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Editorial

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This special issue has its origin in the NASAGEM 07 workshop that took place in October 2007, held as part of a sequence of events including the HAPTEX 07 workshop and the Cyberworlds 07 conference. NASAGEM stands for "New Advances in Shape Analysis and Geometric Modeling". The goal of that workshop had been to attract papers emphasizing the relevance and power of modern mathematical methods applied in the context of shape analysis and geometric modeling. The program chairs of NASAGEM 07 were Nicolas M. Patrikalakis (MIT), Bernd Hamann (University of California at Irvine) and Franz-Erich Wolter (Leibniz Universität Hannover). The papers presented at the NASAGEM 07 workshop were published in October 2007 in an IEEE proceedings volume including the papers presented at the Cyberworlds 07 conference and the papers presented at HAPTEX 07.

Prior to the NASAGEM 07 workshop, a proposal to create a special issue of the JCAD originating from the best papers presented at NASAGEM 07 had been accepted by the editors in chief of JCAD and by the publisher of JCAD. The selection for this special issue was carried out by the three Co-Editors of this special issue: Bernd Hamann, Konrad Polthier (Freie Universität Berlin) and Franz-Erich Wolter. The subset chosen from the workshop papers also received the highest scores in the reviewing process for NASAGEM 07. The authors of the selected proceedings papers were invited to create substantially extended versions of their workshop papers, including at least 30% new material and carrying a new title. The extended articles were subjected to another review handled by the three Co-Editors to ensure that they satisfied the requirements.

All this resulted in a special issue including the subsequently described papers being quite different with respect to methods, concepts and their respective applications and intentions.

The article "3D Terrestrial LIDAR Classifications with Super-voxels and Multi-scale Conditional Random Fields" co-authored by Ee Hui Lim and David Suter deals with the classification of outdoor range data obtained with a terrestrial laser scanner. This article introduces a new method in the given context proposing discriminative conditional random fields and modifying the model to incorporate multi-scale concepts for super voxel labeling.

The paper "Single-Rate near Lossless Compression of Animated Geometry" co-authored by Rachida Amjoun and Wolfgang Strasser presents a new compression scheme for animated meshes with constant connectivity. This scheme encodes the differences between original and predicted locations in a local coordinate system which splits into two tangential and one normal component. As the coordinates in tangential and normal spaces show strong temporal clustering behavior, they appear to be well suited for temporal prediction.

The article "Generating Parametric Models of Tubes from LaserScans" co-authored by Ulrich Bauer and Konrad Polthier shows how to compute a precise parametric model of a piecewise defined pipe surface from an unorganized point set. A pipe surface is defined as the envelope of a sphere with a constant radius moving along a curve called a spine curve. In this paper the spine curve is defined by a piecewise G^1-continuous curve consisting of circular arcs and line segments. An important application of the method presented in this paper is the inspection of tube surfaces after undergoing a bending process in order to compare them with CAD data describing the requested idealized results. Another application is the reverse engineering of tubes for which bending data are not known.

The contribution "Computing Handle and Tunnel Loops with Knot Linking", co-authored by Tamal K. Dey, Kuiyu Li and Jian Sun characterizes, detects and generates handle and tunnel loops for a class of closed surfaces embedded in a three-dimensional Euclidean space. The class of surfaces being considered are assumed to be graph-retractable, avoiding knotted embeddings. A closed surface in a three-dimensional space separates the ambient space into a bounded and an unbounded component. A loop being a closed curve on the aforementioned surface is called handle or tunnel loop respectively in case the loop spans a disk surface in the bounded or in the unbounded component, respectively. The methods described in this paper may be used to detect handle and tunnel features in CAD surfaces. Furthermore, the methods may, for example, be applied to remove unwanted handles or tunnels by filling in the respective disc surfaces.

The paper "Laplace–Beltrami Eigenvalues and Topological Features of Eigenfunctions for Statistical Shape Analysis", co-authored by Martin Reuter, Franz-Erich Wolter, Martha Shenton and Marc Niethammer, describes methods for global and local shape analysis using Laplace–Beltrami eigenvalues and eigenfunctions with Dirichlet and Neumann boundary conditions for surfaces and solids. The aforementioned eigenvalues and eigenfunctions depend on the isometry type of the underlying manifold (here surface or solid) only. The article suggests employing eigenfunctions on surfaces and solids for detection and registration of features on shapes. All those concepts could be applied on shapes stemming from any field of applications including various kinds of engineering applications. The paper also presents a bio-medical application

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showing that eigenvalues as well as geometric features related to level sets of eigenfunctions can be used to statistically distinguish shape differences in caudates of human brains stemming from two distinct populations with one population containing subjects having schizotypical personality disorders while the other contains normal control subjects.

Finally, the article "Characterization of 3D Shape Parts for Semantic Annotation" written by Marco Attene, Francesco Robbiano, Michela Spagnuolo and Bianca Falcidieno, describes a system called the "Shape Annotator" dealing with the problem of providing useful semantic annotations to 3D-shapes. The paper discusses how to decompose a shape into different relevant features by introducing a theoretical framework for working with multi-segmentations allowing for the flexible support of semantic segmentation. In general, this article treats the difficult problem of creating tools for constructing flexible formal bridges from a specified knowledge base (containing semantically defined and semantically linked objects) into the world of geometry containing geometric realizations of the latter semantically defined objects. Progress on the problem for providing efficient and practical formal bridges between geometry and semantics will certainly need a significant amount of work, especially in the areas of geometry processing and geometrically defined shape classification topics that were addressed in the other five papers of this special issue.

We hope that this selection of papers will be inspiring. It is our belief that the methods presented in the papers of this special issue are exemplary in the sense that they develop effective computational techniques based on sound and sometimes quite advanced mathematical foundations, with diverse and relevant applications to contemporary applications arising in science and engineering.