PARALLEL TERRAIN COMPRESSION AND RECONSTRUCTION

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We introduce a parallel approximation of a solver for an Over-Determined Laplacian system of linear equations (ODETLAP) which is applied to the compression and restoration of terrain data used for Geographical Information Systems (GIS). ODETLAP can be used to reconstruct a compressed elevation map, or to generate a dense regular grid from airborne Light Detection and Ranging (LIDAR) point cloud data. With previous methods, the time to execute ODETLAP does not scale well with the size of the input elevation map, resulting in running times that are prohibitively long for large data sets. The algorithm presented here divides the data set into patches, runs ODETLAP on each patch, and then merges the patches together. This method gives two distinct speed improvements. First, scalability is provided by reducing the complexity such that the execution time grows almost linearly with the size of the input, even when run on a single processor. Second, ODETLAP can be calculated on the patches concurrently in a parallel or distributed environment. This new patch-based implementation takes 2 seconds to run ODETLAP on an 800×800 elevation map using 128 processors, while the original version of ODETLAP takes nearly 10 minutes on a single processor (271 times longer). The effectiveness of the new algorithm is demonstrated by running it on data sets as large as 16000×16000 on a cluster of computers. Results from running on an IBM Blue Gene/L system with 32,768 processors are also discussed.