

Special Issue on Shape and Solid Modeling in Product Development

This Special Issue of JCISE includes selected papers that were presented at the IEEE Shape Modeling International Conference (SMI'04) and the Ninth ACM Symposium on Solid Modeling and Applications (SM'04). The conferences were colocated at the Palazzo Ducale, in the historic center of Genoa, Italy in June 2004 as part of the International Convention on Shapes & Solids 2004 organized and chaired by Bianca Falcidieno (CNR, Italy). The Shape Modeling International Conference is an annual international forum for the exchange of research and applications related to all the aspects dealing with modeling, representing, processing and retrieving of digital shapes and associated properties from a broad multidisciplinary perspective. The ACM Symposium on Solid Modeling and Applications is also an annual international forum for the exchange of recent research and applications of solid modeling and computing in design, analysis and manufacturing, as well as in emerging biomedical, geophysical and other areas.

The SMI'04 program cochairs selected 6 papers from a list of 40 papers of the plenary full and short format articles to be included in this issue, based on the papers' quality and interest for the engineering domain. All papers were revised and reviewed by at least two additional referees for JCISE. Using similar criteria, the SM'04 program cochairs selected 5 papers from the list of 20 plenary full papers presented at the SM'04 symposium. The subjects of the papers reflect the recognition that geometric and solid models have become the primary medium for creating, editing, exchanging, analyzing, and simulating computational models in engineering. As such, the disciplines of geometric and solid modeling now play central roles in computing and information science at large. The selected papers reflect this prominent role of geometric modeling by describing a wide range of impressive advances in the field.

The first six papers in this issue are based on the SMI'04 conference papers. Related to manufacturing processes, the paper *Mold Accessibility Via Gauss Map Analysis*, by G. Elber, X. Chen and E. Cohen, addresses the problem of defining a valid partition line for a two-piece mold. Unlike most of the previous work in this area, this paper deals also with NURBS models. It demonstrates that a valid solution exists under specific hypotheses for the given object's topology and surface continuity, and provides a method for its evaluation.

The problem of defining effective and efficient tools for modifying and reusing free form shapes is crucial in CAD applications. Two papers of this special issue deal with different aspects of such a problem by extending the applicability of the feature-based approach to parts that include free-form surfaces. The first paper, titled *Fitting and Manipulating Free-Form Shapes Using Templates* by Y. Song, J. S. M. Vergeest and W. F. Bronsvort, focuses on the development of tools for the easy control and modification of existing shapes. This is done by adopting free-form feature templates, which are recognized over existing surfaces, and modifiable through a few intrinsic parameters. The paper *Shape Tuning*

in Fully Free-Form Deformation Features by J. P. Pernot, S. Guillet, J. Leon, B. Falcidieno and F. Giannini, presents a method for deforming and tuning the shape of surface areas in a predictable manner. A formulation of the optimization problem of the adopted deformation method is proposed that permits the establishment of a correlation between the combination of the quantities to be minimized and its meaning in terms of the resulting shape behaviors.

Well known in animation, subdivision surfaces are gaining attention in wider domains. In the paper *Detail-Preserving Variational Surface Design With Multiresolution Constraints* by I. Boier-Martin, R. Ronfard and F. Bernardini, existing variational modeling methods have been adapted to multiresolution subdivision surfaces showing the capabilities of such a representation scheme for interactive rapid shape prototyping.

The problem of extracting medial axis surface models of thin plate structures from Computed Tomography (CT) data is addressed in the technical note *Contouring Medial Surface of Thin Plate Structure Using Local Marching Cubes* by T. Fujimori, H. Suzuki and Y. Kobayashi. A new algorithm for contouring a medial surface is described that first extracts the medial cells using a skeletonization method and then applies the Marching Cubes algorithm. The method adjusts the topological connectivity using appropriate cell operations.

The challenging problem of curvature estimation from scanned dense meshes is treated in the technical note *Verification of Scanned Engineering Parts with CAD Models Based on Discrete Curvature Estimation* by B. Lipshitz and A. Fischer, where a comparison among three of the most well-known methods (the angle based, Taubin's and Hamman's) is given.

The next five papers in this issue are based on the SM'04 symposium full plenary papers: *Planar Parameterization For Closed Manifold Genus-g Meshes Using Any Type of Positive Weights* by D. Steiner and A. Fischer; *Fast Continuous Collision Detection for Articulated Models* by S. Redon, M. C. Lin, D. Manocha, and Y. J. Kim; *Automatic Building of Structured Geological Models* by S. Brandel et al.; *Trivariate Simplex Splines for Inhomogeneous Solid Modeling in Engineering Design* by J. Hua, Y. He and H. Qin; and *Labelling Engineering Line Drawing Using Depth Reasoning* by P. A. C. Varley, R. R. Martin and H. Suzuki.

The first paper by Steiner and Fischer addresses the problem of the parametrization of three-dimensional meshes, which has important applications in texture mapping, remeshing as well as morphing of meshes. The second paper by Redon et al. focuses on the problem of collision detection on a time interval continuum, rather than evaluating collisions at sequences of fixed times. The resulting algorithm has applications in design, simulation, robotics, virtual environments and computer games. The third paper by Brandel et al. proposes a new method for significantly ameliorating the construction and update of three-dimensional geological models used for hydrocarbon exploration by the oil industry. The fourth paper by Hua et al. proposes a new method for represent-

ing, modeling, creating and rendering complex inhomogeneous solid objects using the trivariate simplex spline method, with applications in design and analysis of heterogeneous objects. The fifth paper by Varley et al. focuses on the important problem of the automatic generation of boundary representation models of engineered solid objects from line drawings, a problem with significant applications in the design industries.

We hope that JCISE readers will find the papers stimulating and thought provoking. We also hope that, by focusing on the key role of geometric computations in engineering applications and demonstrating the many exciting opportunities for further advances, this issue will encourage you the readers to participate in the future shape and solid modeling conferences. This issue, and indeed the convention itself, became possible only due to the hard work of many individuals. We wish to thank the authors for their willingness to contribute to this special issue, the referees for their thorough reviews under very tight deadlines, the JCISE Editor, Jami Shah, for his support, as well as the ACM, the IEEE and the Eurographics Association for a permitting reprint of some contributions and the inclusion of revised and expanded versions of papers from the convention in this special issue.

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Editor's Note

JCISE is pleased to publish selected best papers from ACM Solid Modeling conference, for the fourth consecutive year. Since the 2004 Solid Modeling conference was held jointly with the IEEE Shape Modeling International Conference, we decided to include selected papers from both conferences. Unless otherwise noted, papers appearing in this issue have been revised and enhanced for JCISE. We thank ACM (co-sponsor of JCISE) and IEEE for permission to include their respective papers. We also thank the co-chairs of both conferences for serving as Guest Editors for this issue.

- Jami J. Shah, Editor JCISE