Darwin's Lake : Sketch-Based Creature Creation System Enables Users to Collaborate with Contents Designers.

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1   Introduction

In this study, we propose a novel system to create vivid animated 3d creature model from user's freeform 2d stroke. The most famous technique that construct 3d model from user's 2d sketch is Teddy system[Igarashi et al. 1999]. Past teddy like system create 3D mesh from user sketched 2d-shape, only what is needed is the stroke. These approaches allow a lot of freedom of creativity to us. However, there are also the cases we need to build the identification or determine the character of contents such like most games. In these cases, although it proper to design or control the contents in advance by the developers, the past methods are too much freely to control their contents. To address this, our approach enables end-users to collaborate with product developer's design without decreasing the freedom of creativity. It creates 3d animated creature from the combination of user's freeform stroke and the primitive models that are created by contents' designer beforehand. The generated creature depend on the user's inspiration, so obtained variations are infinte, but don't lack of the identification of the contents which is designed by the creators. Furthermore, our approach makes us to animate the generated model as if it is alive much easier than past methods.

2   Model Construction

Our algorithm creates a new creature-like 3d model from the combination of the user sketched stroke and model parts(means primitives, which represent heads, bodies, tails, fins...etc) which is created by designers in advance. We first create a closed planar polygon by connecting the start-point and end-point of user defined stroke(Figure.1-a), and extract the spine and control skeletons from the polygon. These control skeletons are used for animation. Next, we construct box-shaped model deformation spaces from the skeletons. Finally, we apply preconstructed model parts, which are created by designers of the contents, into the model deformation space by performing Free Form Deformation(FFD).

When user's 2d stroke is given, the system then performs constrained Delaulay triangulation of the polygon(Figure.1-b). The edges of user defined initial polygon are called *external edges*, while edges added in the triangulation are called *internal edges*. We then divide the triangles into three categories: triangle with two external edges (terminal triangle), triangle with one external edge (sleeve triangle), and triangles without external edges (junction triangle). This prodecure is same as teddy system. In the case of terminal triangles and sleeve triangles, we define *rib lines*(red lines in Figure.1-c) which is obtained by connecting the midpoint of external edge and the vertex with opposite side of each triangle. The midpoint of rib lines becomes the *control skeletons*(Figure.1-d). In the case of junction triangles, control skeletons are defined as the midpoints of each line segment of the triangle and the gravity point. By connecting the adjacent control skeletons, the spine of the polygon is obtained. Next, we elevate rib lines propotional to their length, and construct 3d-trapezoids that is called *Control Plane* as surrounding the control skeletons(Figure.2). These control planes are related to each control skeleton, and move accorrding to the skeletons. Finally, we connect each vertices of adjacent control planes, and construct box-shaped model deformation space(Figure.2). The spaces are divided into three categories:terminal space which correspond to head or tail of creature, sleeve space which correspond to body, junction space which is constructed from junction triangle. We adjust model parts(The designer created primitives), and fit into each space using Free Form Deformation technique(Figure.1-f).

3   Animation

To animate the created creature, we move the positions of control skeletons. Accompany with the motions of skeletons, the plane
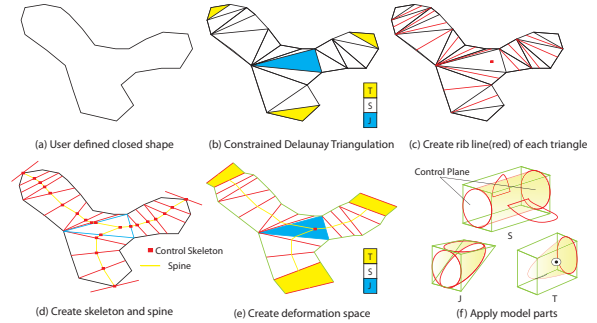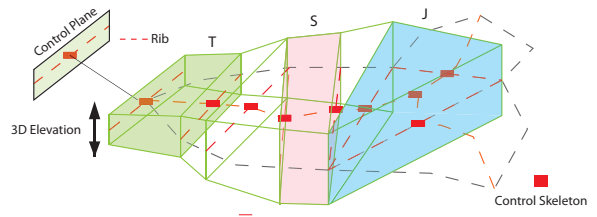

Fig.1 Construction of 3D creature.

Fig.2 Three kinds of Model Deformation Space

related to the skeleton move and rotate, and model deformation spaces are deformed. Using these spaces, we can animate the model parts by performing FFD again. Each position of skeletons P^k are updated by blending rigid body motion and physical motion.

$$P^k = bR^{k-1}P_{rel}^k + (1-b)S(P^k) \qquad (1)$$

where P_{rel}^k denotes the relative position with the parent skeleton at the initial state. The first term of right hand side of Eq.(1) represents rigid body motion, and the second term represents physical motion obtained by calcurating the forces $S(P^k)$ genatrated by simulating the creature's tissue. For physical forces, we know the third order nonlinear spring and damper system is well performed experimentaly. The Parameter b denotes the blending weight which also represents the rigidity of the creature's tissue, and R^{k-1} is the rotation matrix of the parent skeleton. Additionally, if the model parts have an animation data, we can apply both motion obtained by Eq.(1) and the animation data by blending the positions of the vertices.

4   Results and Conclusion

Fig.3 Vivid animated creatures.

Our prototype system "Darwin's Lake" explore infinte variation of 3d creature from user's sketch, but don't lack of the identification as a content at all. What users should do is drawing a 2d closed shape, and selecting a model parts, and then 3d creature is genareted easily. The genarated creatures can be animated as if it is alive in this system. Additionally our algorithm can animate more than 500 creatures in real time using low spec PC using CPU only.

References

Takeo Igarashi, Satoshi Matsuoka, and Hidehiko Tanaka. 1999. *Teddy: A Sketching Interface for 3D Freeform Design, ACM SIGGRAPH,1999.*