DreamWorks Animation's Face System, a Historical Perspective: From *ANTZ* and *Shrek* to *Mr Peabody & Sherman*

Lucia Modesto
DreamWorks Animation
.Lucia.Modesto@dreamworks.com

Dick Walsh
DreamWorks Animation
Dick.Walsh@dreamworks.com

Figure 1. *From ANTZ (1998) to Mr Peabody & Sherman (2014)*

1. Abstract

We present an overview of the Academy Award winning Facial Animation System utilized by DreamWorks animation in most of its movies since 1997from *Antz* and *Shrek* to *Mr Peabody & Sherman*. The presentation will cover the concept utilized and its application in the creation of the system. As the requirements and challenges of each new movie change constantly, the necessary evolution and adaptation of the system will also be discussed.

2. Concept

A thorough analysis of face anatomy – bone structure, skeletal and superficial muscles motion, sparked the initial idea for the structure used in the face. The system also relies on the knowledge of which muscles are triggered for each facial expression. The idea was to create an anatomically based Elastic Network that would be a good representation of the facial muscles.

We reproduce the anatomical facial bone and skeletal muscles structure with joints. The facial superficial muscles network are represented by an **ENET** (Elastic Network) organized in a similar topology to the anatomical superficial muscles. Each Elastic Link has a default tension in its reference state. Programmed link tensions simulate muscle contraction.

A facial ENET is composed of Elastic Links that reproduce each muscle segment, Fixed Points that represent the muscles attachment point to the bone, Floating Points represent a muscle attachment point to other muscles and Anchors are off-surface fixed points, used to maintain the relaxed ENET's volume. The ENET is relaxed through iterative simulation of all point positions. As one point is moved, the points around it are re-positioned to keep the elastic links at rest. As these neighboring points are moved, their surrounding points are then moved to achieve a new rest state. Usually 20 to 40 iterations are sufficient to achieve a stable result.

3. Face Layers

In order to propagate the muscle motion achieved by the ENET to the final model, a set of intermediate layers were used. Polygons were attached to the ENET points. This faceted surface is called a Mask. A second layer of various Smooth surfaces are attached to the Mask. This Smooth layer on top of the Mask, reproduces the behavior of the face fat layer. A continuous smooth Skin is then driven by the smaller smooth surfaces. Finally the character facial geometry is attached to this Skin layer.

4. Face Programming

Most human faces use the same muscle groups to achieve a facial expression. So a smile control can be programmed by setting tensions on the Elastic Links that correspond to the muscles that triggers a smile. The animation controls are programmed by setting the joints rotation and translation values (bone motion) and the Elastic Links tensions (muscle contractions), As the animators select a combination of pre-programmed expressions, the system calculates the final tension of each link by mixing all its tensions on active controls. Once the tension of each link is calculated the ENET is relaxed, achieving its final shape.

5. Evolution

The facial system evolved, triggered by work flow improvements, new available technology and new animation or character design requirements. The ENET (Elastic Network) was substituted by EMESH (Elastic Mesh), thus reducing the complexity of the Face Layers. The EMESH is a subdivision surface, whose hull is relaxed as an Elastic Network. The final model is directly attached to it, allowing us to remove some layers. As each new movie brought us new design styles with their own challenges and requirements, the system was further changed and improved.

6. Conclusions

The facial animation results are very believable, as the EMESH relaxations create a natural propagation of the motion of facial features. Even a small localized motion triggers a series of muscles, creating subtle skin motion. Disconnected blocks of motion are thus avoided. This system allows very broad cartoony expressions while maintaining a natural muscle behavior. As it is a programmable system, muscles extreme poses can be pushed as far as directed by animation.