Vegetation Choreography in The Good Dinosaur

Olivier Soares, Thomas Moser, Frank Aalbers
Pixar Animation Studios

Figure 1: *Vegetation in The Good Dinosaur, 2016 Disney/Pixar. All Rights Reserved*

Abstract

Nature plays a major part in Disney/Pixar's The Good Dinosaur, and in order to make the world of the environment come alive we wanted to have it react to weather conditions, and with other characters' actions. Doing so required we choreograph and potentially simulate the motion of each piece of vegetation in the film - from flowers, grasses and shrubs to a multitude of trees and branches (modeled both geometrically and procedurally). Our goal was to have the world feel truly alive across a range of weather conditions, from calm to violent and all shades between, and encourage the other actors to move freely in, and interact with that world. We built a directable vegetation simulation engine that produced compelling motion in our assets, and developed techniques for generating a library of simulated motion, dressing that motion and allowing the characters and world to interact.

Keywords: simulation,vegetation

Concepts: •**Computing methodologies** → **Simulation;**

1 The Vegetation Simulator

We developed a new mass-spring simulator (Ape) that uses a semi-implicit integration scheme [1] to operate on the hierarchical curves (1 parent and any children) that thread through our vegetation models. It was designed to handle large amounts of data (our largest model has 20 million curves and 80 million particles), is heavily multi-threaded and uses the classic edge, bending and altitude springs, as well as kinematic angle springs to maintain the angles between each span from their rest positions.

The final geometry we render has to be deformed based on the simulated curves and to do so a smooth skinning algorithm is applied using dual quaternions. To bind the final vegetation geometry to the simulated curves, we initially used projections and Euclidean distances but to improve the binding model we used width as a further heuristic - representing each curve segment as a cylinder of diameter 'width' that we filled with particles, and using a k-nearest neighbors algorithm to classify the vertices of the geometric primitives to tag for deformation.

2 Vegetation Clips and Dressing

Vegetation is present in almost every shot in the film, and to tackle this scale we generated a clip library of simulations for each vegetation model. Each asset was simulated under a range of wind conditions (from calm to violent) and we baked the results into a series of clips of around 25 seconds long -15 different wind levels in the palette of motion led to around 20 terabytes of data. As we commenced work on a sequence, working from a weather chart we blocked the wind levels. Each bit of vegetation in the shots would pick up the relevant clip - there were sufficient frames to time offset into the clips and hide any repeating patterns, and we'd use the same wind levels to drive procedural motion such as wind-flutter and grass sway. By creating an implicit simple connection between weather conditions and sequence/shot (rather than explicitly simulating assets), it was trivial both to make dressing changes to the environment and have the motion automatically be picked up, or change wind levels en masse.

3 Hero Simulation

We could selectively swap out clips per asset per shot, or hero simulate on demand which we'd typically do when characters interacted with the environment - for example characters running through trees - or when we wanted very specific choreography - e.g. trees sliding during a mudslide or bending in a storm. We also had many instances where we wished to have characters interact with procedurally generated grasses - perhaps leaving trails, moving aside spots of vegetation artfully (e.g when Arlo and Poppa kick up fireflies with their tails and legs) as well as modeling rolling winds etc. To do so we generated proxy guide geometry for the procedural curves, used Ape to simulate the contact and/or wind motion against those guides, then re- conformed the procedural geometry to follow our guide prior to rendering. Collectively these approaches proved so successful that we were able to tackle a very high amount of hero character/environment interaction that, taken together with the ambient motion of all the various elements we hope creates a compelling, vibrant and living environment for the viewer to discover

SIGGRAPH '16, July 24-28, 2016, Anaheim, CA,
ISBN: 978-1-4503-4282-7/16/07
DOI: http://dx.doi.org/10.1145/2897839.2927435

with our protagonists as they go on their journey.

Acknowledgements

We would like to thank Gordon Cameron for helping on this submission and for leading us on The Good Dinosaur.

References

BRIDSON, R., MARINO, S., AND FEDKIW, R. 2003. Simulation of clothing with folds and wrinkles. In *Symposium on Computer Animation*, 28–36.