A Deformer-Based Approach to Facial Rigging

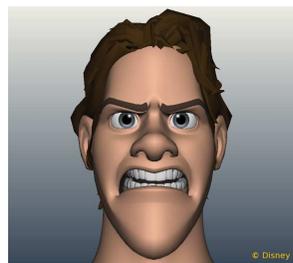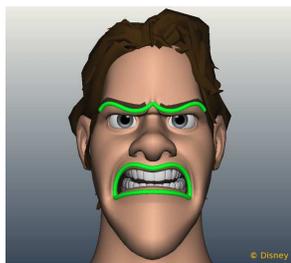John Kahwaty   Gene S. Lee   Greg Smith   Andy Lin   Matt Schiller
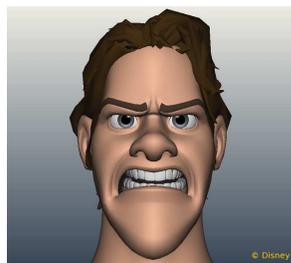Walt Disney Animation Studios *†
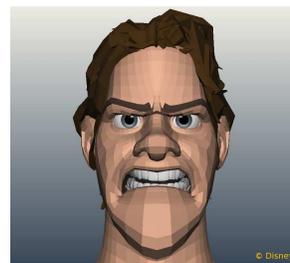
(a) *Hi-Res Rig without PSD*   (b) *Wires w/PSD on Hi-Res Rig*   (c) *Hi-Res Rig with PSD*   (d) *Lo-Res Rig with PSD*

Figure 1: *Breakdown of Deformer-Based Facial Rig*

1 Introduction

Facial rigging is the process of adding controls to a face for animating facial expressions. These controls are commonly bound to either deformers or blendshapes, both of which modify the face's shape, scale, or orientation. Facial rigs created with complex deformers are intuitive, yet commonly slow and less tunable. Facial rigs created with blendshapes are fast, yet memory intensive and sensitive to model changes.

This paper introduces a rapid, deformer-based approach to facial rigging using only skin clusters, (in-house) wire deformers, and pose space deformation (PSD) [Lewis et al. 2000]. The resultant rigs are fast, art-directable, and quick to build. Wire deformers adjust the face by deforming the local space around a few (nurbs) curves. These curves act like the armatures used by sculptors. PSD is a technique for scattered data interpolation that is useful in manipulating both geometry and numerics. Geometry is deformed by interpolating between sculpted target shapes. In the context of this work, PSD directly modifies both the geometry of the face and the curves of the wire deformers. This deformer-based approach was used to rig the characters of the features *Wreck-It Ralph* and *Frozen*.

2 Two Layered Facial Rig

Our deformer-based approach consists of two highly correlated layers, *hi-res* and *lo-res*. Figure 2 illustrates these layers, with geometry dataflow shown in red and control inputs in blue. The two layers are similar in function, yet different in speed and resolution. Lo-res is derived directly from hi-res and shares the same controls.

The hi-res layer creates a detailed facial expression with wire deformers and PSD deformations. For example, Figure 1(c) was created by applying both wires and PSD to Figure 1(a). The wires use curves (Figure 1(b)) to define the contours of the face. The wires are influenced by PSD twice. Once to precisely sculpt the shape of the curves, thereby increasing their deforming potential, and a second time to add fine level details to the face. It is impossible to obtain this level of detail with wires alone. The lo-res layer (Figure 1(d)) is a simpler representation of the face with only PSD deformations. The targets for these PSD deformations are obtained by baking the outputs of the hi-res layer and decimating the results.

There are three primary benefits of this approach. First, it readily supports art-direction. Modifications to the face are created progressively, from large to small scale. Fundamental changes, such
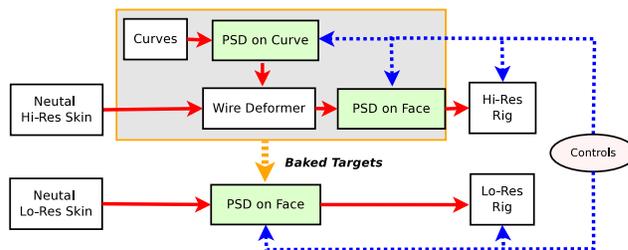

Figure 2: *Architecture of Art-Directed Facial Rig*

as the opening of the mouth, are created by setting the location, scale, and orientation of the curves. Intermediate tweaks, such as the creasing of the lips, are created with PSD modifications on the curves. Fine details, such as the wrinkles on the lips, are created with PSD modifications on the wires. Second, the approach creates two layers with tight correspondence. The lo-res layer visually matches the hi-res, and is manipulated by the same controls. Third, the approach supports clean interpolation of PSD targets. PSD modifications are distributed across both curves and wires. This results in fewer targets, with each defining only moderate adjustments. Interpolation with PSD is less desirable when there are many targets and when the magnitude of any target is large.

3 Production Results

The features *Wreck-It Ralph* and *Frozen* successfully applied this approach to create art-directable facial rigs. Artistic updates commonly involved changing facial contours and ensuring the aesthetics of profile views. Construction of a fully-operational hi-res layer commonly took two weeks, involving continual interaction between animators and riggers. The lo-res counterpart was quickly constructed from the hi-res layer in less than a day. The biggest gain to production was speed and the high fidelity between the lo-res and hi-res layers. The lo-res layer used 50% fewer polygons, ran 10x faster than the hi-res, and was still aesthetically pleasing. The next big gain was the establishment of a systematic approach to rig building, such that there was significant reuse between layers. The lo-res was primarily used for blocking and quick setup while the hi-res layer for final animation. However, when characters were placed far from view, it was acceptable to animate and render the lo-res layer only.

References

LEWIS, J. P., CORDNER, M., AND FONG, N. 2000. Pose space deformation: A unified approach to shape interpolation and skeleton-driven deformation. In *Proc. of SIGGRAPH*, ACM Press, New York, NY, USA, 165–172.

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