Hair Smash

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Figure 1: *Render Hair Smash and Level of Detail Tube Hair Smash with Hats and Headsets*

Abstract

We present techniques to smash render hair under hats and headsets in animated shots that produce significant savings in time and disk space. Techniques are discussed to smash both the fine render hairs and the Level of Detail (LOD) hairs where low resolution proxy tubes riding on guide curves are substituted for fine render hairs. Precise collision resolution is ensured for those tight fitting collision objects. This procedural hair smash technique was used in the feature films *Turbo*, *Penguins of Madagascar*, and *HOME*, and allowed the automated creation of a large number (hundreds) of hair variations with ease. These variations are stored in a library and are used to generate the smashed hair on individual characters in a shot at render time.

1 Motivation

Traditionally, adding hats and headsets to hair grooms produces hair variants, both in Rigging and Surfacing/Look, that need to be created and ready for use early in production. The combinations of hairstyles/heads/bodies/hats (Eg: 1*8*3*2 = 48 variations) can be quite large to create the necessary variation in crowds. Since hats and headsets are fitted tightly to the head, a precise collision resolution technique needs to be employed to clear all render hairs of collision. LOD hair collision resolution also needs to reduce the thickness of tubes to resolve collision. The hair needs to be smashed even under motion. These requirements can be overwhelming to satisfy and would also require a large amount of time to groom and rig ($\approx$ 2 weeks per variation) and disk space ($\approx$ 15 MB per variation per frame) to calculate and store animated hair smash data to smash rendered hairs. Our technique is procedural in nature, minimizing time ($\approx$ 2 minutes per variation) and disk storage ($\approx$ 15 MB per variation, just 1 reference frame), and allows us to smash hair with hats and headsets later on in the pipeline, as needed. Any new hair smashed variation can be added without affecting the original groom or rig.

2 Technique

2.1 Smashing and Storing One Reference Frame

We export 15% of the render curves at reference frame per hairstyle/head/body/hat combination and smash those curves with the collider using our custom *Smash* technique in Houdini. *Smash* detects hair segments colliding through the hat and resolves those collisions by iteratively pushing the hair to the scalp. The *Smash* has options to falloff the effect of collisions over distance to smooth the transitions and also to keep hair deformations closer to the hat. We store these smashed hair curves at the reference frame along with a collider distance point attribute, which is the closest distance to the hat. This attribute is used by the hair geometry generator to resolve collisions at render time for full hair renders, and to affect the radius of the tubes for LOD hair.

2.2 Applying Reference Smash to Animation Surfaces

The smashed curves stored at the reference pose are moved to the animated skin surface for each rendered frame. An operator is placed in the shader hierarchy that locates an attachment point for each curve root in the reference pose and moves those curves to animated pose, but like a common wrap deformer with each whole curve following a single transform. Since this process is done at render time, the relocated curves are never saved to disk.

2.3 Collision Resolution at Render Time

The curves are passed to the hair geometry generator as "motion" guides, a name we use to distinguish them from classic modeling guides used for grooming. A motion guide actually has two curves representing the state before and after the intended deformation. If these two curves are identical for any guide, any hair associated with the guide is not deformed by it. When the curves are different, any hairs that follow that motion guide will deform by the same amount. The deformation is essentially a wrap deformer, but the method also includes shearing effect to help lay the hairs down on the skin.

Additionally, each hair is constrained not to deviate from its guide by more than the varying collider distance stored on the guide. This happens regardless of whether a motion guide actually applies a wrapping deformation. By imposing this distance constraint, we guarantee that no render hair will pass though the collision surface even though the simulation has no knowledge of the individual render hairs and the hair geometry generator has no access to the collider surface. In situations where LOD hair is used, the radius of the tube is simply adjusted to not exceed the collider distance of the corresponding guide segment.

2.4 Smash Library and Pipeline

The hair smashing technique is automatically applied to each character at render time. All artistic work is performed one time for a particular head accessory, head shape, and hair style combination. This is then saved to a library location. Settings on the hair geometry generator that control hair growth are bound to expressions that take into account the variation information of the character. This logic checks if they are wearing an accessory capable of providing hair smash, and if so queries a look-up table to find the appropriate data in the library to guide the hair shape. This behavior is built into the setup for all hairstyles, and thus will trigger for all characters with no additional work from an artist in every shot. In cases where the accessory has significant independent motion in a shot, smashed motion guides can be recreated on a per frame basis.

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SIGGRAPH 2015 Talks, August 09 – 13, 2015, Los Angeles, CA.
ACM 978-1-4503-3636-9/15/08.
http://dx.doi.org/10.1145/2775280.2792543