The Atmosphere of Raya and the Last Dragon

Marc Bryant
Walt Disney Animation Studios

Ryan DeYoung
Walt Disney Animation Studios

Wei-Feng Wayne Huang
Walt Disney Animation Studios

Joe Longson
Walt Disney Animation Studios

Noel Villegas
Walt Disney Animation Studios

ABSTRACT

The cultures of South-east Asia provided plentiful inspiration for the setting and art direction in Walt Disney Animation Studios' "Raya and the Last Dragon". This fantasy adventure required many unique environments ranging from desert landscapes to tropical forests, each describing rich lighting scenarios paired with the appropriate atmospherics.

Many departments collaborated to create the extensive amount of atmospherics required by such varied and lush locations. Simultaneously, emphasis was placed on making the atmospheric Lighting workflow more efficient. We focused on improvements to allow Lighting artists more flexibility and control over making complicated atmospheric setups without having to request new assets or assistance from the Effects department on every shot. This in turn would save time and relieve significant production strain.

CCS CONCEPTS

• **Computing methodologies** → **Rendering**; *Volumetric models*; *Simulation by animation.*

KEYWORDS

lighting, fx, volumes, rendering, atmospherics

ACM Reference Format:
Marc Bryant, Ryan DeYoung, Wei-Feng Wayne Huang, Joe Longson, and Noel Villegas. 2021. The Atmosphere of Raya and the Last Dragon. In *SIGGRAPH '21: Aug 01–05, 2021.* ACM, New York, NY, USA, 2 pages. https: //doi.org/10.1145/3450623.3464676

1 ATMOSPHERIC INTEGRATION

Environmental realism and believability were important to the directors and atmosphere would be a key player in helping to give the film its motivated, naturalistic lighting with an extra focus on tonalism. This meant that atmosphere would be used as a tool to create silhouettes, attenuate light, and craft large tonal masses. Knowing this, Lighting artists would require access to a wider range of volumetric assets than in the past. In addition, show leadership placed great emphasis on a "Rough to Fine" workflow, including early cross departmental sequence based reviews (show early with as much context as possible). We would therefore need a more efficient way of set-dressing these new assets as well as an entirely new way to publish from Lighting so that the other departments could see where the sequence was headed.

Clearly this called for a close collaboration between the Effects, Lighting, and Software teams. We needed an efficient library of realistic atmospheric elements from which to build our environments.

2 EXTENDING OUR TOOLSETS

Disney Animation already had a solid framework for cross departmental Effects asset collaboration. Our Foundation FX toolset had been used extensively in the past by the Layout department [Bryant et al. 2017]. Several improvements were needed in order to support Lighting's heavy use of volumetric assets.

Atmospherics needed to be visible in cross departmental reviews, so Lighting needed more than the ability to place and render assets, but also to publish their atmospherics back into the pipeline.

Furthermore, Lighting artists needed the ability to quickly place and visualize many assets, with the expectation that the volumes in Disney's Nitro interactive display would closely match the final render. To better support the interactive placement and preview of heterogeneous volumes, we replaced Nitro's previous volume slicing approach with a full-resolution, fixed-step ray marching fragment shader, with first hit optimizations and blue noise offsets.

To support the artist controlled parameters in our final frame renderer's volume material model (e.g. albedo and extinction color), we started with a single scattering model with wavelength independent transmittance. Multiple scattering was approximated using Bauer [2019]'s approach, adding multiple octaves of direct light while increasing isotropy. Inter-volume transmittance was approximated via Order Independent Transparency, while shadowed illumination for volumes required optimizations to real-time shadow mapping techniques. This approach enabled volumetric assets to live alongside traditional opaque and translucent surfaces.

3 RENDERER IMPROVEMENTS

Disney Animation's final frame renderer, Hyperion, also required a few upgrades.

To decrease render iteration time, we focused on improving IPR performance. Hyperion's volume majorant octree update logic

SIGGRAPH, Aug 01–05, 2021, Virtual

ACM ISBN 978-1-4503-XXXX-X/18/06.
https://doi.org/10.1145/1122445.1122456

Figure 1: Before and after atmospherics: note how much of the final dramatic look (such as the godrays, bloom, and silhouetting) comes from integrating atmospherics.

