Evaluating Hydrology Preservation of Simplified Terrain Representations

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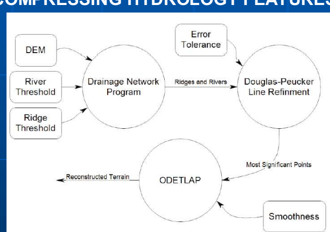
PROBLEM

• Large Dataset Sizes: Terrain data is being sampled at ever increasing resolutions over larger geographic areas requiring special compression techniques to manipulate the data

• Sampling Issues: Dataset inaccuracies due to insignificant resolution sampling and data collection errors impedes water flowing causing small and unrealistic watersheds.

• Measuring Effectiveness: Typically, terrain compression algorithms seek to minimize RMS (root mean square) and maximum error. These metrics fail to capture whether a reconstructed terrain preserves the drainage network.

COMPRESSING HYDROLOGY FEATURES



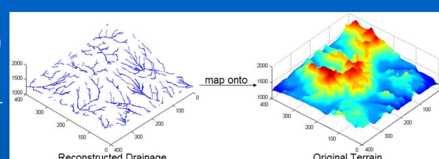
The flow chart above describes the methodology behind the ridge-river compression method. Inputs are in boxes and programs in circles.

1. We compute the drainage network and ridge network. This locates the valleys and ridges.

1. Next, we eliminate redundancy in the network by taking the most significant points using the Douglas-Peucker method.

1. We use ODETLAP to interpolate the surface based on a subset of known, hydrology significant points.

MEASURING HYDROLOGY ERROR



To determine the amount of hydrology error lost during terrain simplification the drainage network computed on the reconstructed geometry is mapped onto the original elevation matrix.

$$EnergyDown = \sum_i max(0, E_i - E_{r(i)}) * W_i$$

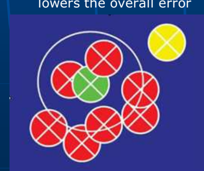
$$EnergyUp = \sum_i max(0, E_{r(i)} - E_i) * W_i$$

$$Error = \frac{EnergyUp}{EnergyDown}$$

• Error is determined by illogical flows of the water over the terrain

• Large amounts of Water flowing uphill at steep angles drastically increases the error

• The opposite is true for water flowing downhill which lowers the overall error



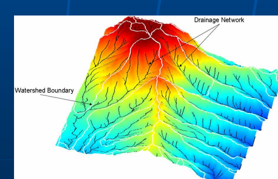
To reduce error in our compression technique, we add k number of points with the highest error.

Points that are within a certain distance of each newly added points are forbidden from being added.

RESULTS

	Compr. Ratio	Ridge-River %up	Ridge-River error	JPEG2000 %up	JPEG2000 error	TIN %up	TIN error
hill1	13	2.05	0.0023	0.12	0.0020	0.79	0.0432
	32	3.16	0.1149	0.18	0.0030	1.11	0.0502
	54	2.46	0.2316	0.24	0.0082	1.33	0.0600
hill2	14	0.85	0.0005	0.21	0.0010	1.25	0.0333
	37	1.21	0.0063	0.31	0.0017	1.80	0.0304
	60	1.39	0.0129	0.46	0.0047	2.43	0.0421
hill3	11	2.65	0.0026	0.10	0.0059	0.76	0.0311
	27	4.33	0.0075	0.11	0.0051	0.77	0.0434
	47	2.70	0.0100	0.13	0.0161	0.85	0.0405
mtn1	16	3.75	0.0267	0.41	0.0026	3.96	0.0563
	39	4.96	0.0530	0.80	0.0036	5.11	0.0583
	60	5.91	0.0611	1.33	0.0067	6.28	0.0667
mtn2	16	3.93	0.0769	0.40	0.0033	4.42	0.0748
	38	5.15	0.1169	0.75	0.0033	5.72	0.0874
	59	6.21	0.1377	1.32	0.0067	7.09	0.0904
mtn3	15	3.10	0.0254	0.40	0.0015	4.16	0.0592
	39	4.33	0.0493	0.78	0.0027	5.63	0.0624
	61	5.13	0.0639	1.40	0.0050	6.63	0.0650

Each dataset is compressed by 3 different lossy compression schemes at 3 different levels. For each, the percent of flow uphill and the energy error metric is presented.



Above we see the drainage network in black and the watershed boundary in white. High compression often results in fragmented drainage networks, with small insignificant and unrealistic watersheds.