Coloring and Texturing Volume Simulations from Texture Images

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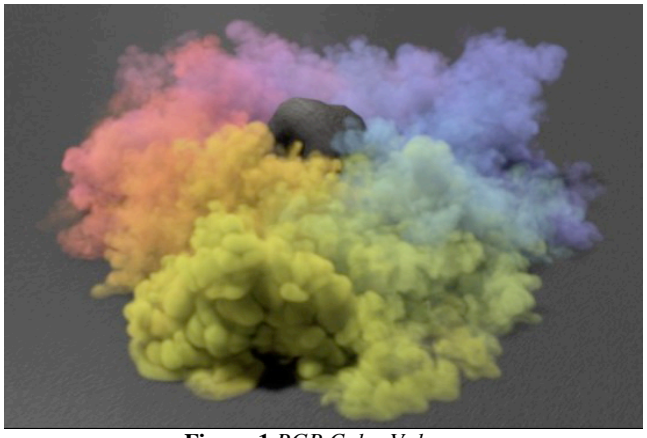

Figure 1 *RGB Color Volume*

Introduction

Fluid simulation is often used to create dust, smoke or ground explosion in visual effects. In some cases, dust contains colors according to ground condition. It makes dust shading more realistic and accurate to the ground color. In this talk, we propose fluid system to emit density with color vector and noise patterns from textured images to provide intrinsic qualities from the source and to add stylization to the volume.

Motivation

Our first attempt used conventional techniques; color the particles based on the texture map from source geometry. This provides a surfacePos that reads out the UVW of the map and attribute transfer to change the color of volumes. However, this technique has limitations as it fails to deliver a natural quality of diffusion and dissipation of color and results in flickering artifacts at areas that are unreachable due to particle radius and results in under sampled textures in between particles. We needed more complete methods to generate color for the volume simulation.

Density Color Volumes

Density is a float value that is equivalent to one channel of color. We present a new type of density that has color channels including alpha. With density as an alpha channel, red, green and blue channel attributes are built into the fluid source with their own density opacity. A surfacePos from the source emission drives each RGB and Alpha channel. Using density as a mask, density advects RGB through velocity and density gradient fields. Results of color channels from the fluid simulation combine in the RGB volume shader using volume compositing techniques.
In order to be used in the production, the techniques should be robust on a couple common production situations:

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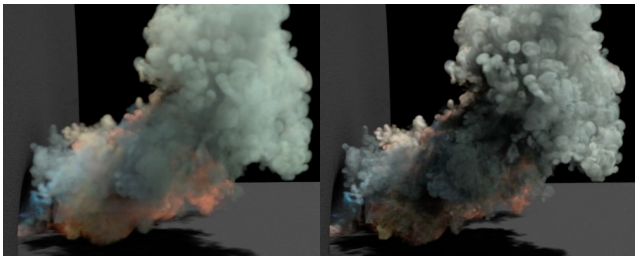
a. Texture Emission. We built the automated system so that assigned textures on the surface emitter transfer the color channel to the volume's color field. We made additional attributes that control sources that can be changed and manipulated by artists. This gives flexibility to artists to have art direction on colors while they progress on look development.

b. Color Mix Test. As color density diffuses and dissipates, the color maintains it's own color property without any flickering artifacts. If color mixes with other sources of color emission, it also blends colors accurately, as when color powders mix in the air. Each source of color emission is prepared in the volume creation stage to write unique names for source volumes, in order to identify each emission to advect density before it blends, diffuses and dissipates.

c. Particle Texture Advection. The source volume is also used for particle advections that carry surfacePos attributes from emitting geometry. The particles with their surfacePos can be assigned procedural texture and transferred into the simulated volume as well. This allows stylization on the volume to add texture patterns like drawing, sketch and noise. The particles from the source volume can also be used as forces to create localized turbulence. This helps to add details into the simulation for additional stylization.



a. Color Volume b. Textured Color Volume

Figure 2 *Particle Texture Advection*

RGB Volume Shader

We accounted for lower opacity color volumes on dark parts of texture. The system uses density based on an opacity gray scale value. Dark parts of the texture do not emit fluids and the bright parts do, so density in black scale has to be simulated with RGB color. We used volume compositing in the RGB volume shader. We subtracted red, green and blue density channels out of black density channels. Then the results of subtracted black density channels were added back to red, green and blue density channels. With this technique, the RGB volume shader shades all the gray scale and color schemes of the density.

Conclusion

The system provides actual color channels for volume simulation, to rely less on conventional particle techniques. It diffuses and dissipates like density simulation without any flickering artifacts and under sampling. After many drills and tests, the technique was ready to use in any production.