Offset Curve Deformation from Skeletal nimation

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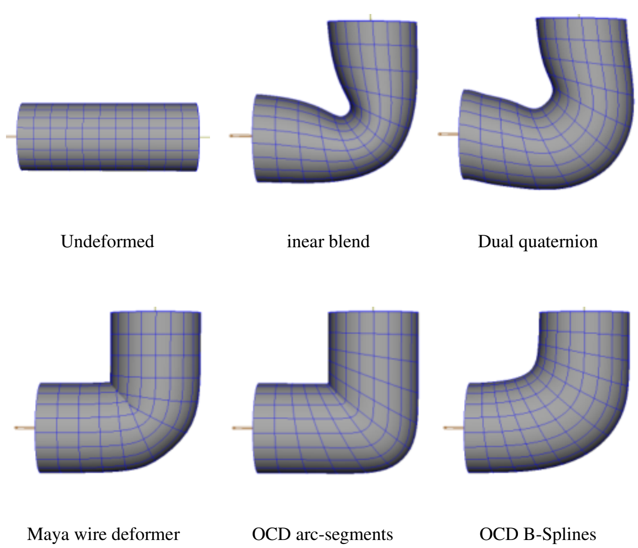
1 Introduction

Skin deformation based on an underlying skeleton is a critical part of the modern animation pipeline. inear blend skinning is fast but suffers volume loss at a bend and "candy wrapper" pinching under twist. More complex methods using dual quaternions [Kavan et al. 2007] and bind-point offset from intermediate curves [Singh and Fiume 1998] are nearly as fast and reduce these artifacts, but dual quaternions are limited only to rigid transformations and bind-point techniques continue to suffer from offset distortion, which increases with distance from the bind point, causing uneven stretching and self-intersection on the inside of a bend when offsets exceed the radius of curvature.

Our OCD algorithm attempts to avoid this trade-off of cost and quality by abandoning bind-point techniques in favor of offset curves. In our method, each surface point gets its own separate offset curve that intersects the surface at that point. With this technique, we get the low cost of a bind point technique by using arc-segments (elbow, knuckles) or B-splines (shoulder, chest, neck), both of which are fast to evaluate. Examples of both are presented and compared below. A complete discussion can be found in our technical report [Gregory and Weston 2008].



2 Basic pproach

At bind time, we record the bind parameter (the fractional arc-length of the bind point along the influence curve) and offset needed to reproduce the bind position. This happens by design (for arc-segments) and by search (for B-splines).

The arc-segment method creates curves by offsetting segment pairs parallel to the animation skeleton, then connecting them by tracing out ellipses in the halfplane of the common influence joint. There is exactly one smallest circular arc connecting these coplanar offset segments for which the offset curve is everywhere G1-continuous. The arc-length is known in closed form and evaluated at the point of fractional arc-length given by the bind parameter.

The spline method uses a cubic B-spline (with nonuniformly-spaced knots) because of its inherent smoothness and local control (any given point on a cubic B-spline being linear in and fully defined by its two nearest control points on either side). We simply offset each spline control point by the same constant vector from its corresponding influence control point position in the latter's own local space. The artist is free to displace the offset curve along and normal to its local twist axis, as well as parametric rescaling and sliding.

At deform time, the surface vertex is evaluated on the offset curve at the bind parameter. There may be multiple influence curves, in which case the surface point deformation is calculated independently for each influence curve, then linearly blended using artist supplied weights. Initial default weights are computed automatically based on distance.

3 Discussion

We prefer the B-spline offset model over the arc-segment offset model. It is more general, intuitive, and amenable to artist control. Although it may require more tweaking of parameters to get the same look as the arc-segment model out of the box on knuckle and elbow bends, we are investigating better methods for supplying default parameter settings.

When exact control over the look of a given pose is needed (more typically in VFX than feature animation), the OCD base deformation technique works well with secondary pose-space deformation.

References

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