LIDAR processing
R&D Program for NASA/ICREST Studies
Project Report 09/16/01

Program Objectives:

1. Examine the accuracy of LIDAR data typically acquired for City-type application.
2. Examine and document some of the issues that are encountered when working with LIDAR data within various GIS and Image Processing packages.
3. Examine the accuracy of various portrayals of the LIDAR data (TIN, Kriged, Grid, Topogrid, etc.).
4. Document and create a bare-earth model of these data with known error metrics.

Progress Summary:

Elevation Accuracy Assessment:

One goal of using Light Detection and Ranging (LIDAR) data was to assess the accuracy of the first return elevation values delivered by the sensor. Using a "truth" consisting of 60 static Global Positioning System (GPS) points and approximately 49,000 kinematic points, various surface modeling techniques were assessed to determine the most accurate surface model for later analysis. LIDAR data for the Urban Validation Site (UVS) in Springfield, Missouri was processed and converted into several different surface models. Included in the analysis were a Triangulated Irregular Network (TIN), lattice, point grid, topo grid, and several kriging variations. The USGS 30-meter DEM for the UVS was also tested as well as the variation of the static and kinematic GPS points for control.

A profile was taken across each surface model in the same location. This arc was densified and then converted to points with the resulting point file elevations assessed against the "truth" to determine overall accuracy of the surface. The underlying assumption with this method is that the data is continuous, but we found that due to signal absorption and errors in the data, that is not always the case. This method did however allow us to determine the best surface for future analysis and should be considered the standard when conducting future work with the data set.

Results show that after the completion of the elevation accuracy assessment, the lattice model yielded the best accuracy for the entire UVS with an overall absolute elevation difference of 0.620-meters. Elevation accuracy for the USGS DEM was much worse with an absolute difference of 2.056-meters. All elevation accuracy assessment results for the UVS can be seen in the following table and graph.

LIDAR Processing:

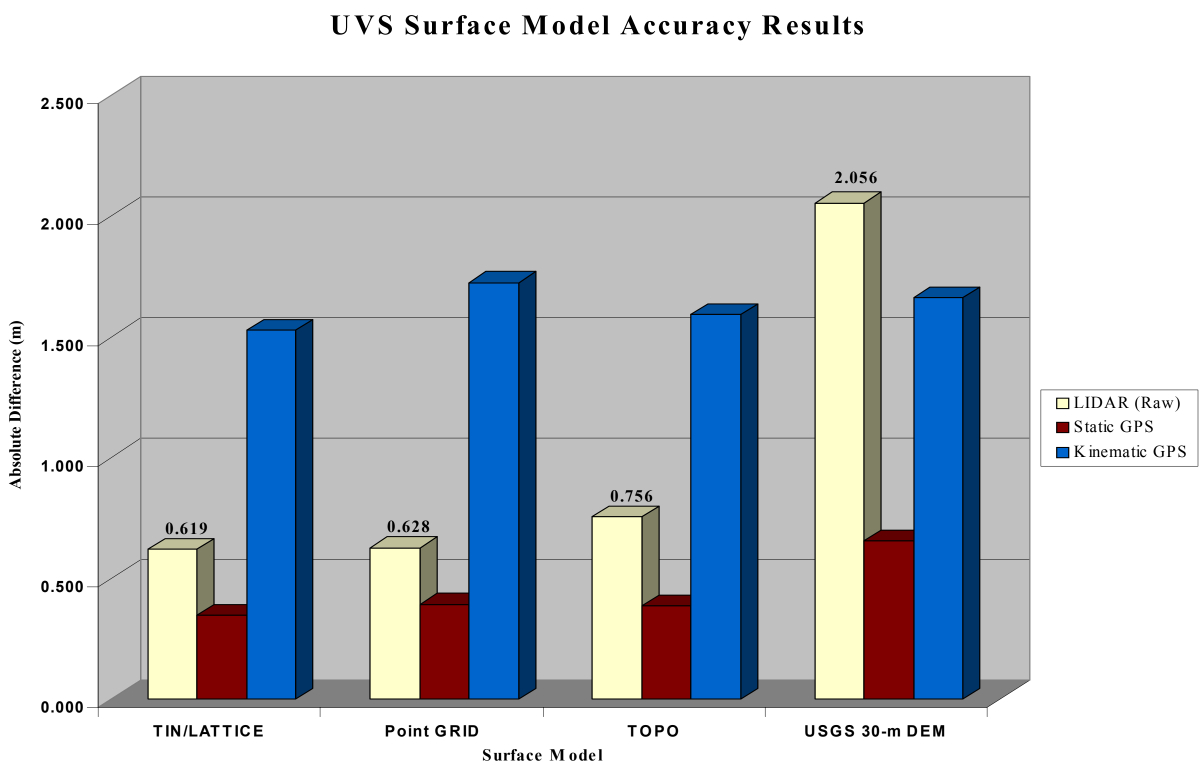
Each raw LIDAR text file was uncompressed using WinZip and transferred via File Transfer Protocol (FTP) to a workspace on a RS6000 UNIX machine. This raw text file was assessed using the *wc* Unix command to determine the number of lines in each file. If the file was found to contain in excess of 5 million lines, the text file was split into smaller files containing no more than 5 million lines each for ease of processing. Each sub-file was processed using an in-house arc macro language (AML) program, which rearranged the text file into a comma-delimited necessary for generation of an Arc coverage. The resulting comma delimited files were loaded into ArcView as a table, and added as an Event Theme. Each Event Theme was then converted to an ArcView shape file then converted to an Arc coverage in ArcInfo using the *shapearc*. In the point attribute table, both the system number and ID attributes were altered to make the output width large enough to accommodate the number of spaces necessary for a coverage with ~39 million points. Each attribute for the positional information and elevation was altered on each file to the names X, Y and Z, after which all the sub-file coverages were appended in ArcInfo thus creating one coverage of the raw LIDAR points. At this point, all other files were cleaned off to clear the disk space necessary for the subsequent surface modeling.

A surface model was developed for each LIDAR point cloud using the following protocol. In ArcInfo, a Triangulated Irregular Network (TIN) model was created from the point coverage using the *createtin* command. This intermediary model was then used to create a lattice model in ArcInfo using the *tinlattice* command. This model generated an equally spaced grid from the point cloud with the grid cell surface sloped based on surrounding elevation values. This methodology was developed after the elevation accuracy assessment determined the lattice model to produce the most accurate results.

UVS Surface Model Accuracy Results:

Data Source	TIN/LATTICE	Point GRID	TOPO	USGS 30-m DEM
Lidar (Raw)	0.620	0.628	0.756	2.056
Static GPS	0.346	0.392	0.386	0.655
Kinematic GPS	1.529	1.726	1.592	1.664

*Absolute Elevation Difference (m)



Ongoing Activities:

This process has been performed on all of the raw LIDAR data and is underway on the bald earth LIDAR data. Bald earth processing is approximately 25% complete at the time of this report. Approximate process time from raw data to lattice model is approximately 10 hours per quarter-quad. Projected process time for the bare earth processing is approximately 135 hours. A manual is in draft form for this processing and is being used by novice users in this process for screening and assessment.

LIDAR Bare Earth Product Generation/Validation/Error Modeling Team

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