Available online at www.sciencedirect.com
ScienceDirect
Computer-Aided Design 40 (2008) 1–2
COMPUTER-AIDED DESIGN
www.elsevier.com/locate/cad

Preface

Special issue on constrained design of curves and surfaces

It is indeed an honor and a pleasure to act as guest editors for this special issue on *Constrained Design of Curves and Surfaces (CDCS)*. We would like to thank the editors of *JCAD* for supporting our view that generating, analyzing and modifying shapes is a process usually driven by a variety of constraints, whose methodological, algorithmic and computational handling deserves to obtain autonomy within the CAD literature, rather than being hosted by diverse, and possibly remote to each other application disciplines.

The quality and number (19) of received submissions show that the CAD-researcher community responded positively to our CfP (Call for Papers) in September 2006. After a two-round peer review cycle for all but one submission, 11 papers were selected for publication. This special issue could not have materialized without the expertise, persistence and patience of nearly fifty (48) referees: their decisive role is acknowledged with pleasure.

Here is a short description of the goals and achievements of each paper.

CDCS-1: "*Rational cubic spirals*" by D.A. Dietz, B. Piper and E. Sebe.

This paper deals with the construction of planar rational cubic curves satisfying boundary conditions of position, tangent and curvature while securing monotone curvature as well as robustness and efficiency of the materializing numerical algorithm.

CDCS-2: "*Dual evolution of planar parametric spline curves and T-spline level sets*" by R. Feichtinger, M. Fuchs, B. Juettler, O. Scherzer and H. Yang.

Evolution of parametrically- and implicitly-defined curves, referred to as *dual evolution*, is introduced for combining the advantages of both representations for fitting curves to a planar point cloud. Dual representation enables handling a wide spectrum of constraints, such as guiding the topology of the fitting curve, range, area and convexity constraints.

CDCS-3: "*Constrained curve fitting on manifolds*" by S. Floery and M. Hofer.

This paper discusses the on-manifold constraint of fitting a B-spline curve to a point cloud measured on a smooth manifold. The proposed constrained minimization algorithm allows imposing additional constraints such as one-sided fitting or surface regions to be avoided.

CDCS-4: "*Geometrically exact splines*" by A. Theetten, L. Grisoni, C. Andriot and B. Barsky.

This work develops a model for handling the physical simulation of deformable 1D objects, formulating mechanically rigorous and geometrically exact expressions of stretching, bending and twisting energies. Despite its accuracy the model is able to comply with the real-time constraint, guaranteeing usability for constrained CAD applications, e.g., cable positioning.

CDCS-5: "*Constrained design of polynomial surfaces from geodesic curves*" by J. Sánchez-Reyes and R. Dorado, and

CDCS-6: "*Cubic polynomial patches through geodesics*" by M. Paluszny.

Both papers develop methods for constructing parametric polynomial surfaces that interpolate polynomial geodesics. This constrained design problem occurs in the textile and shoe industries for garment design, a study initiated in a *JCAD* paper by Wang et al. (CAD 2004; 36(5): 447–459). In CDCS-5, the existing degrees of freedom are identified in terms of control points, which enables the resulting interpolating surfaces to be readily embeddable into commercial CAD systems.

CDCS-7: "*Boolean surfaces with shape constraints*" by P. Costantini, F. Pelosi and M.-L. Sampoli.

In this paper, Boolean sum of variable-degree operators is used for constructing a hybrid scheme for interpolating a set of grid lines and approximating spatial data under shape constraints.

CDCS-8: "*Detecting approximate symmetries of discrete point subsets*" by M. Li, F.C. Langbein and R.R. Martin.

Detecting symmetries of approximate B-rep solid models can be used for improving their shapes, simplifying their analyses as well as constraining them during editing. The paper provides an incremental algorithm to detect *local approximate symmetries* in a discrete point set, derived from a B-rep model, at various automatically detected tolerance levels.

CDCS-9: "*Structure-oriented contour representation and matching for engineering shapes*" by S. Hou and K. Ramani.

