Hair Emoting with Style Guides in *Turning Red*

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ABSTRACT

For Pixar's feature film *Turning Red*, the grooming and simulation teams faced the challenge of handling characters with millions of fur and hair curves, which often needed to behave differently in each shot reflecting the characters' emotional states. This work describes new tools developed to assist artists in managing and sculpting these large amounts of fur and hair. In particular, we present a novel surface-aware technique for curve deformation that interpolates hair sculpts at varying levels of detail, accompanied by a customized user interface for interactively browsing hair layers.

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1 INTRODUCTION

At Pixar, hair and fur grooms are set up in the Presto animation system where artists can shape guide hairs as well as view the full set of render hairs interactively [Butts et al. 2018]. In this system, grooms are designed by first growing guide hairs with roots attached to a scalp surface mesh, followed by non-destructive operators that define hair styles, and organized in layers describing different hair regions. Moreover, grooms can be animated by applying physically based simulations onto guide hairs combined with key-frame edits and constraints [Iben et al. 2019]. The final render hairs are then populated by scattering root points over the scalp mesh based on user prescribed density maps and blending nearby guide hairs through kernel interpolation.

In the feature film *Turning Red* (2022), the main character is a red panda covered with fur and hair whose grooms contain approximately 12 thousands guide hairs and about 2 million render hairs, both structured into a dozen hair layers. Importantly, these dense grooms needed to be posed in unique ways for different shots in order to help convey the character's expressions, as illustrated by the teaser figure. However, sculpting thousands of individual guide hairs is cumbersome and time-consuming. Even simple tasks such as isolating hair layers and switching between guide and render hairs becomes tedious when working with such a large hair rig.

In this work, we present a series of tools that helped streamline hair sculpting workflows on *Turning Red*. We start by introducing style guides as an auxiliary representation for hair sculpting that coarsens guide hairs (§2). We then develop a new method for transferring deformations from this coarse resolution back onto the dense hair set (§3). In addition, we propose a user interface for managing and selecting hairs layers efficiently (§4).

2 HAIR STYLE GUIDES

To avoid manipulating thousands of hairs, we propose an additional groom that defines a resolution coarser than the original set of guide hairs. We denote this sparser hair set as *style guides*, while we rename the original guide hairs as *sim guides* to emphasize their simulation usage. Style guides can be built into a character's default hair rig or generated on demand based on the needs of each shot. To speed up the creation of style guides, we take a sparse subset of the existing sim guides by running a k-means clustering on the root points of the sim guides based on a user prescribed percentage and then selecting a style guide for the hair closest to the centroid of each cluster. Artists can also add and remove individual hairs

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Figure 1: Left and right columns show our different hair representations before and after sculpts. Top row displays style guides, while middle row indicates sim guides, and bottom row has final render hairs. ©Pixar.

manually or grow new grooms if necessary. The rows in Figure 1 exemplify style guides, sim guides, and render hairs.

3 HAIR STYLE MOVER

Equipped with style guides, artists can now explore groom shapes by managing significantly fewer hair edits. Our next step is to propagate any deformation made onto the style guides back to the sim guides. Initially, we considered reusing the kernel scheme that blends sim guides to render hairs but now between style guides and sim guides. Unfortunately, the spatial nature of the kernel interpolation combined with the sparse layout of styles guides over the scalp mesh leads to noticeable deformation artifacts.

To overcome this issue, we developed a new surface-based method for transferring sculpts from the style guides to the sim guides, which we refer to as the *hair style mover*. By accounting for the scalp surface, our results handle varying hair resolutions at interactive rates while preserving curve details (Figure 1). At its core, our approach builds upon the surface grooming technique presented in [de Goes et al. 2020], which smoothly interpolates isolated curves attached to a polygonal surface by optimizing curve segments via a pair of Poisson solves. The hair style mover starts by interpolating the rest shape of the style guides onto the vertices of the scalp mesh. We then construct an interpolated version of the style guides at the root location of every sim guide by simply averaging nearby vertex curves based on barycentric coordinates. We also repeat this process for the sculpted style guides, producing an interpolated version of deformed style guides evaluated at the roots of sim guides. At last, we extract the rotation matrix and scaling amount between the segments forming each pair of interpolated curves and apply this transformation to deform the current shape of the sim guides. When the guide curves have different number of points, we resample all the curves using the largest point count.

Figure 2: This example shows a snapshot of our hair picker tool in Presto, which provides a quick interface for managing hair layers and scene attributes, in addition to our various hair representations. ©Pixar.

The hair style mover can either operate pre-simulation, in order to set the undeformed simulation state, or post-simulation, allowing edits to the final groom shape. When creating style guides for the pre-simulation case, we can simply copy the original sim guides warped to the current pose of the character mesh. However, in the post-simulation case, we need to maintain the style guides in sync with the latest simulation run. To achieve this goal, we generate the style guides based on the rest state of sim guides and also add a deformer that keeps track of upstream changes that occur to the sim guides. Since this deformer is live in the hair rig, sculpts to the style guides are applied after simulation updates take place.

4 HAIR PICKER

Our last contribution is a new user interface called the *hair picker* that assists artists to more efficiently manage render hairs, sim guides, and style guides within Presto sessions. This interface has significantly reduced the amount of time spent on common tasks that would otherwise require manually searching through the scene graph for objects in the hair rig. Our implementation takes inspiration from animation pickers, which are used by animators to pick rig controls in a panel that graphically resembles a character. Our hair picker UI presents the top level hair scopes (head, eye, face, and body) and allows users to toggle the visibility and pickability of the respective render and guide hairs. The full list of hair layers is also shown for more granular control, enabling artists to select individual curves in each hair layer. We also provide a panel for users to quickly perform common actions such as updating the hair level of detail and viewing scalp meshes. Figure 2 shows a screenshot of the hair picker in a live Presto session.

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