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<th>Depth Representation Method by Color Tone for 3D Graphics Modeler</th>
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Abstract—3D computer graphics modeling software that is meant to be operated in a 2D environment comes equipped with a mouse and a 2D display; it is difficult to use these tools to edit 3D mesh objects. This paper proposes an interface for a 3D computer graphics object editing tool to facilitate editing of 3D mesh computer graphics. The interface is able to represent a sense of depth via a perspective view and the gradation of tone color on a 2D display.

Keywords-component; 3D CG modeling tool; color tone; a depth perception; monocular stereopsis

I. INTRODUCTION

The latest tools available for editing 3D mesh objects have complex interfaces that are capable of constructing orthographic views (front view, top view, side view) and perspective views. 3D computer graphics modeling software that is meant to be operated in a 2D environment comes equipped with a mouse and a 2D display; it is difficult to use these tools to edit 3D mesh objects. Editing a 3D mesh object is a complex process because it is difficult to locate the depth of a vertex in a 2D environment. However, the focus of research has not been on editing tools for 3D mesh objects as much as it has been one a geometric modeling[1][2]. Additionally, a vanishing line mesh has been to be effective for depth representation in 3D scene on a monocular computer display[3].

Depth sensation on a monocular computer display is constructed via certain depth cues[4][5]. These depth cues in human perception are as follows: 1) “Linear Perspective” which implies that parallel lines converge to a vanishing point. 2) “Relative Height and Size,” which is represented by changing the location of horizontal line and the object size depending on depth position. 3) The gradient of a color, which serves as a depth cue for humans.

In this paper, we propose a depth control plane in perspective view for virtual 3D environments, wherein a vanishing line mesh is used as the auxiliary depth coordinate. Further, a depth control plane is used to specify and move the depth position of vertices. Additionally, a sense of depth via color tone is applied to the 3D computer graphics modeling tool. This proposed depth control plane enables intuitive and efficient interaction in the manipulation of a 3D mesh object.
III. DEPTH CONTROL PLANE

Figure 2 provides an overview of the editing operation for changing the depth of a vertex. Figure 2(a) shows that the vertex is moved from its initial (depth) position to the next (depth) position in the cross-sectional plane by dragging the mouse. The cross-sectional plane is called the “depth control plane.” Next, by moving the cross-sectional plane back and forth, the user can move the vertex in the cross-sectional plane to adjust the depth position. This means that the depth of the vertex can be changed by varying the position of the cross-sectional plane. Figure 2(b) shows how the vertex can be moved in the cross-sectional plane by dragging the mouse. If a user drags the mouse over the vertex on the 2D display, the vertex of the 3DCG object is moved in the depth control plane.

IV. DEPTH REPRESENTATION BY COLOR TONE

A. A sense of depth via color

Humans are able to perceive a sense of depth through color. One such perception is a sense of depth via gradation of colors, and the other is a sense of depth using warm and cold colors.

Tone gradation is a gradation both in brightness and in saturation. Bright is luminance. Saturation is one of three coordinates in the HSV color space. Warmth color or coldness of color is responsible for the sensation of depth. Warm colors, based on red, orange, and yellow, are called “advancing colors.” Cold colors, based on violet-blue, blue and green-blue, are called “receding colors.”

The depth representation by warmth of color is difficult to control for many 3D computer graphics objects. However, gradation of colors can be controlled easily. Therefore, we use gradation to represent depth.

B. Representation method for a sense of depth

If there are a number of 3D computer graphics objects to edit, the order of the objects along the depth direction is represented by scaling among the objects, overlapping of the objects, and the degree of transparency. However, these methods of representing a sense of depth have significant effect losses, while the objects are created and edited. Thus, we add the gradation of color effect to the perspective view in the 2D display.

Figure 3 shows the test images used to evaluate the sense of depth. Figure 3(a) shows “type a,” in which three triangles are represented by a different gradation of brightness, depending on their order along the depth dimension. Figure 3(b) shows the same three objects represented by gradation of saturation. Figure 3(c) shows the same three objects represented by gradation of color tone, that is, changes in both brightness and saturation. Figure 3(d) shows the three objects without the use of gradation of color; therefore, they are drawn with the same brightness and saturation.
In this experiment, we evaluated the four types of gradation of color shown in Figure 3 so as to adopt the best depth sensation. The test subjects were ten young males. They ranked the four test pictures on a scale of 1 to 4 in the recognition term of order between three triangles.

Figure 4 shows the evaluation results. Type (c) had six first ranks, two second ranks and two third ranks. Type (a) had one first rank, eight second ranks, and one third rank. Type (b) had three first ranks and seven third ranks. Type (d) had ten forth ranks. Thus, type (c) was better adapted to the representation of depth.
V. CONCLUSIONS

We presented a modeling tool for displaying 3DCG using a cross-sectional plane with a vanishing line mesh coordinate. A depth sensation by gradation of color tone was applied to 3D objects. Our proposed tool provides a more intuitive scheme for the manipulation of the vertices of a 3DCG object. In the future, we will also investigate a more intuitive manipulation method and geometric modeling for vertex manipulation.

REFERENCES


