Animating Hand-drawn Sketches

Yutaka Ono*
The University of Tokyo

Bing-Yu Chen†
National Taiwan University

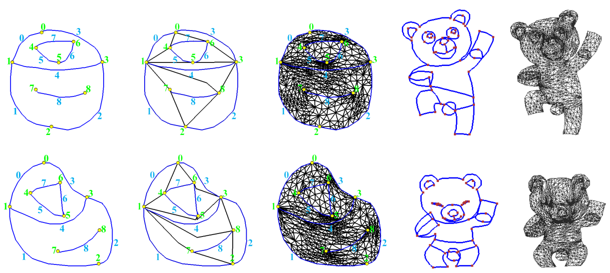
Tomoyuki Nishita*
The University of Tokyo

1 Introduction

We present a method for creating consistent 3D models from 2D vector drawings to add effects such as shading, shadowing, or texture mapping of characters on cel animations. We here say 3D models are consistent if they have one-to-one vertex correspondence and their 2D projections coincide with input drawings. To create such models, we first make consistent 2D triangles from the drawings and then apply an inflation method on them. Unlike the previous method by Petrović et. al. [2000], due to the consistency of the models, we can use this method for animatable-character modeling systems from sketches or for making inbetween frames that interpolate the key-frame drawings by using morphing techniques.

2 Creating Consistent 3D Models

Figure 1 (a) shows simple input drawings comprised of two frames. We assume that it is possible to establish vertex and path correspondence among all of the input drawings, which is specified by the user (green and blue numbers), and each input drawing does not self intersect and is topologically equivalent to others. To create consistent 2D triangles (Figure 1 (c)), the system finds pairs of vertices that can be connected by additional paths without intersecting existing paths, and inserts such paths from short-to-long to make each closed region of the drawings bounded by exactly three vertices and three paths (Figure 1 (b)). Then, the system triangulates each closed region by recursively subdividing it and smooths the generated triangles (Figure 1 (c)). Note that new paths must be inserted so that they do not violate the equivalence of topology among frames. To fulfill this requirement, we use trapezoidal maps of the drawings and derive paths from them.



(a) (b) (c) (d) (e)

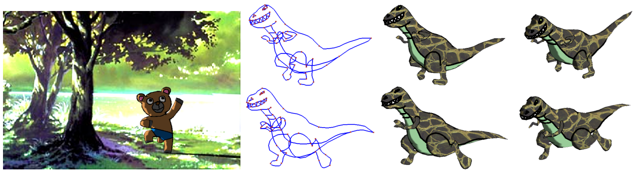
Figure 1: (a)∼(c) The process of making consistent 2D triangles. (d) Two input drawings of a dancing bear and (e) their output 3D models. Upper row is Frame 1; lower row is Frame 2.

After making consistent 2D triangles, the system inflates them to create consistent 3D models. If the number of the input frames is sufficiently large, we can apply a non-rigid shape reconstruction method. Otherwise, we apply a method by Igarashi et. al. [1999] and adjust the depth of each vertex by taking into account the coherence among frames. Figure 1 (e) shows an example of the output models. If the input drawings have self-occluding parts, e.g. the fore arms and the tail of the bear, the user separates drawings into some layers and annotates the joints among them. The system independently creates 3D models for all the layers and composites them by offsetting and shearing the depth so that they are connected at joints and do not intersect with others.

*e-mail: {yutaka-o, nis}@is.s.u-tokyo.ac.jp
†e-mail: robin@ntu.edu.tw

3 Results and Applications

The models of a dancing bear in Figure 1 (e) are created from six drawings as Figure 1 (d). Figure 2 (a) is a synthesized example using the created model with shadows and cartoon shading. It took about 30 minutes to make vector drawings and 10 minutes to specify the correspondence on six scanned hand-drawn images. However, we believe that the time for making vector drawings can be significantly reduced since animators are becoming to use vector drawing from the beginning in the process of making cel animations. The 3D models of a running dinosaur in Figures 2 (b)∼(d) are created from six images and viewed from a different viewpoint from the original one.



(a) (b) (c) (d)

Figure 2: (a) A synthesized scene using the bear model. (b) The input drwaings of a running dinosaur. (c) Output 3D models with a texture. (d) 3D models from another viewpoint.

By adding drawings from several viewpoints as an input, it is also possible to create view-dependent 3D models. Figure 3 shows an example. The upper row of this figure also shows the animation sequence generated with our method by using the input drawings shown in Figure 1 (d). We thus can help the animators to generate both of temporal and spatial (or viewpoint) intermediate shapes. However, due to the condition that input drawings have one-to-one correspondence, the range of view-angles tends to be small. To relax this condition is one of our future work.

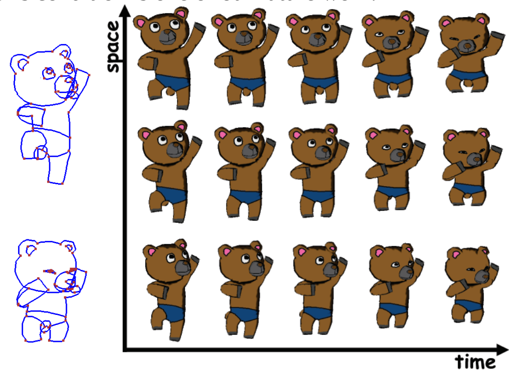


Figure 3: Left: additional input to Figure 1 (d). An animator drew those from a different viewpoint. Right: view-dependent morphing. 3D Models on four corners are corresponding to the input drwaings.

References

IGARASHI, T., MATSUOKA, S., AND TANAKA, H. 1999. Teddy: A sketching interface for 3d freeform design. In *Proceedings of SIGGRAPH 1999*, 409–416.

PETROVIĆ, L., FUJITO, B., WILLIAMS, L., AND FINKELSTEIN, A. 2000. Shadows for cel animation. In *Proceedings of SIGGRAPH 2000*, 511–516.