Area of Research

Our primary research interests are in CAD/CAM/CAE/CAT, including geometric modeling, shape interrogation, computational geometry, fitting curves and surfaces, reverse engineering, machining automation, layered manufacturing, path planning for autonomous vehicle. The current research topics as of April 2011 are:

1) 3D shape reconstruction from 2D images.
2) B-spline surface reconstruction from a point cloud.
3) Fitting B-spline curves and surfaces with prescribed tangents and curvature vectors.
4) Merging of B-spline curves and surfaces.
5) Geometric modeling and processing of subdivision surfaces.
6) Path planning for autonomous vehicle using B-spline curves.

Advantage

We have published about 40 journal papers and a book. According to Google Scholar as of February 2011, the number of citations of these articles is more than 1100. This clearly shows the effectiveness of our research.

Case Study

We introduce a system to reconstruct a 3D polygonal model of 3D micro objects with outer dimensions ranging from several hundred microns to several millimeters from multiple 2D images of an object taken from different views. The data acquisition system consists of a digital microscope that captures still images at a resolution of 1600 x 1200 pixels and a computer-controlled turntable. We employ the Shape-From-Silhouette (SFS) method to construct a voxel-based 3D model from silhouette images. The concave shapes are further carved by using the Space Carving technique. In order to make the resulting model compatible with the commercial CAD/CAM system, the voxel model is converted into a triangular mesh using the Marching Cubes algorithm. Because the mesh generated from the voxel model by using the Marching Cubes algorithm inherits the staircase effect, the mesh is adjusted to recover the object precisely by using silhouette images. Finally, we evaluate the accuracy of the proposed method. The reconstructed model of M2x3.5mm screw indicates the effectiveness of the 3D shape reconstruction system for micro objects.

Research Topics for Cooperative Study

- Reverse Engineering
- Geometric Modeling
- B-spline curves and surfaces
- Subdivision surfaces
- Shape Interrogation

Peer reviewed conference papers

- System for reconstruction of 3D micro objects from multiple photographic images, Computer-Aided Design, 2011 (To appear)
- Generating B-spline curves with points, normals and curvature constraints: a constructive approach, The Visual Computer 26(6-8), pages 823–829, 2010
- Curvature Continuous Path Generation for Autonomous Vehicle Using B-Spline Curves, Computer-Aided Design 42(4), pages 350-359, 2010
- Point-Tangent/Point-Normal B-spline Curve Interpolation by Geometric Algorithms, Computer-Aided Design 41(6), pages 412-422, 2009

Patent

- Shape-Intrinsic Watermarks for 3-D Solids, US Patent No.20030128209

Book

- Shape Interrogation for Computer Aided Design and Manufacturing, Springer-Verlag, 2002/02