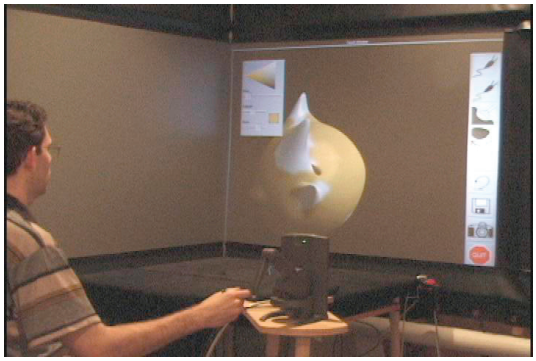
Touch-Enabled 3D Model Design

Department of Computer Science | University of North Carolina at Chapel Hill | February 2004



An artist modeling with the ArtNova system.

The Challenge

While there are numerous commercial modeling systems, as well as scanning technologies available, simple, intuitive, and fast modeling remains a challenging problem. An ideal modeling package should allow the users to create a basic model, edit it with finer details, and further enhance its appearance by painting colors and textures, all with ease and flexibility via an intuitive and simple user interface.

One of the limitations of existing commercial modeling systems is that one must interact with a 3D model by means of 2D input and output devices. The resulting interaction is neither obvious nor natural, inhibiting creative expression.

The Approach

We have been designing systems that couple stereoscopic visual display with force feedback so that one can see and feel an object in three dimensions. The user has a choice of virtual tools with which to reposition, deform, and paint, making the systems useful for all phases of the 3D model design process.

ArtNova

ArtNova is our most recent system based on this philosophy. Users can deform models at different resolutions with a natural, smooth force response, paint colors and patterns directly on the surface, and adjust the viewpoint in a variety of ways.

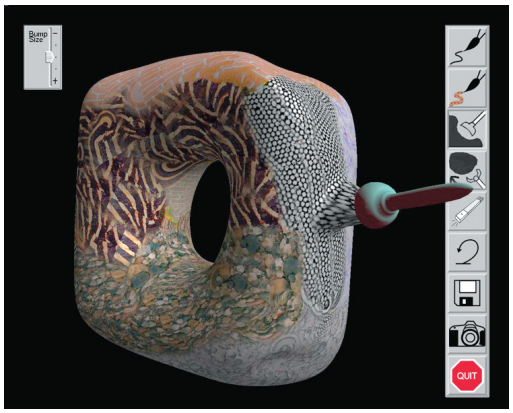
User Interface: There is a 2D menu drawn over the edge of a stereo projected 3D scene, which contains the model being edited along with the tool being used. The user can effectively interact with the 3D scene and the 2D menu without ever having to let go of a stylus, which is a PHANTOM three degree-of-freedom force-feedback device. The user can position, orient, and scale the models, and deform them by picking a feature size and directly manipulating the surface. For

Highlights

- **Intuitive 3D interfaces for interactively editing and painting a polygonal mesh at various levels of detail using a force feedback device.**
- **The coupling of innovative haptic technology with visual feedback allows users to naturally create complex forms and patterns.**

3D painting, one can interactively choose the color of the brush stroke as well as its radius and falloff. Alternatively, patterns can be selected from a menu and applied to the surface with the brush. At all times, the surface can be felt through the input device.

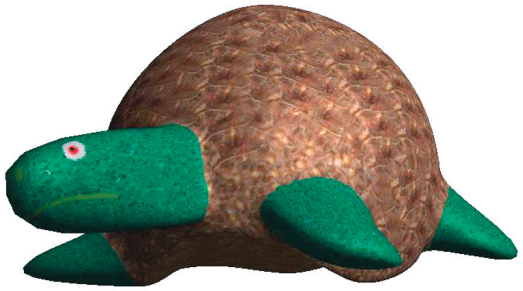
Mesh Editing: We use a subdivision mesh to represent the geometry of the model. This type of representation allows for modifications to occur



The user interface for ArtNova.
A toroidal model is being deformed.

at multiple levels of detail. The advantage of this approach is that the user can perform relative modeling. That is, when one selects a coarse edit level and deforms the mesh, finer features are pulled along without losing their shape.

3D Painting: The problem of choosing a parametrization for texture mapping has been a long-standing challenge in computer graphics. With ArtNova, users are insulated from this concern because they can paint directly on the model, and the texture coordinates are determined automatically. In addition, while patterns are being applied to the model, a local coordinate system is generated for each brush stroke, keeping distortion small.



A turtle modeled and painted by Adrian Ilie using ArtNova.

Cuts of beef indicated by various textures.

Dynamic Viewing Techniques: The user has a choice of methods for altering the point of view on the object. In addition to the conventional grab-and-turn approach, there are viewpoint navigation and automatic repositioning. With viewpoint navigation one can change the position and orientation of the viewpoint, using the haptic tool to indicate the direction and velocity of motion. Automatic repositioning allows users to indicate the region of interest with a single touch, upon which it is brought to the center of the field of view.

inTouch

The design of ArtNova is based on inTouch, an earlier modeling system following the same philosophy. The subdivision surface framework, haptic interaction, and ability to paint directly on the model originated with inTouch. ArtNova added a number of improvements, including the ability to paint patterns, dynamic viewing techniques, a more natural force response during deformation, and an improved appearance for the user interface.

Project Members

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Past Project Members

Stephen Ehmann, Arthur Gregory

Research Sponsors

U.S. Army Research Office, Department of Energy ASCI Program, Intel Corporation, National Science Foundation, Office of Naval Research

Selected Publications

Foskey, M., M. Otaduy, and M. C. Lin. "Artnova: Touch-Enabled 3D Model Design," *Proc. IEEE Virtual Reality Conference*, 2002.

Gregory, A., S. Ehmann, and M. C. Lin. "inTouch: Interactive Multiresolution Modeling and 3D Painting with a Haptic Interface," *Proc. IEEE Virtual Reality Conference*, 2000.

Gregory, A., M. Lin, S. Gottschalk, and R. Taylor. "H-Collide: A Framework for Fast and Accurate Collision Detection for Haptic Interaction," *Proc. IEEE Virtual Reality Conference*, 1999.

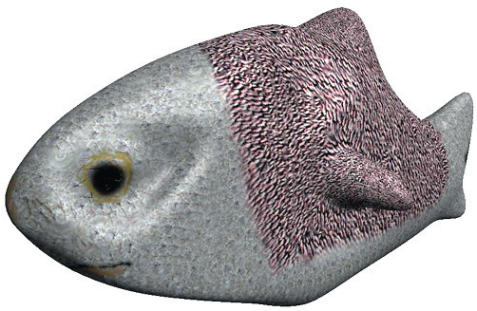
Key Words

Haptics; multiresolution modeling, 3D painting; human-computer interaction; collision detection

For More Information

- gamma.cs.unc.edu/ArtNova
- gamma.cs.unc.edu/inTouch
- gamma.cs.unc.edu/HCollide

A butterfly modeled and painted by Arthur Gregory using inTouch.



A fish modeled and painted by Miguel Otaduy using ArtNova.

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