge the financial support of Carnegie Mellon University. Finally, we wish to thank all conference participants for making GMP 2006 a success.

We hope that the readers will enjoy this book. In our view, it impressively demonstrates the rapid progress in geometric modeling and processing. It shows the importance and range of this field, with its impact in such areas as computer graphics, computer vision, machining, robotics, and scientific visualization. Finally, we hope that the conference and its proceedings will stimulate further exciting research.

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Automatic Extraction of Surface Structures in Digital Shape Reconstruction

Tamas Várady¹, Michael A. Facello², and Zsolt Terék¹

¹ Geomagic Hungary, Ltd., Budapest, Hungary

² Geomagic, Inc., Research Triangle Park, North Carolina, USA

Abstract. One of the most challenging goals in digital shape reconstruction is to create a high-quality surface model from measured data with a minimal amount of user assistance. We present techniques to automate this process and create a digital model that meets the requirements in mechanical engineering CAD/CAM/CAE. Such a CAD model is composed of a hierarchy of different types of surfaces, including primary surfaces, connecting features and vertex blends at their junctions, and obey a well-defined topological structure that we would like to reconstruct as faithfully as possible. First, combinatorially robust segmentation techniques, borrowed from Morse theory, are presented. This is followed by an algorithm to create a so-called feature skeleton, which is a curve network on the mesh that represents the region structure of the object. The final surface structure comprises the optimally located boundaries of edge blends and setback vertex blends, which are well aligned with the actual geometry of the object. This makes the surface structure sufficient for an accurate, CAD-like surface approximation including both quadrangular and trimmed surface representations. A few representative industrial objects reconstructed by Geomagic systems illustrate the efficiency and quality of the approach.

Keywords: digital shape reconstruction, segmentation, combinatorial Morse theory, curve tracing, vertex blends.

1 Introduction

Digital Shape Reconstruction (formerly reverse engineering) deals with converting physical objects into a computer representation. DSR is a particular chapter within a general discipline called Digital Shape Sampling and Processing (DSSP) that integrates all point cloud related computations emerging in various fields [Marks05, Geom06]. There are well-established techniques to create polygonal meshes from measured data, which need to be further converted to a representation suitable for CAD, CAM, and CAE. The biggest challenge is to automate this conversion process while producing a model that meets the requirements of downstream applications, including good structure and high quality surfaces.

In Computer Aided Design and – in particular – in mechanical engineering, the majority of objects are composed of (i) relatively large, primary surfaces