Hair today, Cloth tomorrow: Automating Character Fx on Peter Rabbit

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Figure 1: Examples of the various cloth and hair challenges in Peter Rabbit. ©Sony Pictures Animation. All rights reserved.

ABSTRACT

In "Peter Rabbit" (2018) the characters in the film needed to evolve from their 2D watercolour illustrated past into modern photo-real and engaging performances of a live-action world. The direction of the film necessitated high quality dynamic fur, cloth and feathers in a wide variety of shots, covering nuanced performances to frantic action sequences in a number of environmental conditions. Developing a better mechanism for creating character FX on such a diverse range of characters in over 1,100 shots was a major and necessary challenge.

To achieve the scope and scale of the work, we created a number of workflows using complex hair and cloth tools embedded in multi-process FX rigs for not only the artists, but also for automatic processes in each and every animation review. We termed this "AnimCFX" and the goal was to leverage our large farm processing capability to produce a significant portion of the work and enable more focused iteration time on bespoke hero shots with our small character FX team.

CCS CONCEPTS

• **Computing methodologies → Physical Simulation**;

KEYWORDS

hair simulation, clothsimulation, rendering, production pipeline

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1 INTRODUCTION

To maximise our chances of success we ran simulations in two parallel stages of development. We undertook a number of reference studies of cloth and fur on both small creature and human sizes. At the same time we started to analyse what factors helped to produce more predictable results in these types of simulations. We found stability was greatly improved when inputs were consistent over time and free from internal and external intersections.

2 ANIMATION

Creating animated input meshes to match the technical prerequisites defined during development was the first major hurdle. The majority of Animal Logic's rigging and animation teams had recently completed a series of LEGO films. These films contained non-deforming models often animated in a stepped "stop-motion" style. Additionally, physically impossible animation "cheats" were common. The need to re-educate the performance team was clear, and a series of AnimCFX "love in" training sessions were held. To further reinforce the mantra of "what goes in, controls what comes out" the AnimCFX process was handed to the performance team. Shots could no longer be approved from Animation without sensible simulations delivered at render time. Simultaneous to this re-education process, animation and rigging technology was upgraded to a USD core to provide multi-character realtime playback. With the emphasis on maintaining FPS and interactivity the team decided that animation would work blind to both cloth and fur. Cloth rigs used by animators had simple controls, with results often penetrating skin and stretching in an unconvincing manner. Animation shot-building and validation tools were upgraded to provide key requirements of the Character FX team which were: shots must start in a predefined bind pose and then preroll from this into the characters shot start pose, leaving the animators to output the last constraint: an animated character mesh with no skin to skin intersections.

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3 HAIR VOLUMES

A key input for AnimCFX was an animated hair volume representation that could be used for cloth collisions. To build this representation the skin mesh was expanded to match the final hair groom. However, the lack of muscles or volume preservation in the performance rig meant this volume was prone to collapsing and intersecting in areas of high flexibility. AnimCFX rigs solved this by re-projecting the mesh onto a signed distance field of itself, along with smooth and relax operations. The mesh was also shrunk to approximately 65%-75% of the fur length to mimic the compression of the fur by the cloth garments.

4 CLOTH

A two-phase approval process was key to developing suitable garments for automated cloth. First, a simulated drape of the single sided geometry was used to approve the garment design on a t-pose character. These simulated drapes quickly confirmed whether the garment fit, and any strange reactions in cloth simulation helped identify problematic seams or invalid polygons. Once garment approval was made on a single-sided model, a duplicate “thick cloth” version was produced. This was further tested on multiple range-of-motion cycles for final approval on each character. In this phase cloth settings were tweaked to suit the fabric type and any special behaviours required for buttons, collars, pockets or attached accessories, were also set up at this time. The final cloth geometry from modelling was delivered along with single sided flat panels, this was used to compute rest lengths, and a special UV set enabled the thick cloth to be bound to the thin simulation mesh. This thin mesh was subdivided into triangles prior to simulation in the Carbon cloth solver. At render time, the thick cloth was ingested by our in-house procedural known as “Weave”, which hid the mesh and built millions of woven curves onto this surface. It was important that the cloth mesh did not stretch too much as it would create a transparent appearance due to the expanding spaces between these woven curves. The cloth simulation was post-processed to ensure a small gap between skin and garment was always preserved for fur. This process would be repeated for characters with multiple clothing layers and helped to detangle and prevent undesirable overlap between these layers.

5 HAIR

Our proprietary grooming system “ALFro” produced hair and fur which consisted of anywhere between 5-8 million NURBS render curves for each character. This was re-processed for simulation into an evenly distributed set of guide hairs of about 1-2% density of the original groom. These guides were interpolated onto an animated mesh with an “attach to length” constraint to keep the tips of the hairs at a fixed length to their closest point on the surface. A re-advection step was then performed which maintained original hair length and de-intersected curves with a self collision effect. Simulation of hair utilised a basic fast collision only pass, in which hair was grown along its original path and any segments entering a signed distance field collider were bent away. For complex shots, two advanced simulation approaches were possible: a custom solver built in Houdini VEX/SOPs with hair-to-hair collisions and inertia or a rigid body method consisting of tubes and angular constraints. Interpolation of simulation guide hairs and full density render curves meant every hair needed to be re-run against cloth collisions in a final pass.

6 RIG CONTROLS

Character FX rigs contained a number of common parameters such as fur type, wind strength and direction and collision objects. These could be modulated from presets in our production database “ARK” for each character in each shot. This provided extremely rich results straight out of Animation, which lead to a significantly reduced amount of manual work for FX artist.

7 AUTOMATED PROCEDURES

It was important for Animation to verify their performances with the simulated result within a short amount of time. The character FX rigs were built with a complex ROP dependency chain that was optimised with as many parallel processes as possible. A typical AnimCFX rig had 12-17 stages of processing and would take 2-3 hours to complete. This automatic simulation was only triggered when an animation output produced a significant delta from the previous delivery. Automated review renders would also run when all simulation caches were complete. To ensure that all simulation caches delivered to Lighting remained in sync we filtered the dependencies between any manual character FX work and the automated Animation outputs.

8 RENDERING

The character FX process produced two outputs. The first was a full density alembic hair cache containing 5-8 million curves, including primvar data such as width. This was passed through a procedural and converted to smooth Catmull-Rom splines at render time. The second was an alembic mesh cache of the character skin, whiskers and cloth. This was subdivided to a higher resolution than the originally modelled mesh to provide suitable cloth deformation.

9 LIMITATIONS AND FUTURE WORK

AnimCFX rigs were extremely successful on “Peter Rabbit”. Across 4,162 unique performances, with dynamic fur and cloth, 83% were achieved through an automated process. However, because these rigs contained many processes, there was a steep learning curve for new starters. Simplifying these processes as well as providing faster simulation turnaround is an ongoing challenge. To improve AnimCFX inputs, further volume preservation work is needed, including better skin mesh sliding to reduce stretching and sparse hair distribution.

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