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Guest Editorial

Special Issue on Reverse Engineering and Computational Metrology: Part 1—Surface Reconstruction Methods

Computational metrology has recently begun to play a prominent role in the evolution of engineering systems and the improvement of production technologies. Indeed, this field has become essential due to the use of advanced inspection technologies in manufacturing industries. These technologies, primarily emerging scanning technologies such as coordinate measuring machines (CMMs), laser scanners, and three-dimensional cameras, have led to industrial demands for digital geometric processing (DGP) of sampled data. In response, new methodologies have been developed to cope with the complex metrology problems of registration, data fusion, surface reconstruction, and handling tolerances of the sampled data. These computational metrology methods are used mainly for design, manufacturing, inspection, and quality control applications.

This series of special issues focuses on methodologies, fundamental theories, and practical solutions for reverse engineering and computational metrology. The current issue presents the state of the art research in reverse engineering and surface reconstruction. It offers new computational methods that utilize advanced scanning techniques and integrate data fusion strategies. The next issue focuses on emerging measurement techniques, computational metrology, and software algorithms for data analysis from CMM inspection.

The 13 papers in this issue cover a variety of topics, dictated by the interests of the engineering, scientific, and manufacturing industrial communities:

- RE for design of manufactured parts.
- Scanning planning.
- Data fusion methods of scanned data.
- Surface reconstruction methods (B-Splines, meshes).
- Surface reconstruction from 2D/3D images.
- Multi-resolution representations.
- Object recognition, perception, and classification.
- Free-form feature extraction.

Two of the papers propose new *reverse engineering methods for design of manufactured parts*. The paper by Urbanic et al., "An Integrated Systematic Design Recovery Framework," offers new insight into an integrated approach for design application. Tucker and Kurfess propose a new approach to point cloud registration in their Technology Review (which appears towards the end of the issue) entitled "Point Cloud to CAD Model Registration Methods in Manufacturing Inspection."

The topic of *scanning planning* is the focus of the paper "Scan Planning Strategy for a General Digitized Surface." In this paper, Mehdi-Souzani et al. describe a new methodology for optimal nonuniform scanning for free-form objects.

For a summary of the state of the art of *data fusion methods of scanned data* and a proposed new data fusion method for scanned data, refer to the paper by Jamshidi et al. entitled "A New Data Fusion Method for Scanned Models."

Some of the papers in the issue focus on *surface reconstruction methods for computational metrology*, as related to reconstruction of continuous and discrete geometric CAD models. One of the papers focuses on *continuous representations*. In "Fitting of Reference Surfaces for Engineering Surfaces by Nonlinear Least Squares Technique," Kumar and Shunmugam describe a 3D surface fitting method.

Mesh reconstruction methods are the focus of two other papers. "A New Volume Warping Method for Surface Reconstruction" by Azernikov and Fischer describes a new grid-based method that wraps the space to improve the accuracy of the surface reconstruction. In "Reverse Engineering Methods for Digital Restoration Applications," Rushmeier and Boier-Martin propose an efficient dimension-independent representation for multi-resolution nonmanifold meshes.

Three papers focus on the topic of *surface reconstruction methods from 2D/3D images*. In "A Comprehensive Tool for Recovering 3D Models From 2D Photos With Wide Baselines," Lu and Smith offer an advanced method for reconstructing 3D models from 2D photos. In the paper by Jain et al. entitled "Probabilistic Approach to Modeling of 3D Objects Using Silhouettes," a statistical approach to modeling of 3D objects using 3D silhouette curves is proposed. Galantucci et al.'s paper, "Digital Photogrammetry for Facial Recognition," describes a facial recognition technique from 2D images.

The topic of *multi-resolution representations* is discussed in the paper by De Floriani and Hui entitled "A Dimension-Independent Representation for Multi-Resolution Non-Manifold Meshes," which describes a new multi-resolution structure.

The last two papers in this special issue focus on *object recognition, perception and classification of free-form feature extraction, and modeling*. The first, "Interactive Feature Modeling for Reverse Engineering" by Schreve et al., is an Application Brief. The second paper, "As-Built Modeling of Objects for Performance Assessment" by Kokko et al., proposes feature reconstruction methods.

The above papers together present the state of the art in computational metrology methods from a broad perspective relating to different emerging scanning technologies and various reconstruction methods using them. The methods are based on up-to-date methodologies and theories with practical implementations that can answer industrial demands and improve current sophisticated production systems. It is our hope that this issue can provide you with a wide-ranging view of the role of advanced reverse engineering and surface reconstruction in the field of computational metrology.

We would also like to thank Prof. Deba Dutta and Prof. Elaine Cohen for their advice and guidance in putting together this series of special issues.

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