Art-Directable Procedural Vegetation in Disney's Zootopia

Hans Keim Maryann Simmons Daniel Teece Jared Reisweber Sara Drakeley*
Walt Disney Animation Studios

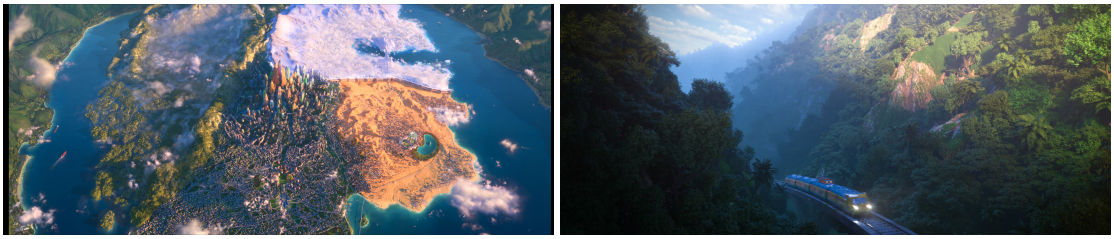

Figure 1: *Left: Wide shot of diverse Zootopia habitats, Right: Interaction with train breeze*

Abstract

With six distinct habitats integrated into one mammalian metropolis, early artwork for Zootopia displayed a large appetite for diverse vegetation. Our flexible toolset for procedural vegetation allowed us to easily customize the system to provide the required variation through new growth and animation module features, while maintaining art-directable control. We enriched the vegetation animation tools and workflows to support various levels of interaction with the characters and environment. To address the geometric complexity produced by all of this variation, we implemented various instancing schemes to allow the renderer to re-use as much geometry as possible.

Keywords: procedural geometry, procedural animation, vegetation

Concepts: •**Computing methodologies** → *Mesh geometry models;*

1 Rich Diversity in Procedural Models

From Saharan shrubbery to lush rainforest, Zootopia called for a wide variation of flora across 156 unique sets (Figure 1, Left). Using *Bonsai*, our in-house procedural vegetation modeling tool, artists were able to achieve variation not just across species, but within the same species of tree or bush. Custom modules for manipulating the growth and animation of tree models allow artists to satisfy the specific creative demands of each show. For example, to meet the needs of a lush rainforest, a new *cling* module provides intuitive control of the growth of vines on trees and other surfaces (Figure 2).

Because characters moved seamlessly between sets designed for mice to those for polar bears, a particular challenge was modeling and populating sets with the appropriate scale, while allowing reuse of assets such as leaves or even full trees. We enlarged our vegetation library and updated our asset authoring workflow to allow greater modularity for vegetation assets. The extensive customizability in our vegetation system allowed artists to have the best of both worlds: procedural variation while maintaining control over the shape language and responding fluidly to artistic direction.

Figure 2: *Close-up view of rainforest environment showcasing variation and cling module*

2 Instancing and Variation

With the possibility of unlimited variation, we needed a way to practically be able to render these environments. Our renderer can support a large amount of non-unique instanced vegetation, achieving over 7.7 million trees in test shots. The key was to combine this high instanced throughput with enough variation to produce a rich environment. We supplemented our instancing architecture with controls to drive the per-tree variation in Bonsai via external variables. Thus, the knob for uniqueness could be turned up or down on a shot-by-shot basis. We also found that certain scenarios called for instancing at the tree level, such as when trees were static or animating with cycles, whereas other setups necessitated instancing at the leaf level, such as the rainforest which called for unique variation in the branching structure of trees, but reused the leaf geometry.

3 Animated Vegetation

The level of interaction of characters with vegetation on Zootopia was on a larger scale than required on previous shows. To support this, we augmented the methods available to effects animators to be able to interact with and control the procedurally generated data in an art-directable as well as simulation-ready way. Through curve systems in Houdini, artists could manipulate the branches of a tree

*e-mail: {hans.keim, maryann.simmons, daniel.teece, jared.reisweber, sara.drakeley}@disneyanimation.com

SIGGRAPH '16, July 24-28, 2016, Anaheim, CA,
ISBN: 978-1-4503-4282-7/16/07
DOI: http://dx.doi.org/10.1145/2897839.2927469

Figure 3: *Shot with ambient motion in leaf shadows*

at any level and subsequent procedural levels (twigs, leaves, etc), would then rigidly follow the simulation. In addition, point clouds could control the leaf locations to get effects such as leaves blowing away as a train passes by (Figure 1, Right). We also implemented a new technique to animate the base points of instanceable subsections of trees, which were then skinned to curves in order to provide unique animation across ground planes without use of cycles and without hitting the render geometry limit.

3.1 Ambient Motion

We knew early on that we needed the world to feel dynamic and alive, thus even background vegetation could not be static. For ambient dynamic vegetation, we used a particularly fast and appealing algorithm for leaf noise in Bonsai [Habel 2009], and increased its usage through additional plugins to our procedural generator, XGen [Thompson, et al. 2003]. In this way, vegetation was easily brought to life without adding to the render burden. By creating multiple variants of tree elements, artists could easily ramp the strength of the motion in shot, and the result is that every plant and even shadows and reflections of trees have animated components. Effects such as the subtle motion of leaf shadows over the environment were carefully crafted in lighting, and were important to achieving the perception of a vibrant, living world. Figure 3 illustrates one example where there is an organic breakup to the illumination on the building wall, created by procedurally generated geometry and ambient wind animation.

4 Results

With our robust vegetation toolset, we were able to model 41 species of bushes and plants with procedural variants, as well as 36 unique hero trees which seamlessly integrated high resolution trunks and procedurally-filled, art-directed canopies. From the smallest tree at 20 inches tall, to the largest rainforest species at 630 feet tall, we realized diverse flora across varied environments, populated hundreds of shots with dynamic vegetation, and brought to life the rich world of Zootopia.

5 References

HABEL, R. 2009. Real-Time Rendering and Animation of Vegetation. SIGGRAPH Animation Festival: Real-Time Rendering 2009

THOMPSON, T., PETTI, E., TAPPAN, C. 2003. XGen: Arbitrary Primitive Generator. In Proceedings of SIGGRAPH 2003, Sketches And Applications.