ELSEVIER

Computer-Aided Design 31 (1999) 163

COMPUTER-AIDED
DESIGN

Editorial

Offsets, sweeps, and Minkowski sums

Offsets, sweeps, and Minkowski sums are important in many geometric modeling applications. Offsets of curves and surfaces are required in NC Machining, geometric tolerancing, and the construction of blends and fillets. Sweeps are an essential tool for designing tube-like shapes. Sweeps of polygons, polyhedra, and free-form curved objects are also needed for collision detection in robotics and CAD/CAM. Minkowski sums form the basis of a range of modeling operations, including interface checking, shape transformation and font design.

Offsets, sweeps, and Minkowski sums are geometrically well-defined; but their practical computation is an elusive and challenging task. In particular, they can easily generate non-rational curves and surfaces; and representing the result of such operations requires the global elimination of self-intersections, which is extremely difficult to implement robustly. This special issue reports interesting new results on these subjects, pointing the way to resolution of computational difficulties and also introducing tools available from hardware as well as software techniques.

The first two papers of this special issue are survey articles on offsets, sweeps, and Minkowski sums. Maekawa reviews recent developments of algorithms for computing offset curves and surfaces. This survey article also does an excellent job as an easy-to-understand tutorial on this subject. The following paper of Hartquist et al. reviews the authors' own work in the past ten years on computing offsets, sweeps and Minkowski sums. A very interesting part of this article concerns a hardware design for these geometric operations.

The next three papers are related to sweeps. Ilies and Shapiro introduce a new geometric modeling operation of *unsweep*. As a generalization of the standard Minkowski difference, this new concept of unsweep has many attractive theoretical and computational properties. In the next paper, Jüttler and Wagner introduce rational motion-based techniques for generating sweep surfaces in an NURBS form. The first part of this paper deals with modeling rational sweep surfaces based on the rotation minimizing frame (RMF) of a spine space curve. The second part presents a surprising result that the exact envelope surface of a developable surface (under a rational motion) can be represented as a rational surface. The following paper of Blackmore et al. considers trimming, a very important computational issue in the swept volume computation. This paper suggests a space–time-based scheme for trimming redundant envelope surfaces constructing the boundary surface of a swept volume.

The last paper of Glaeser et al. involves general offset surfaces, a concept closely related to Minkowski sums. This paper introduces a new theoretical background for testing global millability based on local millability conditions alone. The mathematical theory has important applications in collision-free 3-axis milling of sculptured surfaces and also in the selection (and even the design) of optimal cutting-tools for a given surface.

The importance of developing new strategies for computing offsets, sweeps, and Minkowski sums is not limited to applications in CAD/CAM alone. These operations are crucial in many important steps of geometric algorithms designed for applications in computer graphics, robotics, virtual reality, etc. As result of its importance, many top-notch journals in computational science and engineering have striven to attract more papers on this subject. Thanks to the high reputation of *Computer-Aided Design*, we have been very successful in receiving more than twenty submissions. We are confident that the six papers published in this special issue represent the best quality research in this field.

Acknowledgements

The guest editors would like to thank all authors and reviewers who contributed to this special issue. Many thanks also to the editors-in-chief of *Computer-Aided Design* for their generous support of our special issue.

Gershon Elber
Technion, Israel
Myung-Soo Kim
Postech, Pohang, South Korea

PII: S0010-4485(99)00012-3