VisTRE: A Visualization Tool for Evaluating Errors in Terrain Representations

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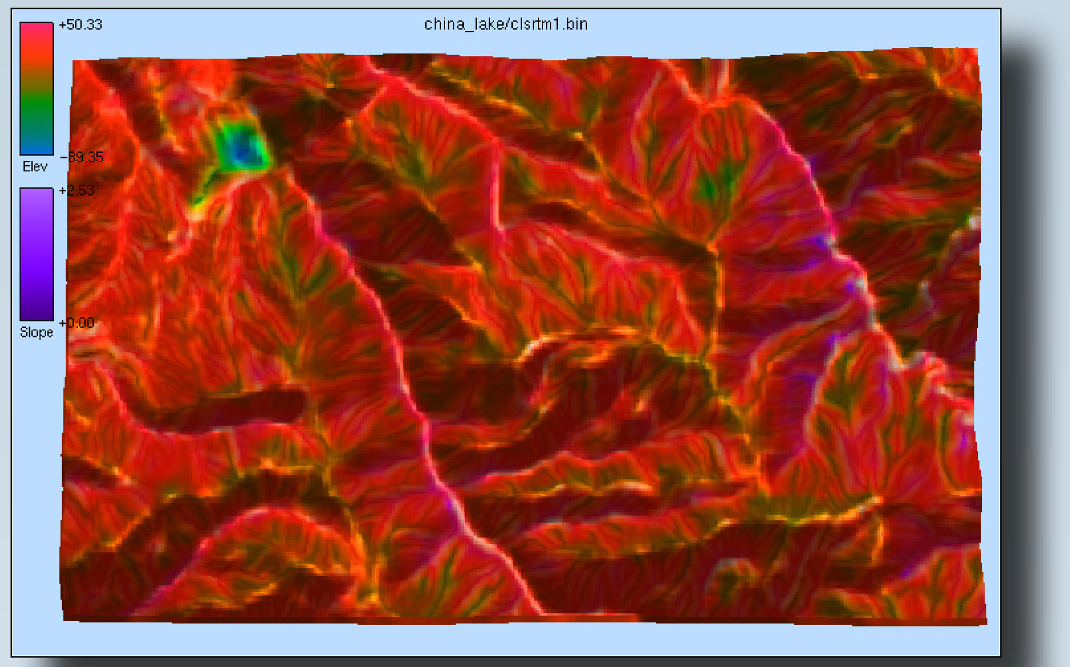
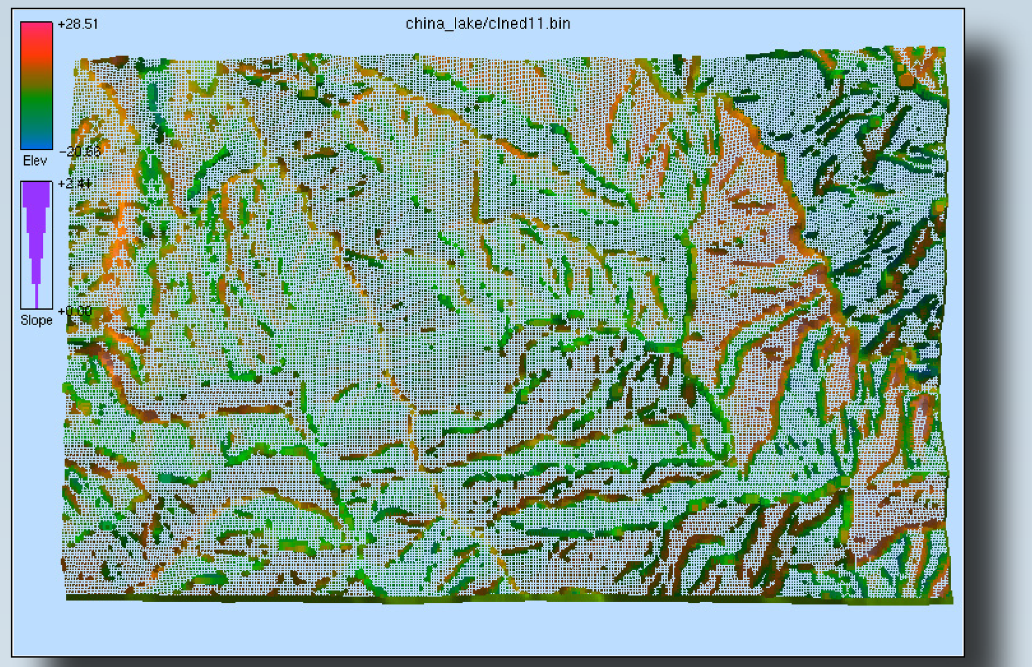
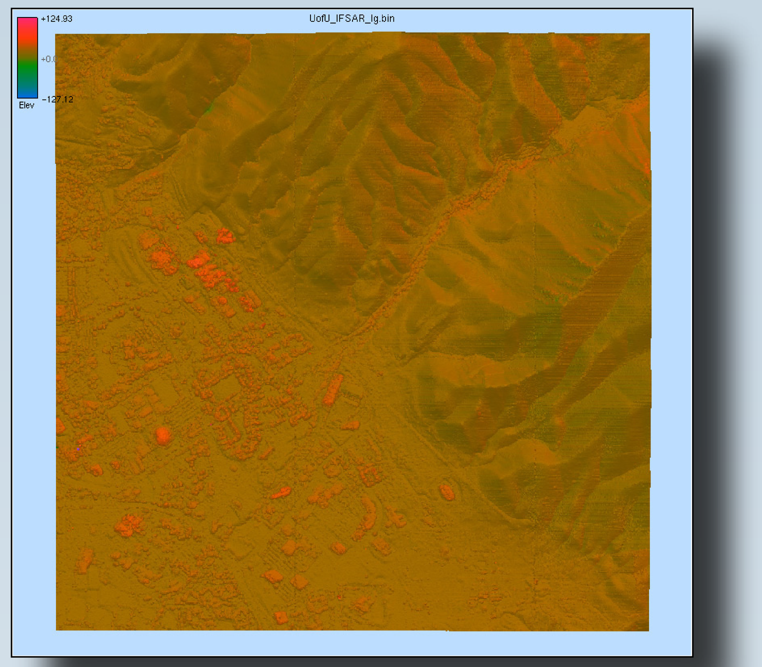


