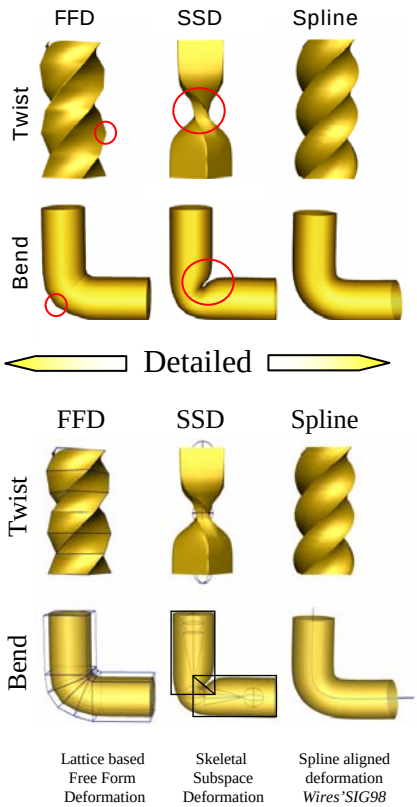
Fast Skeletal Animation by skinned Arc-Spline based Deformation

Sven Forstmann and Jun Ohya

Deformation Types



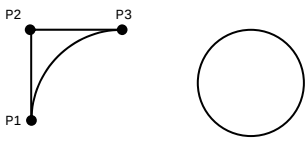
Lattice based Free Form Deformation

Skeletal Subspace Deformation

Spline aligned deformation *Wires'SIG98*

Spline Functions

Arc-Spline



- Seamless round
- Fast to evaluate
- Numerically stable

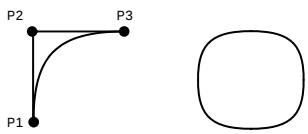
$\forall x \in [0..\pi/2]$

$f_a(x) = P1 + \overline{P1P2} \cdot \mathrm{Sin}(x) + \overline{P2P3} \cdot (1 - \mathrm{Cos}(x))$

$f_a'(x) = \overline{P1P2} \cdot \mathrm{Cos}(x) + \overline{P2P3} \cdot \mathrm{Sin}(x)$

10 arithmetic operations total

Bézier-Spline



- Not seamless round shaped
- Slow evaluation

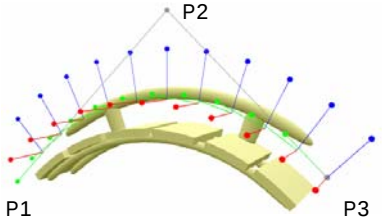
$\forall x \in [0..1]$

$f_b(x) = P1 \cdot (1-x)^2 + P2 \cdot 2 \cdot x \cdot (1-x) + P3 \cdot x^2$

$f_b'(x) = P1 \cdot 2 \cdot (x-1) + P2 \cdot 2 \cdot (1-2 \cdot x) + P3 \cdot 2 \cdot x$

19 arithmetic operations total

Coordinate System



The TNB Frenet Frame

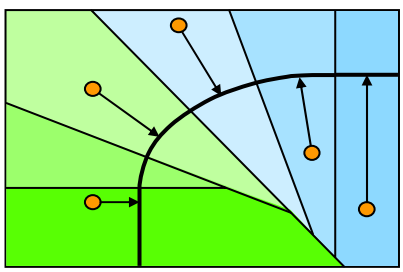
Origin : $b_O(x) = f_a(x)$

Tangent : $b_T(x) = f_a'(x)$

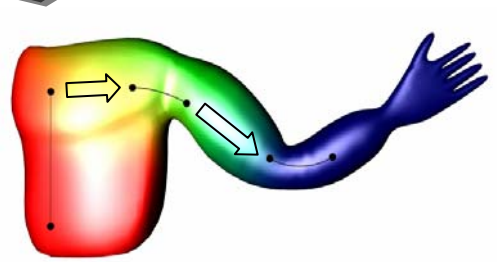
Normal : $b_N = P1P2 \times P2P3$

Binormal : $b_B(x) = b_T(x) \times b_N$

Spline Binding



Weighted Spline Mixing



Rigid "ghost" skeleton

Body spline S_1

Arm spline S_2

Elbow spline S_3

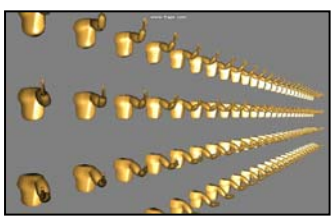
$$1 = \sum_{i=1}^{3} w_i$$

$$v = \sum_{i=1}^{3} S_i \cdot w_i$$

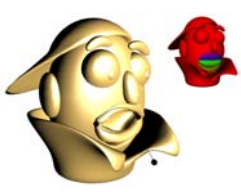
Results from Real-Time Spline Deformation

Twisted elbow without collapse

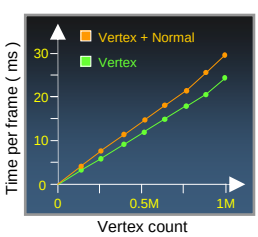
Only one spline required as spine



400k polygons (unoptimized) deformed at more than 30 fps !



Facial animation



1M Vertices @ 43 fps
=
1000 Characters with 1000 Vertices each animated at 43 fps !

Hardware:
Pentium IV 3.2 Ghz
Nvidia GeForce 7800 GTX

WASEDA University
3D Inc.
Svenforstmann @ yahoo.co.jp
Ohya @ waseda.jp