Modeling Go: A mobile sketch-based modeling system for extracting objects

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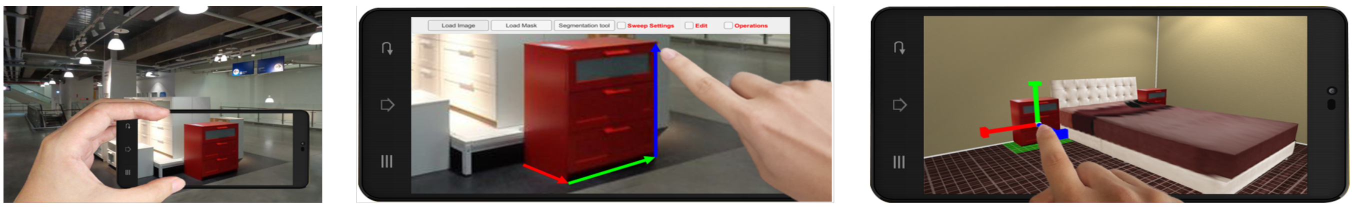

(a) (b) (c)

Figure 1: An use case of our application: when an user found an interesting furniture, they can (a) take a photo of it, (b) create a 3D digital copy with our mobile application, and (c) browse and edit this 3D copy in an interior design application.

ABSTRACT

This article presents an easy to use mobile application which allows users to create 3D digital copies of their interested objects anywhere and anytime. An advanced 3-sweep modeling technique is developed to construct 3D primitives not only from generalized cylinder and cuboid, but also objects with symmetrical or non-uniformly scaled profiles. In addition, our system supports the texture and structure refinement which combine results created from multiple source images. The constructed 3D model will be the combination of our 3D primitives. The combined result can preserve more features which may not be seen from a single photo.

CCS CONCEPTS

• **Computing methodologies** → *Mesh models*;

KEYWORDS

Interactive techniques, Sketch-based modeling, Mobile application

ACM Reference format:
Chun-An Lai and Pei-Ying Chiang. 2017. Modeling Go: A mobile sketch-based modeling system for extracting objects. In *Proceedings of Expressive '17, Los Angeles, CA, USA, July 29–30, 2017,* 2 pages.
https://doi.org/10.1145/3122791.3122797

1 INTRODUCTION

Our motivation is to develop a convenient modeling tool which allows users to create digital copies of their interested objects at anytime with their mobile devices. The created 3D object could be used for various multimedia application including 3D printing, interactive games or interior design (as an example shown in Fig.1). The commercial modeling software tends to have complicated tools which are difficult for casual users to learn and not suitable to run on mobile devices. Automatic 3D reconstruction techniques such as [Snavely et al. 2006] used multiple RGB images to reconstruct object automatically with the structure from motion technique. However, it required a great amount of data and high computational powers. [Fondevilla et al. 2017] proposed an interactive tool to model objects composed of developable parts. The sketch and annotate process of their system were complicated. [Chen et al. 2013] presented a novel sweep-based modeling approach that uses a single image as blueprint and models the object with simple gestures. However, it only supports creating models from generalized cylinders and generalized cuboids. Our system is developed based on the same concept. The differences is that our system supports more types of primitives including generalized cylinder, generalized cuboid, object with symmetrical profile and objects with non-uniformly scaled profile. We designed an easy-to-use user interface so that an casual user can create a model easily. In addition, our system also supports the structure and the texture refinements using multiple source images.

2 METHOD

To create a digital copy, the user first takes a photo of the preferred object and remove its background interactively using grab cut algorithm [Rother et al. 2004]. The system then automatically extracts the border of the shape with the topology analysis method [Suzuki et al. 1985]. Similar to [Shtof et al. 2013], our system decomposes object into simple parts. Our system performs the shape segmentation process using an iterative coarse fitting algorithm to provide suggestion to the user. The user can (optionally) follow the suggestions to model each segment of the object.

