A Resolution Reduction Method for Multi-resolution Terrain Maps

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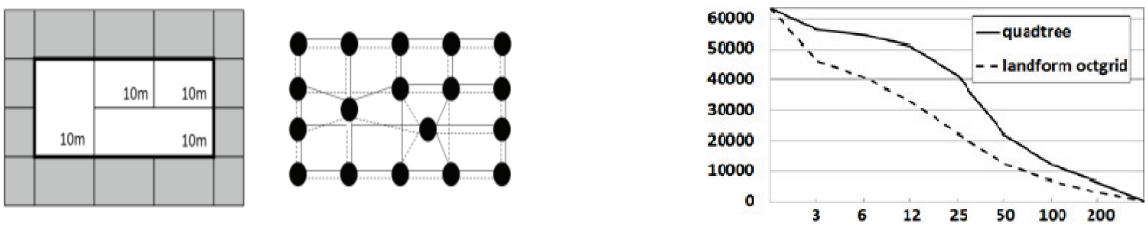

Figure 1. *A landform rectangular dissection (heights in meters)(left), its corresponding landform octgrid (center), and a relation between threshold values (height defferences) for cell unification (x-axis in meter) and cell numbers (y-axis) with the octgrid and quadtree methods for a terrain map of Riva del Garda in Italy (made from NASA SRTM-3).*

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1 Introduction

Raster images such as raster terrain maps are commonly used in computer graphics. For rapid processing such as rendering and rapid feature extraction, rapid resolution reduction methods are required that keep the quality of huge images. This study deals with the resolution reduction methods.

Quadtree models are well-known [Finkel and Bentley, 1972] as data structures for multi-resolution images. But quadtree model representation abilities are insufficient and they have lack of flexibility. On the other hand, rectangular dual models [cf. Kozminsky and Kinnen, 1985] can represent arbitrary multi-resolution raster terrain maps, but they require a large amount of computation time to reduce resolutions.

In this study, we provide another resolution reduction method of huge raster maps for rapid processing, and show experimental results.

2 Algorithms

Raster maps are represented by *landform rectangular dissections* as in Figure 1 (left). We modify an octgrid (e.g. [Kirishima et. al, 2002] and introduce an octal grid graph called a *landform octgrid* [Akagi et al., 2005] as shown in Figure 1 (right). In landform octgrids, nodes are linked by edges if their corresponding cells are nearest and have the ruled line in common. The degrees of the nodes are bounded by 8.

We introduce an algorithm that unifies cells v_x, v_y in a landform octgrid G_D with respect to the given threshold value l and provides the output landform octgrid G_E.

Algorithm *LandformUnifyCell*(G_D, v_x, v_y, l, G_E)

Next, we introduce a resolution reduction algorithm for multi-resolution 3D terrain maps. We call the processing method based on the algorithm the "landform octgrid method".

Algorithm *ResolutionReduction*(G_D, l, G_E)

This algorithm (1) unify nodes along with the Hilbert curve by *LandformUnifyCell*; then (2) unify nodes horizontally and vertically by *LandformUnifyCell*; This method derives resolution reduction for black and white images without threshold values [Shindo et al., 2012].

3 Experimental Results

We compare the landform octgrids with rectangular duals and quadtrees.

Property 1. The octgrid method provides 3D terrain maps with equivalently less cells to the rectangular dual method in $O(N)\times O(n+m)$ time, while the rectangular dual method provides ones in $O(N)\times O(N)$ time, where N is the number of cells and n and m are the number of rows and columns, respectively.

Figure 1 (Right) shows the relation between the number of cells and the threshold values with respect to the quadtree method and to the landform octgrid method. Then we have

Property 2. The octgrid methods possibly reduce by half the number of cells to the quadtree method.

4 Conclusion

We introduced an octal grid graph model called "landform octgrid" for 3D terrain maps. And we proposed two algorithms to reduce their resolution. We compare "landform octgrid" with rectangular duals and quadtrees and claimed that "landform octgrid" has some advantages. We would like to thank to Prof. Kensei Tsuchida of Toyo University.

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