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Editorial

Geometric Modelling and Processing

Research in geometric modelling has produced various important computational techniques based on mathematical theories of numerical analysis and algebraic geometry. Numerical methods have played a crucial role in developing curve and surface approximation and interrogation techniques, and in reducing numerical errors in geometric computation. Algebraic approaches have provided powerful symbolic computation tools that deal with algebraic equations representing various geometric elements.

In contrast although mathematical ideas from differential geometry and topology have made many useful contributions to geometric modelling, there remain important problems to overcome before these disciplines can achieve their full potential applicability. For example, the local theory of curves and surfaces is based on assumptions such as arc-length parameterization, which is rather difficult to realize in practice. Assuring correct topological connectivity of curves and surfaces is quite a challenging implementation task, with various computational hurdles to overcome.

Classical geometry has also been an important source of mathematical tools for use in design of free-form curves and surfaces. Such geometric tools are also critical in developing efficient and robust algorithms for processing free-form curves and surfaces to derive other geometric elements needed in specific applications. The application of analytical methods from classical geometry to solve various interesting computational geometric problems in practice is challenging

Geometric Modelling and Processing '98, held on 7–8 April 1998, in Pohang, Korea, provided a forum to present and discuss new approaches to problems in geometric modelling using differential, topological and classical geometric techniques. The papers presented at the workshop were of a uniformly high standard, and we are pleased that this special issue contains expanded versions of six papers specifically chosen to be of particular interest to readers of CAD. We fully expect that other papers from the workshop will also be published.

The first three papers in this special issue are focused on line geometry and ruled surfaces. The two papers of Pottmann et al. introduce classical line geometry and classical geometry of ruled surfaces; the authors develop computational tools from line geometry and then apply these geometric tools to solve problems in surface reconstruction, robotics, and ruled surface design. The paper by Heo et al. also demonstrates an application of line geometry in the intersection of two ruled surfaces. Using the Plücker condition of line geometry, the surface intersection problem is reduced to a simpler problem of zero-set finding.

The next two papers deal with applications of Voronoi diagrams and medial-axis transformations. Sugihara introduces a modified Sibson coordinate which can be computed directly from the Voronoi diagram, instead of the second-order Voronoi diagram; he then shows how the new coordinate is useful for surface interpolation. Choi et al. present a new approach to medial axis transformation and offset curve computation for a complicated planar domain; their approach is based on two novel ideas of domain decomposition and Minkowski Pythagorean hodograph (MPH) curves.

The final paper is devoted to the construction of cubic Pythagorean hodograph (PH) curves which satisfy a number of nice properties. Jüttler and Mäuer interpolate G^1 Hermite boundary data with cubic PH cubics and then apply the result to the construction of G^1 continuous rational sweep surfaces.

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