The Hair Motion Compositor: Compositing Dynamic Hair Animations in a Production Environment

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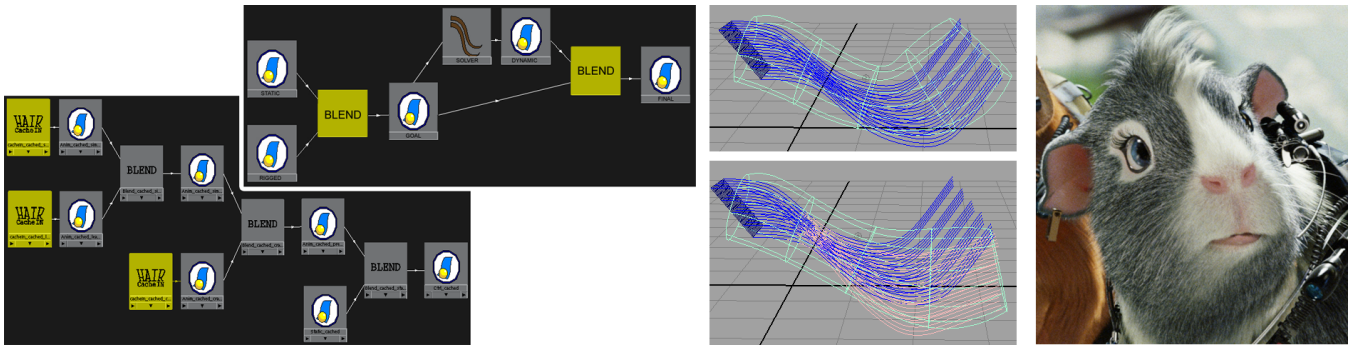

1 - Introduction

Digital characters can appear in both live action and computer-animated movies. Most of them involve some form of dynamic hair or fur, often having to be both believable and heavily art-directed. No matter which dynamic hair solver a facility relies on, there's only so much that can be achieved with a physically realistic model, and most of the artist's time is spent fixing or fine-tuning hair simulations to satisfy a Director or supervisor. To address this, Sony Pictures Imageworks developed the Hair Motion Compositor: a powerful hair animation framework that allows artists to direct, combine, offset and override hair animations that go in or come out of a dynamics solver.

2 - Hair Motion Compositing

Like a 2D image compositing tool, the Hair Motion Compositor (HMC) is a framework that allows the user to combine and modify hair/fur animations by graphically building a network of nodes, where each node can either represent animations or operations applied to these animations. A core building block of the HMC is the blend node which can blend between two (or more) hair curve animations: By cascading blends between different, but similar, hair simulations, the artist can combine them by only keeping the best parts of each instead of trying to find solver settings that would provide a similar combined result. Blends can apply to all the hair curves or just a subset, and can be weighted along the length of the hair so the gross motion of one animation is used, but the tips of the hair behave according to another. This is implemented using linear or rotational interpolation of hair curve segments, between two incoming sets of curves. Blend "balls" can be used to dynamically choose which hairs are affected: on the movie “G-Force,” a really windy simulation was cached out once, and spheres were animated to interactively decide where gusts of wind should go through the guinea pig's fur without ever having to re-compute the physics.

The dynamic hair solver is simply another operational node in the graph, which takes a goal animation as input and produces a physically believable motion as output. A typical graph (shown above) has the solver goal being driven by a blend of rigged animation and static hair (which matches the original comb). If the artist is asked to make the simulation "stiffer" or better match the goal, this can be done interactively by blending back to the goal without having to re-simulate. Any point in the graph can be cached out to disk and brought back in as an input that can be combined with other animations.

3 - Fixing a Shot

Typically, dynamics simulations of hair do not get the artists exactly what they want even after a few iterations. Thus, the animations often need to be corrected or overridden in certain areas. Offset nodes allow the artist to modify an animation using a simplified controller which follows along with the incoming animation. Any tweaks are propagated to the animation of the hair. This is useful when a supervisor likes the movement of a character's hair in general, but wants it to "swing a little higher", as was the case with Mary Jane's hair in some shots of “Spider-Man 3.” The controller can be a lower-resolution curve, which takes on the average shape and animation of the incoming hair curves. An "offset sock" can be used instead of a simple curve if the volume of a group of curves needs to be modified (such as getting a ponytail to expand or contract. In this case, NURBS circles are bound at set parametric positions on the "average curve" and lofted to create a sock shape. Their radius is computed dynamically so the sock encompasses all the hair the user wants to edit, forming a smooth convex hull that can be expanded, contracted or moved. A "super-hair" node can be used to make the outgoing hairs exactly take on the shape/animation of the controller (instead of being offset by it). Internally, this works identically to a blend node that would blend all the incoming curves to a single controller curve. In “Open Season,” super-hairs with blend balls (to localize their effect) were attached to rabbits running through the grass, and shaped to make the grass curves bend away from them, without any dynamics solving necessary.

4 - The Payoff

Over time, most facilities end up developing a catalog of hair rigging solutions and scripts around a dynamic hair solver. With little overhead, these can be made modular and implemented as nodes in a graphical framework, such as the one introduced here, to allow caching, blending, targeting and correcting of hair animations. In our experience, the building blocks are simple to implement, and the benefits of having a consolidated, powerful, yet easy to understand and use GUI can save a lot of time, money and frustration in achieving desired hair animations.

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