High Performance Computing For the Rapid Generationi of Digital Terrain Model From LIDAR Data

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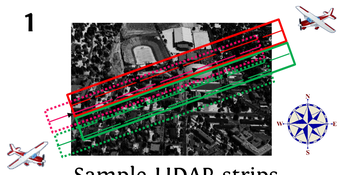
Introduction

LIDAR is an active remote sensing system which acquires data to generate a digital terrain model (DTM) of the Earth's surface. This DTM is a critical input in many research applications such as flood mapping, and hydrological modeling. In this study, the potential utilization of High Performance Computing (HPC) is investigated for the rapid DTM generation from LIDAR data.

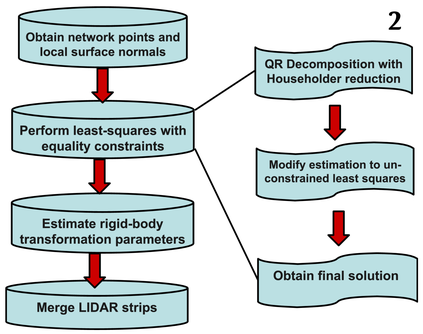
Objectives

- Employ HPC (High Performance Computing) to merge the LIDAR datasets
- Utilization of HPC to generate seamless DTMs from the merged data

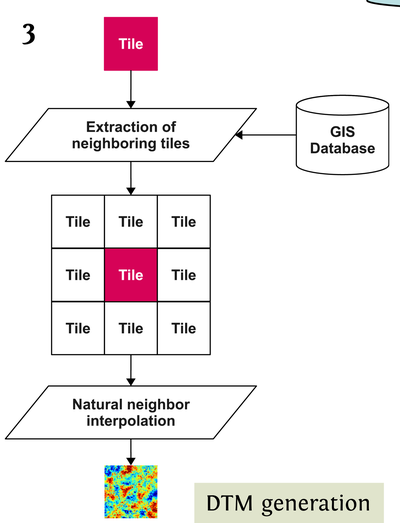
Flowchart



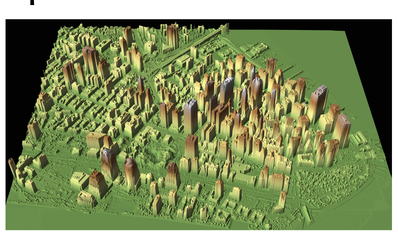
Sample LIDAR strips



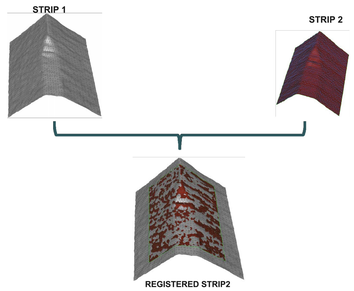
LIDAR strip registration



DTM generation



Sample output

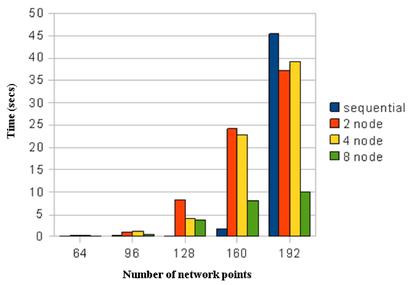


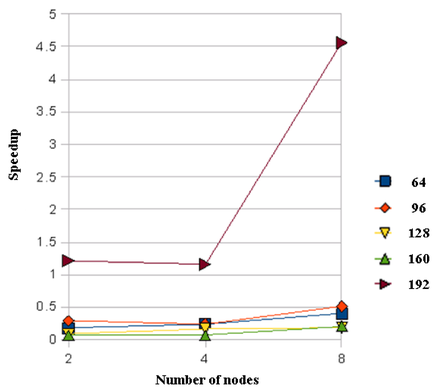
Effect of Registration

Registration Implementation

- Computational resources for parallel registration
  - MC cluster in Math Department, Purdue University
  - MPI library used for communication (No threading)
  - Number of processors: 2, 4, 8
- Number of network points: 64, 96, 128, 160, 192