Expressive '17, July 29–30, 2017, Los Angeles, CA, USA

ACM ISBN 978-1-4503-5174-4/17/07.
https://doi.org/10.1145/3122791.3122797

The operation of creating generalized cuboid and cylinder use three strokes as [Chen et al. 2013]. As the example shown in Fig.1(b), the first two strokes define the profile and the third stroke defines the main axis. The operation of creating objects with symmetrical profile is using the first stroke as a cutting line to cut object and extract the half profile via interactive gesture. All vertices of this half profile will be projected onto 3D profile plane. A mirroring operation is then performed to restore the complete profile. In general, the number of profile vertices we produce will be massive. The Ramer-Douglas-Peucker algorithm[Ramer 1972] is applied to simplify the profile. On the other hand, the profile dissimilarity is considered so that the simplified profile won't lose too much details.

The operation of modeling non-uniformly scaled profile can be described as follows: the user first defines two profiles on each side of the object. As Fig.2 (a) shows, the object has a round profile on the top and a hexagon profile at the bottom. Second, the user draws the main axis to define the height (Fig.2 (b)). Our system will then produce interpolated profiles at each layer (Fig.2(c)). In order to make the created 3D mesh fits better to the border of the original object. We minimize the differences of the outer contours between the mesh and the original object with an iterative binary search technique (Fig.2 (d)). Finally, to color the created 3D copy, the texture of the input photo is projected onto both the front and back surface of the model.

Moreover, our system supports the structure and the texture refinement that combines results from multiple source images. Because in some cases, a digital copy cannot be constructed from a single photo. Some important features may be hidden from a single view. The first row in Fig.3 shows an example of the structure refinement; a temporary result was created with source image A that the bottom of the building was obscured. Thus, we use another source image B that shows the bottom part to create the other part of model. A complete model can be finished by combining two temporary results. The second row in Fig.3 shows an example of the texture refinement. We use source image A for texturing the front surface of the cube and use source image B to texture the back surface. An adaptive unwrapping method [Igarashi and Cosgrove 2001] which allows us to project multiple texture onto one model is adopted to achieve this texture refinement function.

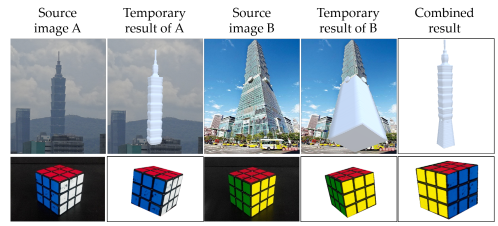

Figure 3: The examples of the structure refinement (first row) and the texture refinement (second row) processes.

3 RESULT AND CONCLUSION

Fig.4 shows some experimental results and the comparison between [Chen et al. 2013] and our work. The first row shows that our system is able to create generalized cylinder objects as [Chen et al. 2013]. The second and the third rows show that our system can create the object with symmetric profile (the bottom part of the candle holder) and the object with non-uniformly scaled profile (the container has a round top and a flat bottom) which [Chen et al. 2013] cannot.

In the future, we would like to support more types of object modeling and continuously improve the design of our user interface to provide better modeling experience on the mobile device.

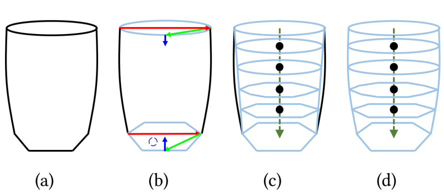

Figure 2: Object with non-uniformly scaled profile.

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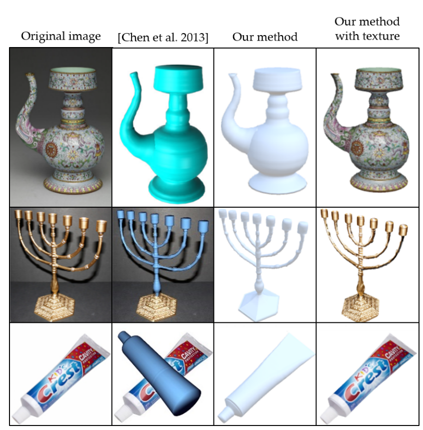

Figure 4: The Comparison of modeling results.