SketchBook : Silhouette Based 3D Sketching Interface (sap_0084)

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1. Introduction

SketchBook is a simple and quick sketchbook-like 3D modeling interface with which designers can modify a 3D object by drawing a new silhouette line over the object’s silhouette. SketchBook provides two methods of modification that can be done in any viewpoint.

(1) Silhouette Modification: The first method is to sketch a new silhouette line over the object’s silhouette (The idea of drawing a new silhouette as an input for modification is analogous to that of Silhouette sketching in Nealen et al. [2005]). Once a designer draws the new silhouette line, SketchBook automatically determines which segment of the object’s silhouette should be modified by the new silhouette line and deforms the object according to the change in the silhouette. The overall process creates a smooth extrusion/inlet adhering to the new silhouette line on the object where the breadth of the extrusion/inlet can be adjusted by the designer.

(2) Virtual Modification: The second method is identical to the first method, except that instead of drawing over the object’s silhouette, the designer first draws a virtual silhouette line on the surface of the object and then draws a new silhouette line over that virtual silhouette line.

2. Method

Silhouette Modification (Fig. 1)

First, SketchBook extracts a silhouette of a 3D object in the current viewpoint and stores a set of vertices along the silhouette that are termed silhouette vertices. Once all silhouette vertices are determined, a Voronoi diagram of those silhouette vertices is computed in the 2D screen space. When a designer draws a new silhouette line, SketchBook determines which segment of the object’s silhouette should be modified by the new silhouette line by keeping track of Voronoi diagram cells through which the new silhouette line passes.

Once the new silhouette line is drawn and the modifying segment of the object’s silhouette is determined, both are parameterized with respect to t ranging from 0.0 to 1.0 in the 2D screen space. Silhouette vertices along the modifying silhouette segment are then mapped to their new positions along the new silhouette line according to their t values. Once mapping is done, the actual displacement of each silhouette vertex is calculated by unprojecting the mapping vector of the silhouette vertex to the 3D object space. As a result, each silhouette vertex moves parallel to the view plane, which makes the modification highly predictable and intuitive.

When a silhouette vertex is modified to its new position, its displacement is diffused to other vertices around it. The displacement diffused to each vertex v is calculated by g(d) times the original displacement, where g is a Gaussian function and d is the Euclidian distance between the diffusion origin (silhouette vertex) and v. Once this step is completed for all modifying silhouette vertices, the modification results in a smooth extrusion/inlet adhering to the new silhouette line. The breadth of the Gaussian function g determines the breadth of the resulting extrusion/inlet. The designer adjusts the Gaussian function breadth simply by dragging the mouse pointer up (which broadens the breadth) or down (which narrows the breadth).

Virtual Modification (Fig. 2)

First, a designer draws a straight virtual silhouette line on the object. When the designer draws the virtual silhouette line, it is drawn in the 2D screen space. SketchBook projects this line to the object surface by casting rays at pixels through which the line passes. The designer then rotates the object to a proper angle for the drawing of a new silhouette line over the virtual silhouette line and draws the new silhouette line. The rest of the modification process is identical to that of Silhouette Modification.

3. Conclusion & Future Work

Silhouette Modification allows a quick and intuitive modification of a 3D object, and Virtual Modification complements Silhouette Modification by allowing the modification of any non-silhouette part of the object from any viewpoint. Through the joint use of both Silhouette Modification and Virtual Modification, designers can perform quick, intuitive and also detailed modifications. However, occasionally an object does not have sufficient vertices in the modification area to perform a proper deformation, which can result in unintuitive modifications. One solution to this problem is to have SketchBook perform an automatic subdivision of the object.

References


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