Comparing shuttle radar topography mission (SRTM) elevation data to a ground truth terrain model reveals a tendency to flatten ridges and valleys, as well as a gravel pit that was dug deeper after the ground truth terrain model was captured



Using different visual features to simultaneously present two error values: elevation error from the national elevation dataset (NED) terrain model at 1-degree resolution visualized using hue, and slope error visualized using size

The NED terrain in its original format is translated in y relative to the ground truth terrain, as indicated by the positive (red hue) errors on the north-facing slopes and negative (blue hue) error on south-facing



Interferometic synthetic aperture radar (IFSAR) terrain model of the University of Utah with elevation error represented by hue reveals the vertical “seams” that were introduced when individual LIDAR patches were stitched together

Project Goals

New sensors and improved computational capabilities allow us to collect huge amounts of sample data on which to build terrain models for a broad range of applications: photogrammetric correction, flood modeling, beach monitoring, visibility simulation, and urban and natural resource management. This project is developing a system to visualize error on terrain models so that we can compare different terrain representations, different data sources, and different levels of detail, both numerical and visually. Specifically, we are:

1. Developing a visualization software tool that uses guidelines from low-level human vision to display multiple terrain error values (e.g. elevation and slope error) in a perceptually salient manner.
2. Studying different terrain simplification algorithms (e.g. meshless wavelets, video-based acquisition of terrain properties) applied to different data sources to identify strengths and limitations of each technique.
3. Implementing a “plug-and-play” API to allow simplification algorithms to integrate directly into our visualization environment, allowing us to compare and contrast new methods as they are developed.

Proposed Approach

Our system has two types of modules.

Surface modules represent a continuous terrain surface derived from data. A surface module must report surface attributes when queried at measurement locations. Each surface module has attributes of elevation and resolution, and may register others such as slope, aspect, or confidence.

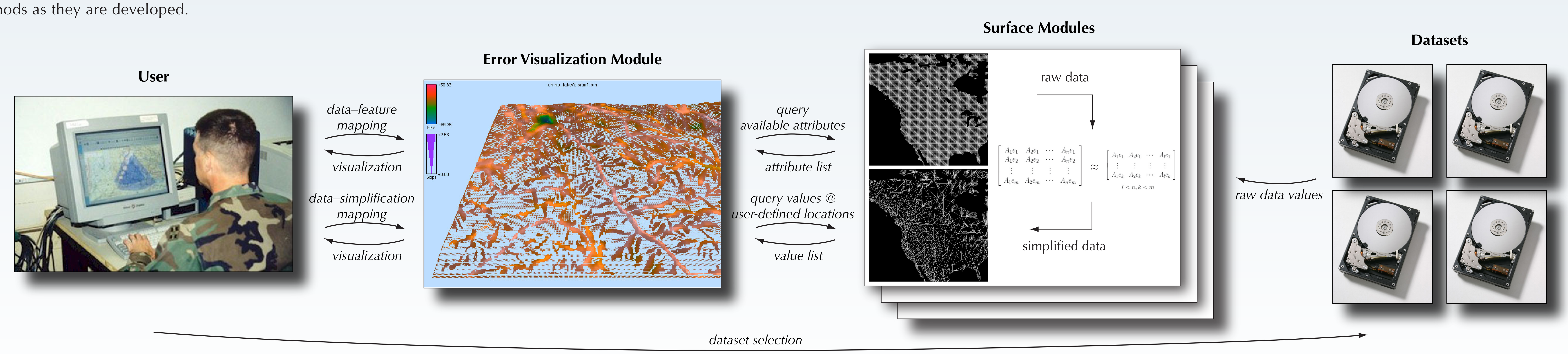
The error visualization module requests attributes at chosen measurement locations (from one or more surface modules, at one or more levels of detail). One set of returned attributes is deemed ground truth — often the user chooses the measurement locations as the most accurate data known for the ground truth surface.

Through user interaction a perceptual-based mapping from attributes, or their deviation from ground truth, to visual features is constructed. By simultaneously visualizing results from two or more surface modules or levels of detail at the same measurement locations, the error visualization module permits the user to compare terrain representations and their errors.

Progress to Date

During the first eight months of the project (initiated in November 2005), we have completed the following tasks:

1. Implemented data handling routines to import UTM-coordinate terrain data at varying resolutions, then register, resample, and derive errors to produce a data stream to be visualized.
2. Investigated the use of color, luminance, size, and motion to visualize elevation and slope error for a user-selected terrain representation.
3. Tested our system with datasets from NED DEM (national elevation dataset digital elevation model), SRTM (shuttle radar topology mission), LIDAR (light detection and ranging), IFSAR (interferometric synthetic aperture radar), and MPEG video data sources.
4. Collaborated with colleagues at the National Geospatial-Intelligence Agency (NGA) to identify the strengths and limitations of our techniques for datasets and analysis tasks critical to NGA.
5. Initiated development of the “plug-and-play” data simplification and visualization APIs, to visualize results from new simplification algorithms as they are developed.



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