Parameter Estimation Results



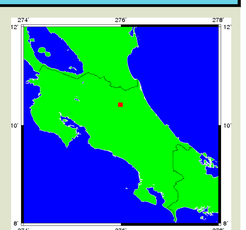


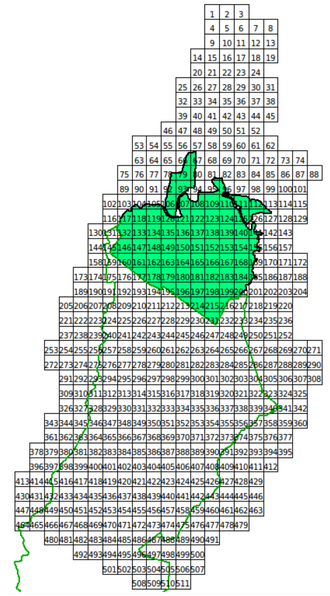
Computational Platform for DTM Generation

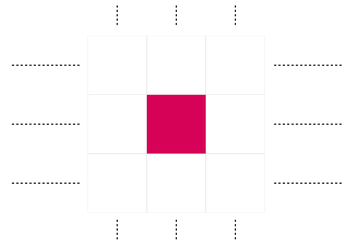
- Hardware (Coates community cluster)
  - 985 8/16 core HP system
  - RAM: 16-32 GB / node
  - Interconnection: 10 Gigabit Ethernet
- Software
  - Python + Numpy library
  - Natgird library: Natural Neighbor Interpolation
  - GDAL & OGR library: Raster and vector data manipulation

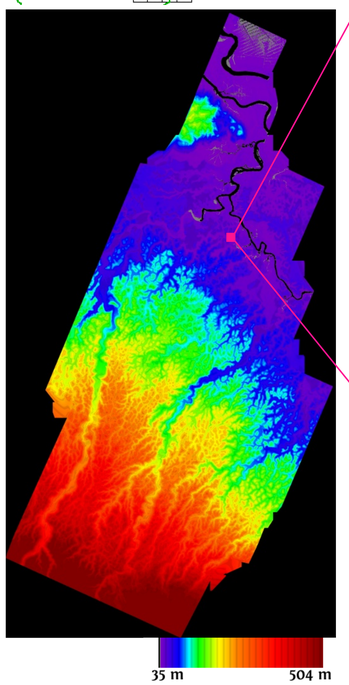
LIDAR Point Cloud Data

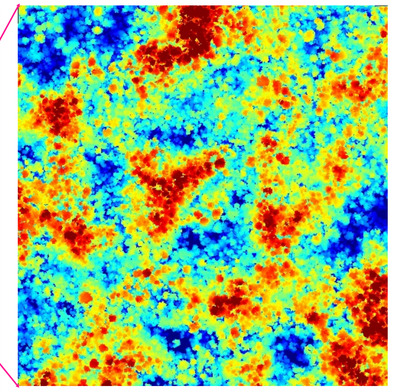
- Leica ALS50 discrete return airborne LIDAR system
  - Coverage: La Selva, Costa Rica
  - Acquisition date: Mar 13, 2006
  - Total number of points: 127,849,839
  - 1.99 observations per square meters in average
  - Number of tiles = 511
  - Spatial dimension of each tile = 500 m x 500 m











DTM generation run time for 511 tiles

	Run time (hr)	Run time (day)
1m DTM	2272.4	94.7
2m DTM	1290.3	53.8
5m DTM	1039.7	43.3

Completed DTM generation for 511 tiles in less than 3 days using pto and standy-8 queue

Seamless DTM Generation

- Classification of LIDAR point cloud data
  - Ground vs. Non-ground points
- Interpolation
  - Natural neighbor
  - Utilization of neighboring tiles

Conclusion

- Positive speedup obtained for 192 points, but poor results for smaller network sizes
- Larger networks (>200 points) should also result in improved efficiency
- HPC promises to improve LIDAR strip registration
- Significant run time reduction in DTM generation by utilizing HPC
- HPC has great potential for near real time DTM generation from LIDAR data