WorldSeed

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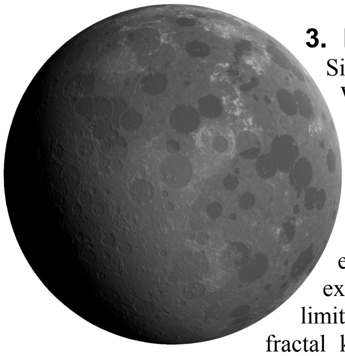
1. Abstract

WorldSeed introduces a fractal architecture that allows to generate and render full scale planets in real-time. Similar to existing concepts (e.g. by Szeliskit and Terzopoulos [1989] [1]) WorldSeed uses self-similar fractal subdivision to generate landscape detail. By expanding the concepts introduced by Bokeloh and Wand [2006] [2] to use triangular patches rather than rectangles, WorldSeed is capable of generating relatively distortion free spherical surfaces. 64bit integer seeds are used to generate consistent worlds, similar to a concept suggest by Teong Joo Ong et al. [2005] [3]. WorldSeed will be an integral part of a virtual reality application within the CodeVenture research project to teach basic modeling and programming skills to teenagers [4].

2. Architecture

The kernel and rendering architecture describe the fractal landscape as a network of triangular surface segments. The considerably increased complexity of triangles over rectangles is outweighed by the possibility of generating spherical surface layouts with minimal distortion. Different hardware-accelerated approaches have been investigated in the course of the project. Due of the complexity of triangle-based layouts WorldSeed currently focuses on CPU-driven approaches.



3. Depth

Similar to existing fractal systems, WorldSeed increases detail by subdivision of existing data, however at a considerably increased depth. The fractal depth of a typical WorldSeed planet ranges between 16 and 22 exponential layers, thus making the entire geometry rather large in its full extend. Without the use of memory limitation and prioritization strategies, the fractal kernel would overwhelm any available memory capacities within minutes or even seconds.

4. Floating point precision and sectors

Planetary geometries enforce a combination of very large coordinates and relatively narrow differences. Unsegmented single precision floating point space is incapable of handling this contrast but remains essential for passing the generated geometry to present-day realtime rendering pipelines.

To cope with this, WorldSeed uses integer offset-coordinates to locate the point of origin of fractal planets, their segments, groups or individual objects, as well as cameras. The currently applied sector edge length of 50km allows the construction of entire solar systems in 32 bit sector space. Using 64 bit instead would expand this range to a thousand times the size of Milky Way.

5. Configuration

One of WorldSeed's primary characteristics is the ability to construct entire planets from an outlining configuration and a singular 64bit integer seed. Given identical configuration and seed the exact same planet is generated, thus making it interesting for distributed environments. The outlining configuration incorporates a number of attributes such as basic radius and height variance, noise-level, etc. Additionally a planetary configuration specifies which visual class to apply to the surface of a new instance. Such a visual class provides information regarding the interpretation of the final fractal data generated by the kernel, i.e. shaders, textures or atmospheric and water coloring.

6. Features

The used techniques primarily attempt to shape earth-like globes, covered by stacked appearance layers in order to imitate natural planetary surfaces. The fractal kernel uses multiple differently paced noise channels, both interdependent and independent, in order to generate a manifold planet surface. The noise channels are compiled to derive a vertex's final height, water availability and layer coverage (rock, plant, sand, snow). By doing so the resulting landscape appears sufficiently diversified without creating repeating patterns as is typical for single-channel fractal maps. Recent enhancements also added macroscopic impact craters to the arsenal of features, thus opening up the possibility of further development towards image based imprinting techniques.

7. References

[1] Richard Szeliskit and Demetri Terzopoulos - From Splines to Fractals, July 1989

[2] Martin Bokeloh and Michael Wand – Hardware Accelerated Multi-Resolution Geometry Synthesis, March 2006

[3] Toeng Joo Ong, Ryan Saunders John Keyser, and John J. Leggett – Terrain Generation Using Genetic Algorithms, June 2005

[4] The CodeVenture project, University of Trier, May 2010. http://codeventure.uni-trier.de