다양한 텍스쳐 표현을 통한 3D 프린팅 기술의 상용화

Personalizing 3D printing through rich Textures

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1. Abstract

With the proliferation of affordable 3D printing technology, we are entering a new era in manufacturing. Nowadays, consumers are able to fabricate plastic objects at home using digital 3D models. However, designing 3D products is not easy, and the current consumer 3D modeling softwares only allow for simple objects with limited expression.

In this project, we developed a novel design tool that helps people personalize 3D printed objects by the application of custom surface texture to arbitrary objects. We studied the possibilities of enhancing user experience with surface texture. We tested several materials and introduce a concept of a user interface.

2. Introduction

Figure 1. Personalized model by giving texture on surface

Nowadays, 3D printers are available to everybody for less than 1000$. 3D printers are getting more efficient, easier to use and affordable. The personal 3D printer is not a far future story anymore. As the personal computer and desktop printer made people publisher, 3D printers and 3D design software will make people manufacturers. An Economist article from April 2012 by Paul Markillie mentioned that 3D printing and associated technologies are part of the "The third industrial revolution" [Rifkin]. Unlike traditional technologies such as injection molding, with a 3D printer it is possible to make every print unique without a penalty. [Lipson & Kurman]

The challenge for personal 3D printers is how people could manage the 3D design tool easily.

Current tools for 3D modeling such as Auto CAD and Rhino are for professionals and are too difficult to use for anyone. Newly developed software for 3D print, such as Tinkercad might be able to break down this barrier. It provides more intuitive interface and much easier way to design the product. However, it still requires good spatial reasoning skills and engineering knowledge to design a 3D product.

In this paper we explore the scenario in which people download a design from the internet, personalize the product by their preference and taste, and manufacture the product at home. We focus on surface texture of product to make unique personalized models. Look and feel could be totally different by putting other kinds of texture, even the exactly same shape.

Our aim is to develop software that supports people to adjust and customize objects so that they feel more attachment to the fabrication of products as if they designed the product themselves.

3. Research Process

Our research process has 3 phases. First we made various textured models using displacement mapping tools. However, displacement mapping has limitation because it requires high density polygon meshes. To solve that problem, we synthesized textures on the 3D shape in the second phase to create an efficient polygon mesh and made several examples. Finally in the third phase, we developed a concept user interface.

3-1. Rhinoceros

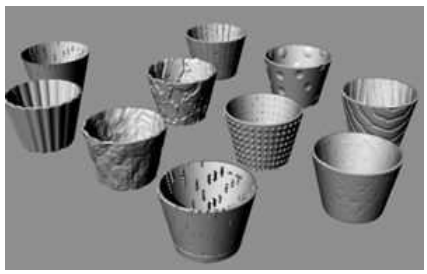


Figure 2. Cup modeling by using displacement mapping in rhino

With Rhino displacement map [3], user can apply various textures to a 3D model. People can make texture from bitmap images, such as woods, marble, stucco and granite. The brightness of image (grey scale value) is mapped to the relative depth of texture. Also user can make texture with geometric patterns. User can adjust the size and repetition, and depth of the texture with simple manipulation. Figure 1 shows 3D modeling cups in Rhinoceros, and then we printed them out with 3D printer as shown in Figure 2. After applying displacement map on surface, the textured mesh is created.

However, downside of the poly mesh is that it creates too many polygons and occupies too much memory.

3-2. Grasshopper Programming

Grasshopper is a visual programming language run within the Rhinoceros 3D Software [3]. Grasshopper's components create 3D geometry and also contain algorithms numeric, textual, audio-visual and haptic application. By using Grasshopper program we created the texture and map on surface in three ways.

Step1. Making volume from 2D image

First, we made 3D volumes from a 2D image using the relative brightness of the image. We draw a grid on the image. With Grasshopper we generate spheres on each grid point and we control the radius of each spheres based on the grey scale sampled from the image. Figure 3 shows the process of synthesizing volume from image.

