Muscle and Flesh Simulation Tool

Design and implementation of an innovative and affordable muscle and flesh simulation method using shape deltas for History Channel series, Jurassic Fight Club (2008).

As artists strive to increase the realism of computer-generated characters, the techniques pursued by creature developers are becoming both increasingly complex and time-consuming for the artist to set-up and to simulate. Perceiving the underlying muscle and flesh movement is an important part of selling the believability of a creature to an ever more sophisticated audience. How do makers of episodic television studios compete with much smaller budgets and less time when broadcasters and audiences demand film quality? Jurassic Fight Club (2008) provided the context to experiment with film based creature research on the not-so-small screen.
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Portfolio Contents List

<table>
<thead>
<tr>
<th>Supporting Portfolio Contents</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location / Dissemination</td>
<td>2</td>
</tr>
<tr>
<td>Research Imperative</td>
<td>3</td>
</tr>
<tr>
<td>Research Process</td>
<td>4</td>
</tr>
<tr>
<td>Research Outcome</td>
<td>5</td>
</tr>
</tbody>
</table>

Greg Maguire

Output Number: 3 of 4

REF2014
Research Excellence Framework
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Location / Dissemination

Jurassic Fight Club is a paleontology-based television series on The History Channel which premiered in the USA and UK in 2008. Jurassic Fight Club was hosted by paleontologist George Blasing. The show ran for one season of 12 episodes. Each episode features a forensic-styled breakdown of a prehistoric battle. Based on fossil evidence and paleontologist analysis, a CGI rendering of the battle is reenacted.
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Research Imperative

The problem for 1080 Productions while completing Jurassic Fight Club was to deliver a realistic looking dinosaurs on a limited budget. With today’s sophisticated audiences, film-quality effects set a high bar for episodic television shows. I was invited to develop a solution with an off-the-shelf 3D authoring digital content creation tool, Autodesk Softimage XSI.

The main issue was to design a solution that could deliver over five hours of flesh and muscle simulations for the History Channel series. Current techniques range from implementing a multidimensional-spring driven tetrahedral mesh or a muscle system over an entire creature. However, both approaches are solely the domain of a facility with a dedicated R&D department developing proprietary software.

The dinosaurs in Jurassic Park (Universal, 1993) were created in an earlier version of Softimage 3D. The movement of the muscle mass contributes greatly to the believability of the creatures. In 1993, CPU and graphics power were underpowered to enable any research into muscle systems. However, the skin deformations on the Velociraptor and the Brachiosaurus can be seen clearly. During an interview with Dennis Muran, the visual effects supervisor on Jurassic Park, he told me that the muscles were a series of extra bones parented to the dinosaurs skeleton with an isolated fall-off around the muscle area. They were then animated by hand after the main body animation was completed. This was a very effective and simple solution but it was also very time consuming and beyond the animation budget of Jurassic Fight Club.
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Research Process

As keyframe animation on the muscles was going to be time consuming, I had to find a solution that could be simulated in software without involving any man hours.

I explored several simulation methods built into the clients software system. All produced an appropriate dynamic spring behavior but all failed to preserve the volume of the creature. How could I harness the physics based system within the software to drive an isolated part of the skin geometry to mimic a muscle deforming?

I designed a solution based upon my earlier research developing a shape based Facial Action Coding System[FACS, Ekmann 1977] for a high-level animation interface for facial expressions. I had successfully used a technique to deform geometry with a two-dimensional controller.

Starting with the original shape, I created four targets objects each with an individual slider driving their percentage weight. Using a linear expression I connected the sliders to the transforms of a nurb circle. At rest position (0,0) the sliders had no effect. Moving the centre circle along the x and y axis drove the shape targets morphing the original shape between them all smoothly.
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A muscle when put under force, such as a foot stomp, will oscillate in all 3-axis. Adding a third axis to the widget enabled me to drive an additional two targets; Target 5 and Target 6. Thereby covering all the extremities of the muscle movement in anterior, posterior, superior, inferior, and proximal to distal.

Translating the nurb circle in three dimensional space morphed the original geometry through six different targets.
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Research Outcome

The 3D authoring tool had a simple and fast dynamics system built in. I created a simple oscillating spring mesh (in red above) and anchored it to the leg of the creature, fixed and the pelvis and the knee. When the creature was animated the physics deformed the red mesh in an appropriate behavior. I attached the nurb circle to the centre points of the mesh where it in turn drove the 6 shape targets.
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The six shape targets of the Ambiens muscle in the thigh of the Deinonychus. Shapes were also created for the Iliotibial and Gastrocnemius muscles in addition to abdominal fat and the anterior triangle below the neck.