Shape Analysis Driven Surface Correction

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Figure 1: *Old man character in* The Little Prince*, visualization of surface correction displacement.*

Abstract

In this paper, we describe a technique called Shape Analysis Driven Surface Correction that introduces a new generalized way of storing and restituting surface corrections and automate their blending by using live surface shape analysis combined with Radial Basis Function (RBF) based interpolators .

1 Introduction

Animation of creature skin deformation is the most common and important application of free form deformation in computer graphics. Pose Space Deformation systems improve final deformations on mesh envelopes using interpolated blendshapes driven by input measurement used to compute the suitable blend factor. Weighting and balancing of these blend factors is commonly solved by scattered data interpolation algorithms.

These systems commonly require a heavy setup, need artist unfriendly parametrization and expensive creation of several intermediate sculpted shapes.

We present a generalized and efficient surface correction system that improves the final quality of animated meshes, increases artist productivity, and avoids most pitfalls of the aforementioned techniques.

The main concepts used in our technology are :

- Surface corrections driven by live surface shape analysis combined with RBF interpolators
- Robust vertices 3D displacements computation and restitution using multiple laplacian smoothed local surface spaces

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2 Live surface shape analysis combined with RBF interpolation

Our system drives shape corrections using the animated shape itself.

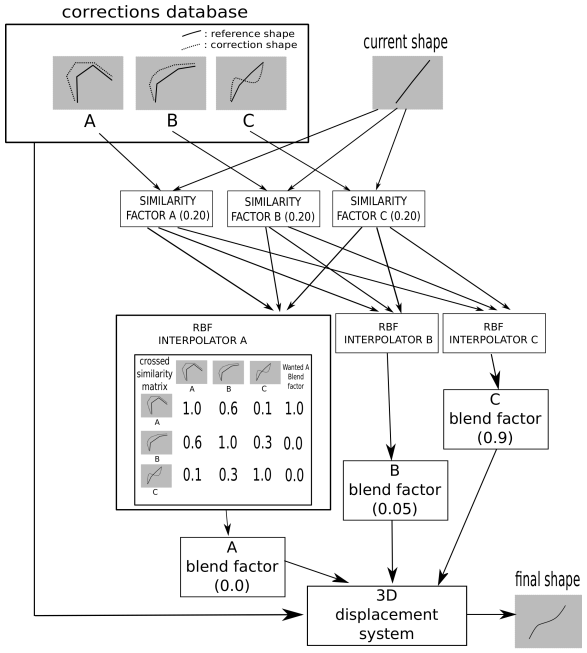

Figure 2: *Shape Analysis Driven Surface Correction system*

We developped a surface shape comparison algorithm to compute the differential factor between a reference shape (the state of the surface without correction for which we have an edited correction registered) and the current state of this surface in a random animation pose.

When a shape is deformed during the animation, our system evaluates its *similarity factor* with each reference shape in the correction database.

The similarity factor is a *translation and rotation invariant point cloud comparison* using both distance and angular metrics.

As our surface correction system relies on additive 3D displacements, the similarity factor cannot be directly used to weight the corrections, thus for each shape correction these similarity factors are used as inputs of a RBF interpolation solver.

The parametrization of each RBF interpolator uses the two by two cross similarity factor between the reference shapes of each correction.

3 Vertex 3D displacement in multiple smoothed local surface spaces

Considering a vertex V from an original surface, and V' the corresponding one after an artist correction, we compute a delta in worldspace. For each vertex Vi connected to a vertex V by the edge umbrella, we compute a set of matrices Mi using the smoothed normal of V and the edge vector Vi-V. The smoothed normal of the vertex V is computed as usual, but after a global iterative laplacian smoothing of the deformed mesh. World space delta of V is then transformed and stored for each connected tangent matrix Mi. This set of deltas Di is called the local 3D displacement of the vertex V.

$$\vec{D_i} = (\vec{V'} - \vec{V}) * M_i^{-1} \tag{1}$$

Restitution of one vertex correction is achieved by the following equations :

$$\vec{R} = \sum_{i=0}^{n} (\vec{D_i} * M_i * \frac{1}{n}) \tag{2}$$

$$\vec{V} = \vec{V} + \frac{\vec{R}}{\left\|\vec{R}\right\|} * \left\|\vec{D_0}\right\| \tag{3}$$

Using multiple 3D displacements per vertex avoids the arbitrary choice of a surface tangent space orientation, and production usage proved that it gives better and more reliable results for the restitution of correction's deltas, even with heavily deformed or noisy meshes.

4 Results

Our tool has been used in two animated features *The Little Prince* and *Mune : The Guardian of the Moon*. It offered an efficient and quick process to achieve shape driven surface correction for body and facial rigs with minimal setup. This system was additionnaly used by the FX department for fast and efficient post cloth simulation shape corrections.

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