Making a Dinosaur Seem Small: Cloudscapes in The Good Dinosaur

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Abstract

The Good Dinosaur is the first Pixar film without matte painted skies; all 800 shots with visible skies were fully modeled, dressed, lit and volume rendered.

In the film, the environment served as an adversary for Arlo to struggle against. Early concept art made it clear there would be multiple sequences during thunderstorms as well as others taking place above the clouds. Volumes were well suited to those settings, but even in quieter moments we wanted to capture constantly changing weather with the perspective and parallax of a true dimensional sky. Finally, 3D clouds enabled the lighting department to treat the environment as a single whole, from foreground all the way to the horizon.

Keywords: cloud modeling, cloud rendering, multiple scattering

Concepts: •**Computing methodologies** → **Ray tracing; Volumetric models;**

1 Making clouds

Previous Pixar films treated volumetric clouds as hero effects. In our case, we created a library of 1200 cloud pieces that artists could recombine into larger and more varied shapes. To create the pieces, we used both procedural noise, fluid simulations and satellite photography.

The modeled cloud pieces were stored in Field3D files as MIP volumes. At render time, PRMan would automatically select the appropriate resolution, and more importantly, artists always had a light-weight visualization representation that could be placed anywhere in the scene without incurring unexpected memory usage or render times due to excessively high resolution. MIP volumes also removed the need to use frustum buffers: an approach commonly used in the past to work around large volumetric scenes.

2 Dressing cloudscapes

The goal when designing the dressing workflow was to make it as nimble as possible. Each sequence was divided into packets of similar shots, and each packet contained a Houdini file with cameras and deep foreground plates that gave artists quick feedback on composition. Artists used custom plugins to select and dress cloud pieces from the library, and the MIP volume representation ensured that visualization was quick and light-weight. Artists could also manually reduce the visualization complexity to visualize cloudscapes with upwards of 1000 volumes.

In addition to placement, artists also had two controls over the density of the clouds. The first was a linear multiplier on density, the second a logarithmic rolloff that gave the artist control over how quickly density increased at the edge of the cloud inwards. The combination of controls allowed artists to re-use library pieces in new combinations, for example to produce rain below stormy cloud banks.

The dressing workflow proved to be very art-directable, and allowed artists close control over individual shots when needed, while maintaining an efficient sequence-wide base. In the end, artists used over 20,000 cloud pieces to compose 180 different cloudscapes.

3 Lighting and rendering

Our initial render tests used an approximation for multiple scattering, which looked plausible when back-lit but gave poor results for front-lit or side-lit clouds. A custom PRMan DSO was developed that allowed us to embed an efficient path tracer with multiple scattering support inside the REYES pipeline that the show used. In the end, lighting artists had orthogonal control over the diffusion and the contrast of each cloud, yielding realistic but highly art-directable looks.

In order to produce consistent atmospheric perspective, a custom Nuke plugin was developed that volume rendered a planet-sized atmosphere and composited it into the deep image data. The plugin gave the lighting artist control over lighting direction, transition contrast, haze amount, and a number of other parameters.

4 Conclusions

The volumetric cloud pipeline greatly reduced the back-and-forth between lighting and upstream departments, as a single artist could light the entire frame, from foreground characters to distant clouds and atmosphere.

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