Elemental Characters: Making Characters Out of Thin Air

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Figure 1: Air Characters Lineup ©Pixar

ABSTRACT

Pixar's upcoming feature film Elemental required many new technical solutions due to its ambitious visual language and storytelling. The film's characters, made of different elements - fire, water, air, and earth, required a unique approach in finding answers.

For our main Air characters we had to come up with a solution to combine two methods, a procedural volume generation and stylized simulated volume model. In addition we had to find a solution for secondary Air Characters, to utilize where there was an overlap in developed techniques and where we had to diverge. In addition we also had to resolve what type of data we had to create to allow shading to have full control over the look of the character.

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1 INTRODUCTION

Creating Air characters with heavy emphasis on design and performance meant that we needed maximum control over their various design features. Being made up of volumetric data, reducing memory and data footprints presented us with a unique challenge. The director also wanted them to feel grounded in reality and unified with the other elements, Fire [Hoffman et al. 2023], Water [Gilbert et al. 2023] in the movie. To add to the complexity, they came in varying shapes and sizes so scalability was an important consideration in our recipe. These characteristics inspired us to create a system that combined procedural animation with physically based simulations to create believable characters that were easy to animate across several shots.

On the look development side, they had a wide gamut of hue and saturation, which in case of primary characters were also tied to their emotional state to convey story beats. Eye and mouth features being a key element for animators was a challenge we had to overcome for our volumetric characters. Another key design feature was stylized graphical line work which was common across Fire and Water elements. We came up with a creative solution to ground this idea in reality as well. We present our approach of creating Air characters by dividing them into Procedural, Simulation and Look Development sections for ease of understanding. We also dedicate a brief section to unique challenges that came up during shot work.

2 PROCEDURAL

Each body part was packed with procedural and modeled spheres preserving their design silhouettes. This was then procedurally animated using uv spaces. For stability and optimization we kept recycling these spheres by reducing their sizes as they reached the end of a procedural cycle. To achieve the desired textural quality on volumetric representations, we added scalable high frequency noise on the animated sphere geometry which was then converted to volumes. The parts of the body which did not have spheres, for example the face, also had a rest based moving noise displacement. Since facial performance for our main Air character Gale was very important, we came up with a unique solution for her by using flowing velocity fields and procedural advection approach to add roiling textural details which blended seamlessly when simulation was added on top of it. Additional controls were exposed to the artists over important aspects of these procedural volumes such as roiling speed, textural noise frequency and amplitude.

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3 SIMULATION

We took the output from the procedural stage and simulated thin pyro wisps emitting from the characters. Local procedural velocities, wind vectors and world space velocities were composed to give the wisps directionality. For further shaping into thin elongated taperings we used lower resolution simulation to influence them. Since optimization was one of the primary considerations, we extended the sources along velocities to avoid costly substepping. To blend simulated wisps and procedural volumes, we used simulation velocities to affect the procedural volumes in local areas of overlap. Particles advected through these simulations were used by shading to transfer color for the final look. Tearoffs were another integral feature which were pieces of cloud puffs coming off of the characters and dissipating. Since they were tied to their performance, we utilized a small fraction of the advected particles. To integrate them with the same level of textural details as the body, a similar procedural noise approach was used after copying noised spherical primitives and adding another layer of secondary procedural animation on them.

4 RESTAGING AND AIR OBLITERATION

In some of the shots, characters were animated to the moving camera which meant that any world space simulations would not hold. Another situation where we faced challenges was when the characters were on a fast moving vehicle. For these scenarios we ran simulations after transforming them into different spaces such as camera, local or even user defined space. In other unique scenarios, characters would disintegrate into several pieces and then re-form. For these situations we had a strong handshake with the animation department and utilized the versatility of Pixar's Universal Scene Description [Pixar [n. d.]] file format. There were several clones of the same character created to manage separate parts with animated presence and visibility properties which were read on the rig side and re-assembled.

5 LOOK DEVELOPMENT

The shading department was leveraging data and attributes which were created during the FX stages and was thereby able to integrate all asset pieces seamlessly. Utilizing points from the procedural elements as well as advected particles, we generated a consistent volumetric scalar noise by spatially averaging point samples. This scalar noise was driving a color ramp to achieve a break up in the albedo. In our BG characters the albedo lookup was outsourced into the shader, because this gave us the flexibility to use the same network for all Air BGs and switch shading variants on the fly. For primary air characters, the same advected points contained keyframed “emotion” point data from animation. We sampled the “emotion” data to drive additional changes in the characters' diffuse color to convey the characters' emotional change.

To maintain readable character animation despite procedural and simulation processes; preserving facial and hand performances was critical. This was accomplished twofold, via texture projection and volumetric density manipulation. First, for texture projection we developed a technique that read traditionally painted texture maps utilizing the R, G, and B channels as masks. Those channels were individually projected into the character volume data from the shot camera, and then unique colors were assigned to each channel per character. This allowed for minimal texture map generation and maximum color control at render time. Second, we manipulated the volume density of high performance areas on characters' bodies, (i.e. eyes, mouth, hands, etc). Through generated SDFs and custom ramp signals in the characters' geometry and point data, could we increase the density and control the falloff of any part of the characters' bodies, to achieve a grounded performance and preserve the wispy detail generated in simulation.

The volumetric nature of these characters posed particular challenges when lighting them. The wispy look required the lighting department to minimize light contribution to prevent light leaks from flattening the appearance. Building on technology developed for Pixar's film *Soul* [Fong et al. 2020] we exposed additional lighting controls to increase saturation in volumetric shadows. Furthermore to retain life in the volumetric eyes we had to generate custom volumetric fields for the characters' irises with exposed shading controls for the brightness, size, and falloff of the iris's gleams and highlights so it looked like they were responding to light in a traditional fashion. Stylized linework as used on other elements took away from the wispy look of air characters. To achieve a more integrated type of linework we generated a 0 - 1 camera based signal that ran from the center to the edge of each air character. Lighting utilized the rim signal to mask light contribution and create a faux rim light effect. Via threshold controls, the rim signal could generate tight sharp rim light shapes, naturally impossible in volumes, and reflective of the linework achieved in Fire and Water characters.

6 CONCLUSION

Our hybrid system was able to capture the performance of our main characters and also accommodate the vast scope of secondary Air characters. Our solution combined procedural and simulation techniques in a seamless way to bring characters to life on screen. The rig we designed made it easy to populate fx for hero and other secondary Air characters efficiently along with providing a good starting point for fx artists to add per shot changes as directed.

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