Hair Effects Factory within a Digital Hair Production Pipeline

Armin Bruderlin, François Chardavoine[1]
Sony Pictures Imageworks

Figure1:
Interface and
Final Results.

1 – Introduction

Digital humans, animals, and imaginary creatures are increasingly being incorporated into movies, both live-action and computer-animated. In order to make them believable, many of these characters need persuasive hair or fur. Our proprietary hair pipeline works much like other systems: the artist interacts with a small number of "control" hairs[2] that are used to interpolate the shape of possibly millions of final rendered hair strands.

One unique module in our hair pipeline is the "effects factory", which allows an arbitrary number of procedurally-generated geometric effects to be applied directly to the final hairs. Whereas control hairs dictate the initial shape of the final hairs, effects can generate subtle or dramatic variations from one hair to the next. Examples include clumping, length, wave, rotate, wind, and magnet effects.
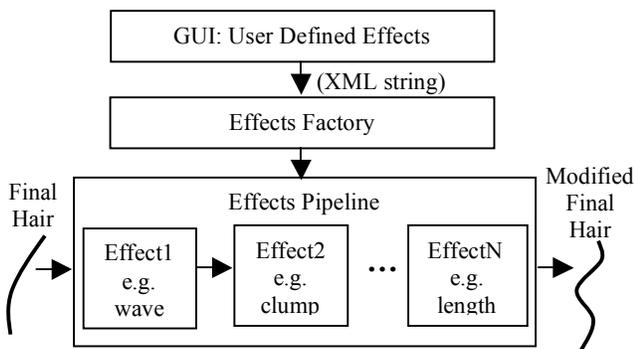
2 – Hair Effects Factory

Figure 2: Effects Factory.

The generation of effects is illustrated in Figure 2. The hair artist specifies which effects are applied to the final hair, the parameters for each effect, and what order those effects should be applied in. This is done via a custom user interface (see Figure 1, left, as an example) that generates an XML string which encapsulates this information. The XML string is passed into the effects factory to manufacture all the effects specified and populate the effects pipeline. All final hairs coming from the interpolation module are handed over to each effect for processing. The modified final hairs are then passed off to the rendering module for further processing.

Effects can be selectively applied to specific hair types, such as "instanced", "unclumped", "clump center", or to a percentage of the hairs. Each effect has a number of parameters (rotateY, clumpRadius, etc.), which all derive from a common type that allows them to be set in many ways: constant, animated, from a texture map, or randomly (with a 2D or 3D noise field, seeded per hair or per clump). Also built-in is the ability to modulate the value along the length of the hair, or with a falloff based on the distance to the clump center, or to another surface in the scene.

One important aspect is that the order in which effects are applied matters. For example, a wave followed by a clump effect looks different than the same clump applied before the same wave effect. The effects factory allows effects to be reordered at any time. Effects can also be instantiated multiple times, e.g. a length effect, followed by a clump, followed by another length effect with possibly different parameter settings.

3 – Example Effects

By applying a well-chosen set of effects with the right parameter values, the artist is able to fine-tune the desired hairstyle or fur coat of a character during "look development", and in "shots". Look development hair effects frequently include clumping (bunches groups of hairs together), length (shortens and/or lengthens individual strands to break up the tips), wave (makes hair wavy), and rotate (rotates individual strands around their base). For example, all these effects were applied to the hair of Sam and Juarez (Figure 1, middle and right).

Hair effects in shots include clumping of wet hair, wind, magnet and reshape (the latter two allow for hair to be "deformed" by external geometry, such as backpack straps or belts), which were all heavily used in the movie "G-Force". For complete flexibility, a "python" effect allows a hair artist to quickly write his own custom code to deform hair.

4 – The Payoff

Our hair effects factory has proven invaluable in achieving the desired look of our characters in two of our most recent motion pictures, "G-Force" and "Cloudy with a Chance of Meatballs". Hair systems are often limited to a set number of effects in a pre-determined order. Using our paradigm puts the power back in the hands of the hair artist to build up a hair look step-by-step adding as many effects as needed. They can easily be added, removed or reordered to achieve the final results.

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[1] email: armin@imageworks.com, chardavo@imageworks.com
[2] Often called "guide" or "key" hairs