Title

Terrain Synthesis from Example

Description

Realistic terrain generation is very important for applications such as video games and special effects in the movie industry. In this project we will focus on the problem of creating new terrains, rather than trying to reproduce existing (real world) terrains.

The widely accepted approach for terrain generation is procedural terrain synthesis, where typically a fractal based function is evaluated to determine terrain height at a given location [Ebert etal. 1994]. These approaches, however, have several drawbacks. First, their parameters are not easy to control and authoring is difficult: The user cannot easily change the shape of generated terrain. This is especially true if a precise terrain type is desired (ie. some mountains resembling the Alpes). Second, they lack various features of realistic terrains (ie. riverbeds, erosion,…). Usually expensive simulations are run on top of the results to increase the realism. One issue is that the final terrain elevation data then need to be stored and cannot be evaluated on the fly, as the user moves around the scene. (Just like with real world terrain elevation maps).

Texture synthesis from example techniques, which generate large images resembling a small input texture sample (or *exemplar*), may also be used to synthesize terrain heightmaps. The terrain elevation data is simply treated as a grayscale image. One advantage of these approaches is that they exploit real terrain data, so we can hope for more realistic results. Since the results mimics the input it is also easier to produce artificial terrains looking similar to existing ones. Finally, it is also possible to guide synthesis in various ways [Hertzman 2001, Lefebvre and Hoppe], and to synthesize the terrain as the user explores a scene [Lefebvre and Hoppe 2005]. However, the main drawback is the lack of variety that becomes quickly apparent. This is due to the use of a small input example. Several synthesis artifacts may also limit the quality of the results.

The goal of this project is to revisit terrain synthesis from example in the light of these issues. Our goal will be to propose a novel terrain synthesis algorithm which offers easy authoring, larger variety of appearances by exploiting existing terrain databases, and can very compactly store these synthesis results. The proposed approach is to let the user identify interesting features in existing databases (chain of mountains, coastlines, riverbeds) and roughly position and deform these features in the terrain to be synthesized. The synthesis algorithm will then produce a new terrain by changing the copied regions appropriately and filling empty locations using patches from the existing databases. Rather than outputting the final terrain elevation we will output the various operations performed by the algorithm and the (hopefully small) set of source data. This should enable fast reconstruction on the GPU during terrain exploration.

References:

[Ebert etal. 1994]
Texturing and Modeling : A Procedural Approach.
David Ebert, Kent Musgrave, Darwyn Peachey, Ken Perlin, and Worley.

[Hertzman 2001]
Image analogies
Aaron Hertzmann, Charles E. Jacobs, Nuria Oliver, Brian Curless, David H. Salesin

[Lefebvre and Hoppe 2005]
Parallel controllable texture synthesis
Sylvain Lefebvre, Hugues Hoppe
SIGGRAPH 2005

[Lefebvre and Hoppe 2006]
Appearance-space texture synthesis
Sylvain Lefebvre and Hugues Hoppe
SIGGRAPH 2006