3D Knowledge: An Interactive Feature-based Search Engine

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Abstract

We present a novel approach for the creation, query, and analysis of discipline-specific (e.g., archaeological, biological, geological) libraries of 3D data. The system supports an enhanced “3D knowledge” (the name comes from an NSF initiative in “Knowledge and Distributed Information”) that may lead to breakthroughs in the quantification and interpretation of datasets as diverse as ancient ceramic artifacts, primate hand bones, cell morphology, or other complex 3D data.

Overview

Many researchers and scientists are in need of ways to identify, locate, and utilize 3D data found on the web, stored within discrete databases, or created from a range of 3D capture devices. Our system, based on a new set of protocols for 3D data creation, storage, query, and analysis, introduces a new web-based, discipline-specific suite of tools for research involving 3D datasets.

New algorithms developed by the PRISM KDI team at ASU allow researchers to intuitively characterize target data for surface and volume description. The system provides support for detailed analysis of 3D data sets and is robust enough to support research by interdisciplinary teams. Our method involves adding semantic and geometric information to make the data more meaningful. A suite of real-world tools integrates the functions of cataloging and indexing information (3D digital library), the development of techniques to query and retrieve the data (shape matching), and interacting with the data once it has been identified (e.g., standard metric measures plus Discriminate Analysis and Cluster Analysis).

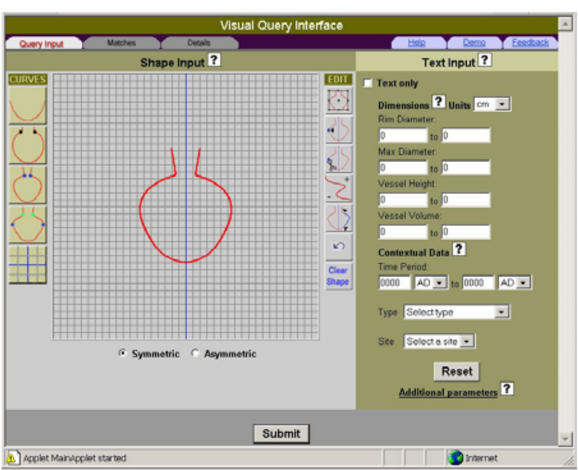

Fig. 1. Screenshot showing input ofsketch to query a large database of ancient ceramic vessels.

Illustrated here is one component—a collection of ancient Native American ceramics—of a multidisciplinary database (other 3D data sets we are investigating include primate bones, animal cells, and lithics). In the case of the ceramic vessels, actual pots are laser scanned and defined as a set of three-dimensional triangulated meshes. The data is modeled with parametric surfaces, and relevant features are extracted to raise the level of abstraction of data. A class-based XML schema is used to catalog and organize vessel data. A visual query process permits interaction with the data using sketches or by selecting sample vessel shapes to augment text and metric search criteria.

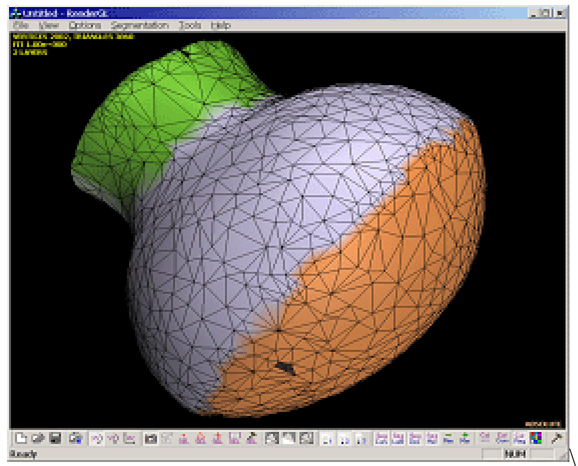

Fig. 2. Polygonal mesh with “watershed” defined areas for complete vessel.

Researchers at other institutions (e.g. Funkhouser, 2002) have been able to identify objects by shape from large collections on the web. However, existing systems provide little or no support for subsequent interaction or analysis of the object once located.

In contrast, the level of accuracy in documentation and measurement of 3D artifacts with our system represents an entirely new capability for 3D data query and analysis that could have a positive impact on any field utilizing 3D data. The binary and derived data about 3D artifacts offers an accurate set of metrics and descriptors that can be immediately shared, re-analyzed, and submitted for comparative analysis within large databases. The system supports research for those without physical access to valuable artifacts, from remote locations, and without the constraints of expensive scientific instrumentation.

Website for the project: http://3dk.asu.edu.

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