Shape Deformation Using Freeform Deformation Axis

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

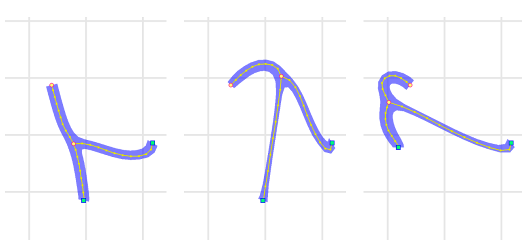
Figure 1: *An example deformation image of sprout using our freeform deformation axis (a) original image and a drawn freeform deformation axis (b) a generated mesh according to FDA's thickness value (c) setup of position constraints (d)-(f) shape deformation results*

1 Introduction

2D Shape deforming techniques has been presented for various applications recently. Particularly, gradient domain 2D deformation techniques shown promising result in the context of visually pleasing deformation and interactive performance.

However, since these approaches treat the whole shape as a simple flat shape without structural meaning, the semantic shape properties such as thickness or segment length are not taken into account.

In this work, we propose a 2D shape deformation algorithm that deforms shapes using thin, deformable freeform skeletal structure called freeform deformation axis (FDA). Our algorithm falls into same category with other approaches which are based on nonlinear least squares optimization[Weng et al. 2006] [Guo et al. 2008]. The key difference of our approach is that we do not directly manipulate the target shape, but first deform the freeform deformation axis and use it as main handle for the desired deformation. This concept separates the shape and the manipulation metaphor and enables user to manipulate various arbitrary shapes in as-rigid-as possible manner and to change the shape attributes intuitively.



(a) (b) (c)

Figure 2: *FDA's deformations showing area preservation.*

2 Our approach

The user first begin with drawing a FDA on a given bitmap image. Then the user draws contour line to assign the thickness value to the FDA. The system then calculates the appropriate thickness of both side of the FDA and updates the thickness value to the result. Thus, the user determines internal structure of deformable shape for representing desired deformation at this initial stage.

To calculate the thickness value from the contour line, we first test the intersection of each edges normal vector of FDA with contour line. Next, the norm of the vector, which is from the intersection point to the edges center point, is assigned as the thickness value of one side of the FDA. The opposite side's thickness value can also be calculated in the same way. Lastly, our system generate the mesh structure based on the user designated FDA.

Our algorithm preserves two shape constraints during shape deformation: line segment lengths and laplacian coordinates, which are represented in a non-quadratic energy function. An iterative Gauss-Newton method is used to minimize this non-linear energy function. Our algorithm also support efficient area preservation based on the length of the FDA's segment as shown in Figure 2.

Our approach enables the user to easily determine the internal deformable structure and to change shape's attribute dynamically. Also, our approach shows promising deformation result and performance.

References

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