

Procedural Terrains on Pixar's *The Good Dinosaur*

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Figure 1: *The Good Dinosaur* is filled with massive environments, often next to very high detail foregrounds ©Disney/Pixar

Keywords: environments,vegetation

Concepts: •Applied computing → Fine arts;

1 Needs

One of the major challenges of designing *The Good Dinosaur* was establishing continuity and context of the environments as early in the process as possible. It's one thing to talk about how a scene will feel with a sixty foot dinosaur walking along a ridge in the rockies, but nothing compares with visualizing that sixty foot dinosaur on a ridge in the rockies. Establishing the terrain at the outset and maintaining it as the anchor throughout production was one of the driving forces in the design of every set.

These constraints meant that the sets department had to address the challenge of building a large number of massive sets in varied terrain styles in a short amount of time. Our solution was to leverage our procedural vegetation system in a new way. We based the background procedurals off of USGS (United States Geological Survey) satellite data. We developed tools for viewing and editing this satellite data to suit our needs, and then at render time used the data as a starting point for our procedural systems. This pipeline saved time and increased terrain variety by allowing artists to do locations scouts using online maps to find real places similar to the desired look and edit them as needed.

2 Technology

The USGS toolset we developed to support this workflow included a realtime visualizer, operations in Maya for editing the data, and new render time procedural types designed to work on top of the data. These tools were designed to work with Maya as well as our propriety software packages. USGS data is stored as simple heightmap files. To support viewing and editing such massive heightmaps (typically hundreds of kilometers in every direction),

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the USGS visualizer was implemented using OpenGL tessellation shaders with dynamic LOD and frustum culling.

For editing the USGS terrains, we supported a number of operations. The USGS terrain could be skrink-wrapped to arbitrary geometry placed in the Maya file, smoothly replacing a section of the terrain. Artists could cut holes in the terrain to either create starting points for sculpting hero geometry or for edits that could be baked back into the USGS data file. This was used in previs as well as sets modeling to tweak or edit the terrain to hit the necessary look.

Multiple procedural techniques were layered on top of the raw USGS data to increase the quality of the visual results. First, the terrain was procedurally displaced to increase its believability. Next, the satellite data acted as a starting point to define where different vegetation types should grow. We leveraged signals like curvature from the USGS terrain to drive density signals for different types of trees and vegetation. To create more visually pleasing looks to aid the composition, we applied techniques to clump or mass types of rocks or vegetation into low frequency shapes. On top of these procedural growth rules, the artists could override the look on a show, sequence, or shot level using painted density or other signals. Artifacts at the junctions between USGS tiles had to be masked via custom normals. Additionally, the USGS procedurals relied heavily on instancing and the system was also hooked into our screen space LOD and analytic SH systems [Garcia et al. 2015].

3 Benefits

This toolset was leveraged by multiple departments including art, previs, layout, and sets. One benefit of this pipeline was the extremely fast iteration time. If the story called for a new set, the art department could go find a similar location online and use it as a starting point for paint-overs, instead of doing a full painting from scratch. We could then use the coordinates to find the corresponding USGS tile and immediately have something to work with. This allowed us to have more varied terrains throughout the film than would otherwise have been possible.

The USGS terrain data combined with our render time procedural system allowed for new workflows that made *The Good Dinosaur* possible. This pipeline allowed us to make more sets in a shorter amount of time, while still retaining the visual integrity of the work.

References

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