International Conference on Artificial Reality and Telexistence
Eurographics Symposium on Virtual Environments (2017)
T. Huang (Editor)

3D Model Deformation in VR Using CUBE

Seong-Jae Lim, Bon-Woo Hwang, Seung-Uk Yoon, Jin Sung Choi, and Chang-Joon Park[1]

[1]Electronics and Telecommunications Research Institute(ETRI), Korea

Abstract

We propose an easy and simple method that deforms a 3D model in VR. The proposed method easily manipulates 3D models which are difficult to handle in VR environment by using semantic shape deformation technique and NUI which is easy to operate with one hand.

CCS Concepts

•***Computer Graphics*** → *Graphics systems and interfaces;*

1. Introduction

In the VR environment, it is not easy to manipulate 3D models such as deformation or editing. In particular, it is very difficult to deform 3D models while ensuring 3D print-ability. This is because simply manipulating the mesh directly can cause problems such as mesh inversion and mesh overlapping, so on. Mesh integrity is very important for 3D printing. There are recently some 3D modeling tools for VR, but most of them are simple viewing or editing, and most of the work is done on PC.

In this paper, we propose a new and easy way to create a new 3D model by linear transformation of reference objects in VR. These generated 3D models are guaranteed to the mesh validation that can be directly 3D printed.

2. 3D Model Deformation

This method firstly creates reference objects with some predefined deformation properties, such as height, thickness, style, and so on. After setting the reference object, we can generate many new 3D models through a linear transformation within the shape of the reference object. Mesh integrity can be managed by limiting the outermost shape that these reference objects can deform.

2.1. Reference Objects Modeling

Figure 1 shows an initial reference object made up of three deformation properties (height, width, style). The designer models the initial reference object according to the deformation properties($2n+1$), and the extended reference object(n^3) is automatically generated by nonlinear transformation of the initial reference object. Here, n is the number of the deformation properties. The extended reference object is automatically generated within the deformation property space using a non-linear deformation method based on the gradient transformation [SZGP05]. The deformation property can be added depending on the feature of the object shape.

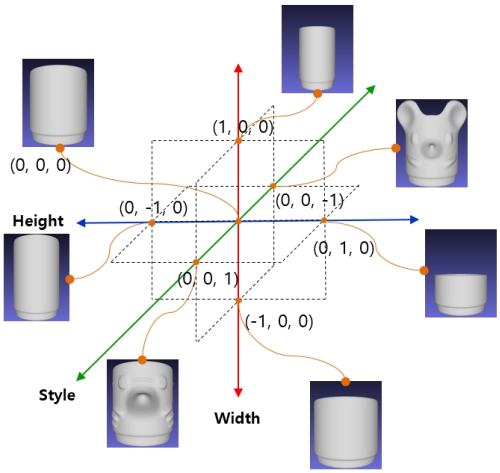

Figure 1: *Initial Reference Object Space.*

2.2. New 3D Model Generation

We can create a new 3D model in real time that guarantees mesh integrity through linear transformations according to the deformation properties in the property space of the reference object. Figure 2 shows an example of selecting three deformation property parameters in the reference object space. In Fig. 2, the blue dot represents the extended reference object, and the red dot represents the new 3D model at the position corresponding to the deformation properties value (height, width, style). Thus, a new 3D model is created by Quadratic programming by adjusting each deformation property

DOI: 10.2312/egve.20171379

parameter from −1 to 1. This is a technique suitable for environments where user manipulation is not easy, such as VR.

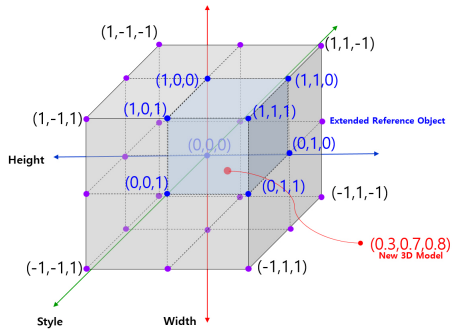

Figure 2: *New 3D Model Position in the Reference Object Space.*

2.3. 3D Model Deformation using NUI, CUBE

We also propose the interface for easy manipulation in VR. CUBE, an NUI, estimates the 3D position by using ultra-wideband(UWB) communication devices and measure the pose of the interface by using an inertia measurement unit(IMU). The position and pose of the CUBE can manipulate that we can pick 3D models and control the deforming parameters on VR devices (Figure 3). Button, position, pose signal of CUBE are mapped to 3D model selection, deformation property selection and deformation property parameter adjustment functions, and used for model editing.

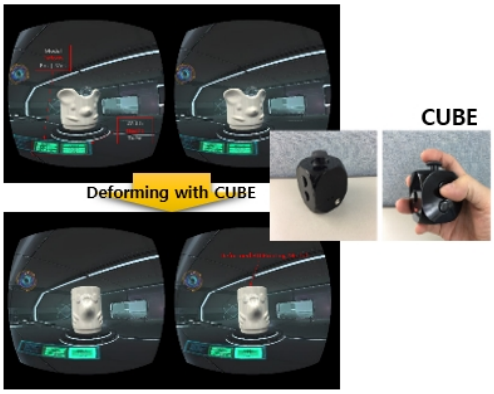

Figure 3: *Example of deforming with CUBE in VR.*

3. Experimental

We performed 3D model deformations on VR and mobile devices. Figure 4 shows a style deformation example (from squid to elephant) of a 3D keychain model performed on a mobile device. Figure 5 shows the result of printing 3D model deformed by our algorithm.

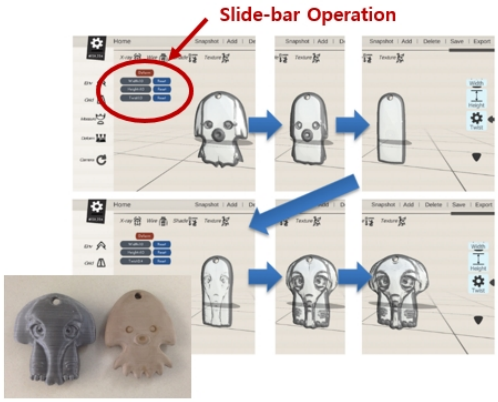

Figure 4: *Example of the style deformation in mobile device.*

Figure 5: *3D Printing Results deformed by our algorithm.*

4. Conclusions

We proposed a method to easily deform a 3D model using semantic shape deformation algorithm and NUI in VR. A user can deform the 3D model by adjusting the deformation property parameter with CUBE and the deformed model can be directly 3D printed with mesh validation.

5. Acknowledgement

This work was supported by Institute for Information & communications Technology Promotion(IITP) grant funded by the Korea government(MSIT) (2015-0-00290 (R0126-16-1025), Development of 3D printing content creation/authoring/printing technology and its applications in the mobile environment)

References

[SZGP05] SUMNER R. W., ZWICKER M., GOTSMAN C., POPOVIC J.: Mesh-based inverse kinematics. *ACM TOG 23*, 3 (July 2005), 488–495. doi:10.1145/1186822.1073218. 1