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Massive Terrain Data Processing: Scalable Algorithms

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Modern remote sensing methods such as LIDAR readily generate very large data sets of high-resolution elevation data. Several applications including stream mapping, landslide risk assessment, hydrological and erosion modeling can benefit from this high-resolution data, but processing the data sets which can be tens or hundreds of gigabytes in size poses a number of technical challenges. LIDAR point sets must be transformed into a digital elevation model (DEM) and derived products such as a river network or watersheds, line of sight information before users can conduct relevant studies.

We describe our approach as a pipeline consisting of a number of individual stages. In the first stage we convert raw LIDAR point sets to a digital elevation models using the spline approximation method with substantially modified segmentation procedure to handle hundreds of millions of points. The constructed DEM may have some artifacts due to sampling noise or introduced by the approximation method. We therefore remove from the terrain topological noise that would impede water flow along a river network while preserving large natural depressions or sinks such as quarries or craters.
The next stages use the denoised DEM for constructing various derived data or terrain analysis tools. For example, we have developed these stages for computing flow network and water shade hierarchies.

We designed and implemented the pipeline mentioned above such that the entire pipeline is scalable to large data sets. A single non-scalable stage in the pipeline would create a bottleneck and limit overall scalability. The experimental results on
real LIDAR data that show our approach is scalable to data sets containing hundreds of million of points--over 20GB of raw data. Our approach allows users to go from raw data to useful high-level

information with little or no manual intervention; at the same time,
our software is highly modular and each stage can be run individually
if certain intermediate results are desired.

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