Procedural Celestial Rendering for 3D Navigation

A Technique to Render a Parametric Celestial Skybox

Alain Galvan
agalvan@fiu.edu

Francisco Ortega
fortega@fiu.edu

Naphtali Rishe
ndr@acm.org

Introduction

We present a novel technique to render a parametric celestial skybox with the ability to light environments similar to natural color corrected images from telescopes.

We first pre-compute a spherical ray map that corresponds to the cubemap coordinates, then generate stars and dust through a combination of different noise generation shaders.

Related Work

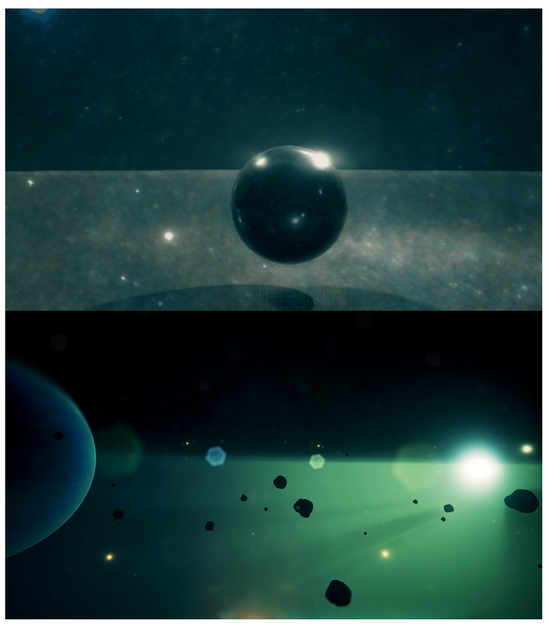
- **Elcott et al.** for Final Fantasy XV generates a sky with raymarching, and used light probes for lighting the scene.
- **Limberger et al.** attempt to render stars using billboards.
- **Elek and Kmoch** provided a model for spectral scattering used in Unreal.
- **Trindade et al.** used cubemaps to rendering multi-scale 3D navigation environments.

Approach

- We first formulate a physically-based model for starlight and stardust based on the user's origin position, star size, and temperature.
- We combine this with **volumetric raymarching** (a volumetric form of ray-casting) techniques for clouds and dust.
- The result is a realtime animated sky that doubles as a radiance map.

Algorithm

- cube based spherical directional map is generated by the shader, which is then used as an input to a four dimensional noise generation algorithm based on the work of Perlin et al. to create volumetric diffuse effects.
- The output of the noise generation algorithms is composited with a white noise function mapped to sharp changes in luminosity values.
- Our system is implemented as a plugin for Unreal Engine 4. Our source code is easy to use and requires minimal changes to existing scenes.



Mapings

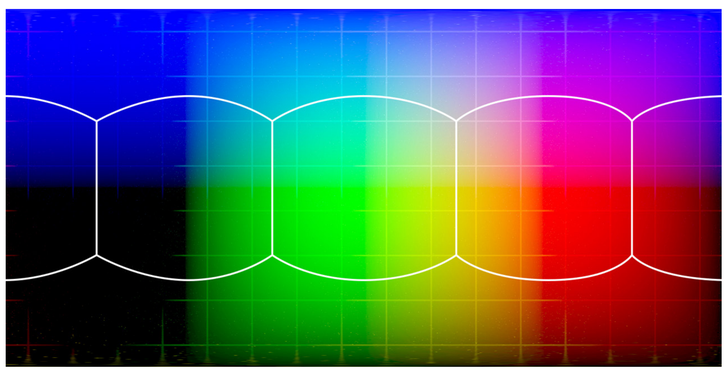


Figure 3: A spherical direction map used as an input for noise generation. The latitude/longitude and round lines were added to help distinguish cube faces.

Elicitation

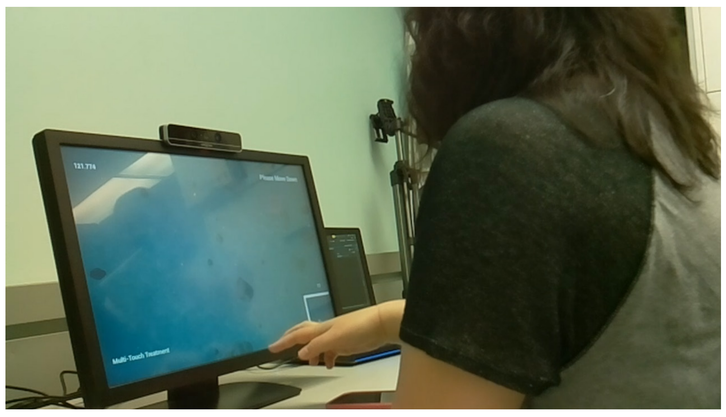


Figure 4: Our first evaluation of the system was in a gesture elicitation study. Users navigated based on instructions.

Evaluation

- During the trials, we were able to constantly refresh the generated sky at 60 frames per second on an **Nvidia 980 GTX** & **980m** (circa 2014) with texels of 1024 pixels per cube face.
- On an **Nvidia 650m** (circa 2012) the effect was too taxing, running at 22 frames per second at 1024 texel size, however 256 texel size ran smoothly at 60 frames per second.

Conclusion

- Our approach provides other researchers with the ability to create large expanses of space for user interaction, in particular 3D navigation.
- The use of cubemap lighting looks similar to color corrected photographs provided by NASA.
- Future work includes the creation of a WebGL implementation of the library.