0010-4485/$ - see front matter
doi:10.1016/j.cad.2007.12.005

Table 1
Special-issue paper classification according to object- and constraint-type

<table>
<tr><th>Paper no.</th><th colspan="3">Type of involved objects</th><th>Type of imposed constraints</th></tr>
<tr><td>CDCS-1</td><td rowspan="7">Continuous</td><td rowspan="2">2D curves</td><td>Rational cubics</td><td>Interpolation, boundary conditions (tangent, curvature), monotone curvature</td></tr>
<tr><td>CDCS-2</td><td>Parametrically- and implicitly-defined</td><td>Topology guidance, range, area convexity constraints.</td></tr>
<tr><td>CDCS-3</td><td rowspan="2">3D curves</td><td>B-splines</td><td>On manifold, one-sided fitting, regions to be avoided</td></tr>
<tr><td>CDCS-4</td><td>Deformable 1D objects</td><td>Real-time handling of geometrically exact expressions of stretching, bending and twisting energies.</td></tr>
<tr><td>CDCS-5</td><td rowspan="3">Surfaces</td><td rowspan="2">Parametric Polynomial</td><td rowspan="2">Interpolating geodesics</td></tr>
<tr><td>CDCS-6</td></tr>
<tr><td>CDCS-7</td><td>Boolean-sum parametric</td><td>Interpolating grid lines and approximating spatial data under shape constraints.</td></tr>
<tr><td>CDCS-8</td><td rowspan="4">Discrete</td><td colspan="2">2D/3D point sets</td><td>Detecting local approximate symmetries</td></tr>
<tr><td>CDCS-9</td><td>2D shapes</td><td>Polygonal approximation</td><td>Shape matching despite large dissimilarity through stretching and/or bending</td></tr>
<tr><td>CDCS-10</td><td rowspan="2">Surfaces</td><td>Polygonal mesh</td><td>Flattenability: discrete notion for developability</td></tr>
<tr><td>CDCS-11</td><td>Carving track covering of complex functional surfaces</td><td>Shape constraints: maxima, monotonicity and convexity/concavity.</td></tr>
</table>

The goal of the paper is to develop a strategy for global matching of part models, that can have large dissimilarity through stretching and/or bending. For this purpose, the shape is decoupled in two levels: a higher-level structure, reflected from the topology defined by the so-called *feature points*, and a lower-level structure, reflected by the local geometry carried by these points. Discrete curve evolution, dynamic time wrapping and elastic matching are employed for feature-point extraction, computing matching cost and performing integrated geometry comparison, respectively.

CDCS-10: "*Towards flattenable mesh surfaces*" by C.C.L. Wang.

This work proposes a discrete analogue of the notion of developable surfaces, referred to as *flattenable mesh surfaces*, and formulates the relevant modeling tool, which inherits the advantages of both the flattenable and Laplacian meshes. Furthermore, a local perturbation approach is developed to improve the flattenability of an almost flattenable triangular mesh.

CDCS-11: "*Integrative 3D modeling of complex carving surface*" by Y. Chen, X. Han, M. Okada and Y. Chen.

In this paper a constructive methodology is developed for digitizing the traditional handcraft carving of Chinese furniture. The approach starts with a 2D curve pattern and combines a scanning analysis algorithm with alternative carving depth functions for obtaining the machining tracks that meet user-specified shape constraints: maxima, monotonicity and convexity/concavity.

Let us end with Table 1 that classifies the papers according to the types of involved objects and constraints.

Professor Dr.-Ing. Panagiotis Kaklis*
Computer-Aided Ship Design,
School of Naval Architecture & Marine Engineering,
National Technical University of Athens (NTUA),
Heroon Polytechneiou 9,
Zografou 157 73, Athens, Greece
E-mail address: kaklis@deslab.ntua.gr.

Professor Dr. Paolo Costantini
Numerical Analysis,
Dipartimento di Scienze Matematiche ed Informatiche,
Pian dei Mantellini, 44, 53100 Siena, Italy
E-mail address: costantini@unisi.it.

Professor Dr. Stefanie Hahmann
Laboratoire Jean Kuntzmann,
Institut Polytechnique de Grenoble (INPG),
BP 53, F-38041 Grenoble, France
E-mail address: Stefanie.Hahmann@imag.fr.

Professor Dr. Tom Lyche
CMA and Institute of Informatics,
PO Box 1053 Blindern, 0316 Oslo, Norway
E-mail address: tom@ifi.uio.no.

* Corresponding editor. Tel.: +30 210 772 1419; fax: +30 210 772 1408.