Figure 2: Before and after atmospherics: note how the atmospherics add additional richness while also making the light sources and character silhouettes more visually readable.

was refined to trigger heavy rebuilds only in cases where volume density was affected by transforms or shader based attributes. This approach resulted in better interactivity when adjusting shader attributes related to albedo or phase function.

Our octree splitting heuristic was adjusted to take real scattering events into account, which kept dense clustered volumes from generating unnecessarily deep octree structures while also reducing scene construction time.

Much of the art direction called for thin atmospherics interacting with light sources and emissive objects. These situations tend to be a major source of variance for Hyperion's spectral decomposition tracking algorithm [Kutz et al. 2017]. To achieve lower variance rendering, we developed new importance sampling techniques based on the energy distribution along each ray path.

To fully utilize the atmospheric assets available, we knew that Lighters would occasionally need to adjust the shapes of the assets themselves. To this end, we extended Hyperion's Region Grads (a 3D grading function similar to RenderMan's PxrRodLightFilter) to work with volumetrics. Using a simple viewport GUI, artists could refine and sculpt asset shapes when placing them in the sequence or shot.

Finally, the Lighters needed robust controls over direct and indirect contributions from emissive volumes. We extended our light transport override system (called Transport Modifiers) to support patterened blending between unbiased results and user specified scaled results.

4 THE BUILDING BLOCKS

In addition to the toolset improvements, we also needed to plan for authoring the specific assets. Based on the developing script requirements, Lighting identified several categories of atmospheric assets, ranging from large scale clouds to subtle localized mist and dust devils. Photographic and video reference were used to clearly communicate the needs and intent of each type of asset.

After strategizing with Lighting, Effects was able to use the aforementioned document to author the (mostly volumetric) assets which would form the building blocks of Kumandra's atmosphere. We were able to reuse some assets from previous work and dedicate early resources to generate the many new assets that would be required. Additionally some new elements were identified during production and added to the library as needed.

By the end of the show we had a total of 92 atmospheric variants spread across 15 assets.

5 ASSEMBLING THE PIECES

The Lighters combined these basic building blocks to carefully craft the look of each sequence. Mist, fog, clouds, and various aerial perspectives were efficiently produced due to the improvements in artist control, visualizations in Nitro, and Hyperion performance. Additionally, artists sometimes used these assets in unexpected and creative ways, crafting custom dust whirlwinds and clouds of debris, thus enabling the Effects department to focus on some of the more bespoke magical elements in the film.

Our library was used extensively, with more than 5,000 instances of atmospheric assets deployed over all sequences. This could have totalled 600TB of disk footprint if treated as per-shot assets, instead of the 10TB that we used for our Atmospheric Library. We fully expect to leverage this library on future projects, which will require migrating the data to conform to changing pipelines. While this step is absolutely worth the effort, our eventual goal is to separate the data from the framework: we'd like a library robust enough to require minimum migration work between shows.

We are proud of our interdepartmental collaboration on this Atmospheric Library. We could not have achieved the same level of visual fidelity and realism without this workflow, and we look forward to applying it to future shows.

REFERENCES

Fabian Bauer. 2019. Advances in Real-Time Rendering in Games: Creating the Atmospheric World of Red Dead Redemption 2: A Complete and Integrated Solution. In *ACM SIGGRAPH 2019 Courses (Computer Graphics Proceedings, Annual Conference Series)*. ACM, ACM Press / ACM SIGGRAPH.

Marc Bryant, Ian Coony, and Jonathan Garcia. 2017. Moana: Foundation of a Lava Monster. In *ACM SIGGRAPH 2017 Talks (Computer Graphics Proceedings, Annual Conference Series)*. ACM, ACM Press / ACM SIGGRAPH, 1–2.

Peter Kutz, Ralf Habel, Yining Karl Li, and Jan Novák. 2017. Spectral and Decomposition Tracking for Rendering Heterogeneous Volumes. *ACM Trans. Graph.* 36, 4, Article 111 (July 2017), 16 pages. https://doi.org/10.1145/3072959.3073665