Surface Simplification by Image Retargeting

Shu-Fan Wang Yi-Ling Chen Chen-Kuo Chiang Shang-Hong Lai*
National Tsing Hua University, Taiwan

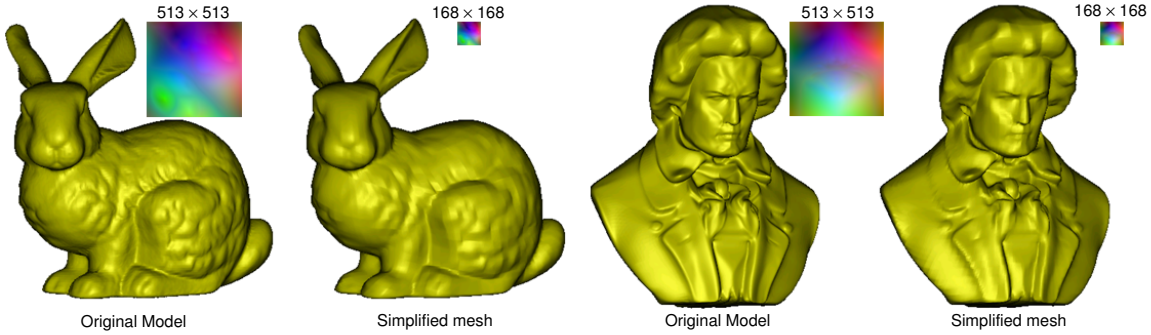

Figure 1: *The simplification results of the proposed method. The first and third columns are the original 3D models and the corresponding geometry images. The second and right-most columns show the simplified meshes.*

1 Introduction

Surface simplification aims to reduce the complexity of a 3D model while maintaining a good approximation to the original model. In this work, we propose a novel combination of geometry images and content-aware image resizing to achieve efficient surface simplification. There are two main advantages to simplify surface based on geometry images. First, it is relatively simple to simplify the surface in the parameterized 2D space because the features of a 3D surface can be easily represented by the gradient energy. Second, the regularity and features on 3D surface can also be preserved without additional effort. The proposed retargeting algorithm performs well both on real images and 3D surface simplification.

2 Surface Parameterization

There are several parameterization metrics based on the mesh geometry. Built from different metrics, a geometry image captures a 3D surface as a simple 2D array of $[x, y, z]$ values. Similarly, surface normals can also be stored as additional 2D images of n_x, n_y, n_z, sharing the same domain as the geometry. Thus, the geometry images denote two-dimensional arrays storing various surface attributes, such as 3D location, normal and color, regularly sampled in the parameter domain. The connectivity relationship is implicitly encoded since the sample points are continuously and regularly distributed over the surface. Since geometry images share the same domain and parameterization, it is suitable to apply signal or image processing for viewing or editing.

3 Optimized Image Resizing

Since a geometry image represents the 3D coordinates of a surface, its gradient simply denotes the density of the 3D vertices. On the other hand, a normal map provides the information of surface normals and the corresponding gradient represents the local variation of a surface. Therefore, with the combination of geometry image and normal map, the gradient energy represents the feature map of a 3D object. In our method, we modify the image retargeting algorithm proposed in [Wolf et al. 2007] and extend it to the surface simplification problem. The problem formulation is cast as solving a constrained sparse linear system. Similar to the content-aware image resizing, surface simplification is accomplished by resizing the geometry images in a way such that vertices around flat regions tend to be merged while vertices with high surface variations tend to be retained.

There are two main differences between the proposed image resizing algorithm and the original warping-based image retargeting by [Wolf et al. 2007]. First, instead of blending the pixels corresponding to the same converged grid pixel, we choose the pixel in the center of these pixel coordinates in the geometry image to avoid the surface shrinking effect due to the blending strategy. Second, we gradually resize the geometry image to the target size instead of using one-step retargeting. This reduces some noticeable visual artifacts, such as distortion of edges or lines in the geometry images, and it is helpful for structure preserving of a simplified 3D surface. In every interleaving step, we adaptively decide the image size of the next step based on the distribution of an energy map.

4 Results and Conclusions

Although the mesh simplification can be considered as a 3D version of the image retargeting, straightforward extension of the image retargeting techniques to mesh simplification may not work well. In this work, we conduct some experiments to evaluate this issue. Compared with other image retargeting methods, the proposed method provides more robust performance for surface simplification. Figure 1 depicts the simplification results of the proposed method. The proposed algorithm improves the original video retargeting technique [Wolf et al. 2007] to obtain resized images with better quality and less structure distortion. Our experimental results demonstrate the performance of the proposed method for 3D surface simplification.

References

WOLF, L., GUTTMANN, M., AND COHEN-OR, D. 2007. Non-homogeneous content-driven video-retargeting. *ICCV*.

*e-mail: {shufan,yilin,ckchiang,lai}@cs.nthu.edu.tw

SIGGRAPH Asia 2009, Yokohama, Japan, December 16–19, 2009.
ISBN 978-1-60558-858-2/09/0012