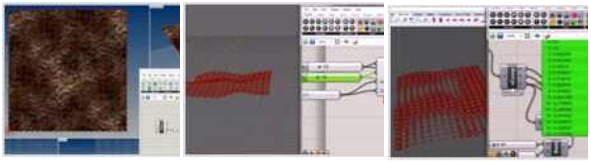


Figure 3 The process of making volume from image

Step2. Applying the texture to objects from textured plane

Second we applied texture to objects as small scale geometry as is often applied to facades in architecture. The Paneling tool component in Rhino is a parametric tool to create and manipulate rectangular grids, attractors and support creative mapping of parametric patterns. As shown in Figure 4, we made pipe texture on a plane by encoding in Grasshopper and then the object and texture encode are connected each other. In that way the object gets the texture.

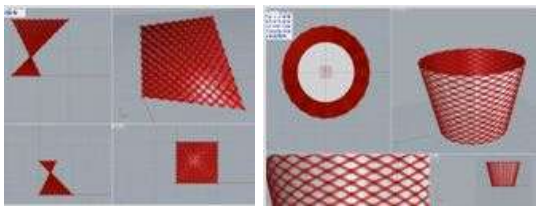


Figure 4 Applying texture on the object

Step3. Controling the texture of 3D object

Third, we control the texture of 3D object We added the bars which control the size and density of the texture. In Figure 5, we can confirm the density of sphere is changed. Moreover, u, v direction of pattern also can be controlled.

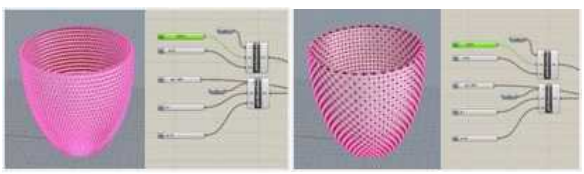


Figure 5 Control texture

3-3. Finalizing Concept

We developed interface concept which named 'Touch my skin'. With Touch my skin users can easily customize 3D prints with surface texture in a similar fashion as applying a color filter to a photograph in Instagram.

As shown in Figure 6, on the left side user can see the current state of the product and they can change the shape of object with a few control points. On the right side, user can choose the texture and control the shape of pattern. On the left side user can see the current state of the product and they can change the shape of object with a few control points. On the right side, user can choose the texture and control the shape of pattern.

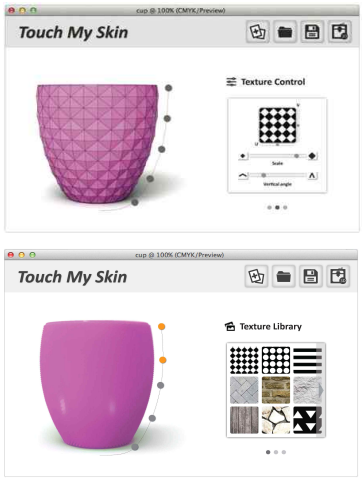
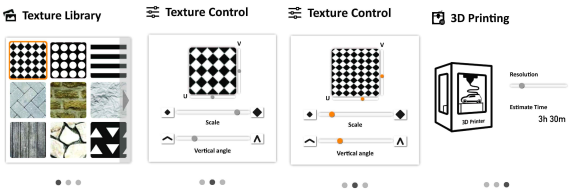


Figure 6. Final Concept



1. Choose texture from library
2. Control the texture
3. Print out the object

4. Conclusion

In the near future, design will be open to those who wish to create their own products. This project provides the platform which allows people to design their products at ease. By giving various texture to the products, user can personalize their design within a material.

Reference

- Lipson, H., Kurman, M., Fabricated. The new world of 3D printing. 2013, John Wiley & Sons.
- McNeel, Paneling tools in Grasshopper, Paneling tools in Rhinoceros, http://www.grasshopper3d.com/group/Panelingtools, http://v5.rhino3d.com/page/panelingtools
- Rifkin, J., The Third Industrial Revolution: How Lateral Power is Transforming Energy, the Economy, and the World. 2011, Palgrave Macmillan