Compressing Terrain Slopes with ODETLAP

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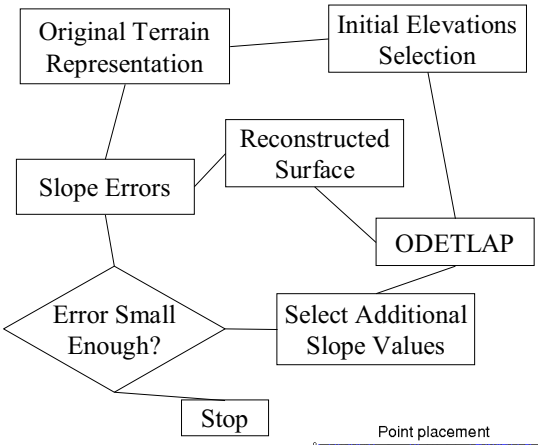
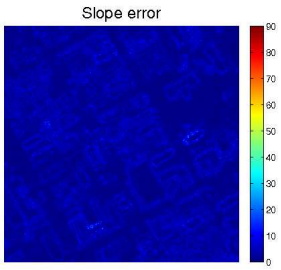
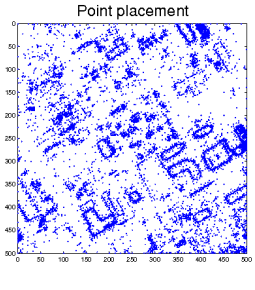
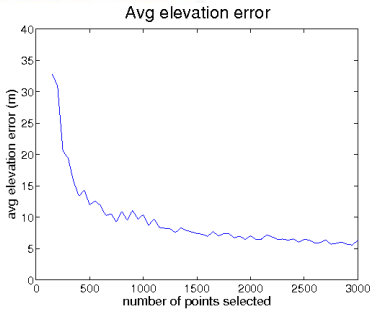
Abstract:
We extend the ODETLAP compression algorithm to include slope equations to specifically target the compression of terrain slopes. Given a subset of the elevations and slopes from the terrain, ODETLAP can reconstruct a full-resolution approximation of the terrain.

Point Selection:









ODETLAP:
Overdetermined set of linear equations
Original ODETLAP equations:
Discrete approx. of Laplacian PDE:

$$z_{i,j} = (z_{i+1,j} + z_{i-1,j} + z_{i,j+1} + z_{i,j-1})/4$$

Known elevations:

$$z_{i,j} = h_{i,j}$$

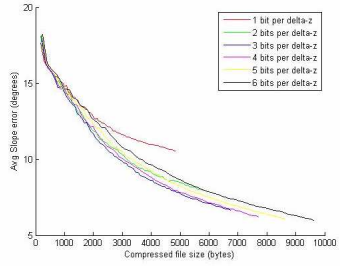
Plus new slope equations, derived from Zevenbergen-Thorne slope method:

$$z_{i+1,j} - z_{i-1,j} = h_{i+1,j} - h_{i-1,j}$$

$$z_{i,j+1} - z_{i,j-1} = h_{i,j+1} - h_{i,j-1}$$

Algorithm:
1. Start with regular grid of elevations.
2. Iteratively solve ODETLAP and add points with largest slope error to the system.
3. Encode (x,y) with Run Length Coding.
4. Encode **Δ**z lossily with k-means clustering.

Compression vs. error (400x400 terrain)



References:
1. W. Randolph Franklin, Metin Inanc, and Zhongyi Xie, “Two Novel Surface Representation Techniques”, Autocarto 2006
2. Zhongyi Xie, W. Randolph Franklin, Barbara Cutler, Marcus A. Andrade and Metin Inanc, "Surface Compression using Over-determined Laplacian Approximation", SPIE 2007, August 2007