Aero-Metric, Inc. under contract with the State of Minnesota

20090604

Southeast Minnesota LiDAR Acquisition

remote-sensing image

MnDNR Nine County LiDAR Acquisition - State of Minnesota, Department of Natural Resources

The Southeast Minnesota LiDAR Acquisition projects goals were to provide high accuracy bare-earth processed LiDAR data suitable for FEMA National Flood Insurance Program (NFIP) for nine counties in southeastern Minnesota. Those counties were Dodge, Fillmore, Freeborn, Houston, Mower, Olmsted, Steele, Wabasha, and Winona. The project consisted of acquisition, post-processing, and classification of LiDAR data. The classified bare-earth data achieved the following: nominal horizontal spacing of 3 feet based on the Universal Transverse Mercator System, Zone 15, related to the North American Datum of 1983 (2007). Vertical accuracy was to achieve a Fundamental Vertical Accuarcy at a 95% confidence level of less than 0.36m in the "Open Terrain" land cover category. Accuracy statement is based on the area of moderate to flat terrain. Diminished accuracies are to be expected in areas in dense vegetation and steep slopes. The accuracy of the LiDAR data as tested met the vertical accuracy of 0.36m or less standards, however, derived products may be less accurate in areas of dense vegetation and steep slopes due to a lesser number of points defining the bare-earth in these areas.

20081118

20081124

ground condition

Complete

As needed

-93.65645130

-91.15730677

44.48777166

43.46710646

Light Detection and Ranging

LIDAR

Bare Earth

Point Cloud

DEM

GEODATABASE

Breakline

Southeast Minnesota

Minnesota

Nine Counties

Dodge

Fillmore

Freeborn

Houston

Mower

Olmsted

Steele

Wabasha

Winona

County

None - this data is available to the general public

None.

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LAS data are V1.1, file geodatabases are ESRI ArcGIS 9.2 Geodatabases

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Unclassified

The Consolidated Vertical Accuracy (CVA) of the TIN achieved a 0.205 meters at a 95% confidence level in all land cover categories. 127 control points were used in this evaluation.

Data have been checked and validated to conform to attribute standards defined by the project

Complete

All these data products were acquired at 2400 meters above mean terrain (AMT) and have a horizontal accuracy of 0.40 meters, with a nominal point spacing of 1.0 meters.

The Fundamental Vertical Accuracy (FVA) of the TIN achieved a 0.161 meters at a 95% confidence level in the "Open Terrain" land cover category. 26 control points were used in this evaluation. The Consolidated Vertical Accuracy (CVA) of the TIN achieved a 0.36m at a 95% confidence level according to ASPRS Guidelines, Vertical Accuracy Reporting for LiDAR for all land cover categories. 127 points covering 5 land cover categories were tested. Land Cover categories are the following: Open Terrain, Tall Weeds and crops, Brush lands and low trees, Forested areas fully covered by trees, and Urban areas with dense man-made structures. Supplemental Vertical Accuracy (SVA) of the TIN are shown below at a 95% confidence level, derived by the ASPRS Guidelines, Vertical Accuracy Report for LiDAR Data based on the 95th percentile error in all of the individual land cover categories. Below is the land cover categories with the achieved accuracy reported at a 95th percentile error and the number of test points. Open Terrain 0.144m 26 Tall Weeds and crops 0.240m 23 Brush lands and low trees 0.248m 22 Forested areas fully covered by trees 0.165m 22 Urban areas with dense man-made structures 0.216m 34

The LiDAR data was captured using fixed wing aircraft equipped with LiDAR systems. The LiDAR system includes a differential GPS unit and inertial measurement system to provide superior accuracy. Both Aero-Metric, Inc and Surdex Corporation acquired LiDAR data over the project area. Surdex's data was post-processed to a raw point cloud by Surdex and then delivered to Aero-Metric to be merged into one raw point cloud dataset. Acquisition parameters: 1. Scanners - Optech ALTM Gemini (Aero-Metric) and Leica ALS50-2 (Surdex) 2. Flight Height - 2400m above mean terrain 3. Swath Width - 32degrees 4. Sidelap - 60% 5. Nominal Post Spacing - 1.0m. GPS and IMU processing parameters: 1. Processing Programs - