Developing an Algorithm for Visualizing Large Terrain Environments in Real-Time

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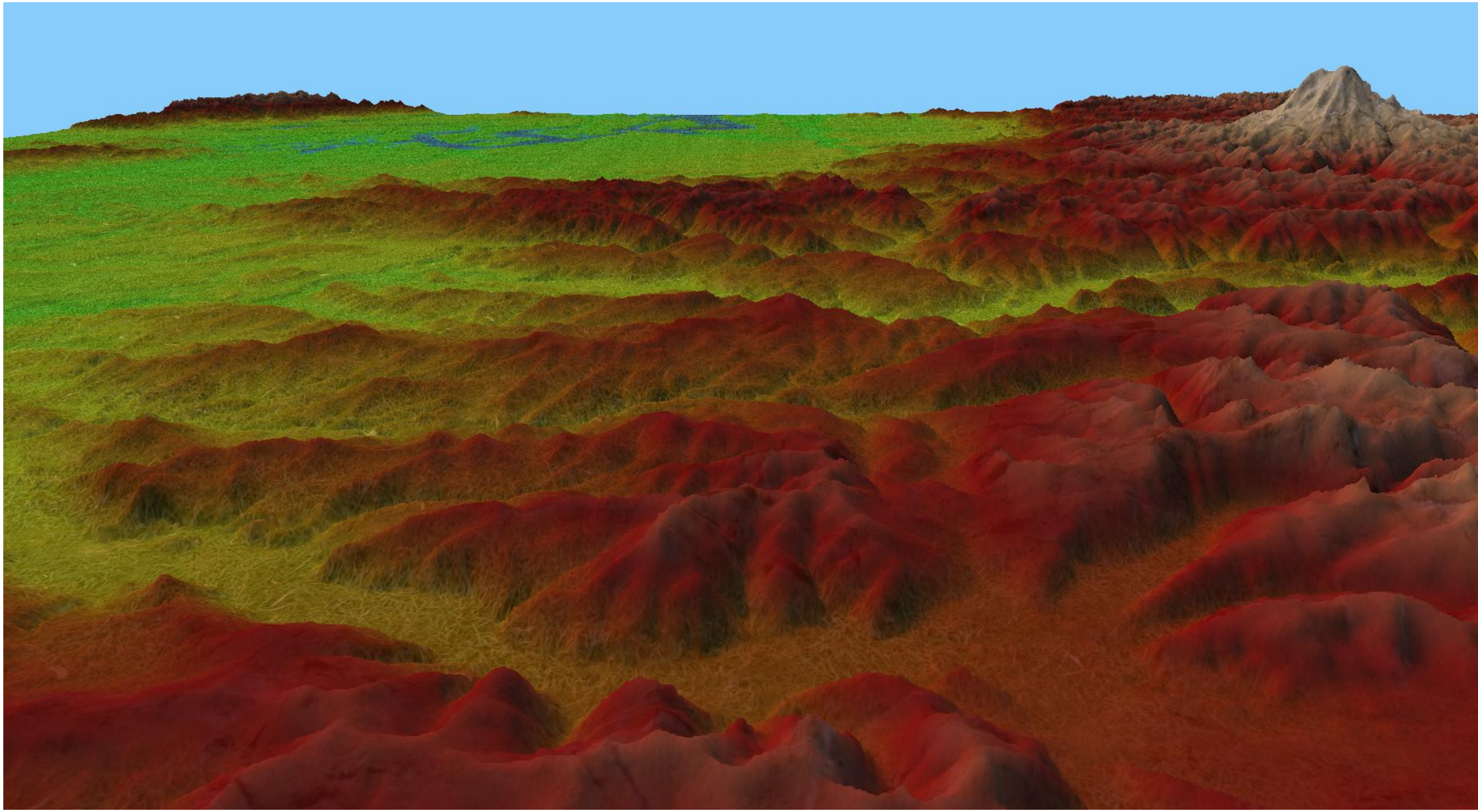

The Puget Sound area with 4097 × 4097 16-bit samples and inter-pixel spacing of 40 meters rendered by the designed algorithm

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Abstract

Terrain rendering has many important applications in the fields of modeling, geographic information systems, videos games, space modeling, flight simulation, synthetic vision systems (SVSs) and others. Due to this, it has been an active area of research for decades. Terrain rendering methods have been devised to handle the rendering of massive terrain datasets in real-time. These methods are designed to deal with large datasets at interactive frame rates to render terrains covering large areas in real-time.

In this research, several approaches to this problem are investigated and based on this investigation, a quad-tree level-of-detail (LOD) multi-activity based method for real-time terrain rendering is presented. The method uses two concurrent activities running in parallel. The errors activity decides what to be rendered and the rendering activity do the actual rendering. The two activities communicate with each other via a LOD hierarchy that is constructed by the errors activity and stored in main storage and each one of them is assigned a CPU thread and a GPU context. The rendering activity then renders the whole terrain as small blocks with different sizes using reusable vertex and index buffers with different scaling and translation parameters based on blurred versions of the height-field texture that are calculated on-the-fly on a vertex shader. Discontinuities are handled using incremental constant vertex and index buffers that cover all possible cases of LOD differences ensuring a tight mesh of terrain geometry where each LOD difference adds a number of

indices from the same index buffer used to handle all cracks.

A hybrid fuzzy texturing method that combines real and artificial details is also presented. It is based on an automatic fuzzy system for blending different detail textures with the terrain base texture to give varying artificial details based on terrain geometry. The original base color that comes from the real terrain texture is still preserved though by using a weighting scheme that favors the base color.

The results of the conducted case study show that although the proposed Hierarchical Error Map method achieves expected interactive frame rates at guaranteed very small screen-space errors of 1, 2, and 3 pixels, the CPU usage is been kept minimum due to the proposed notion of errors texture that is calculated entirely on the GPU.

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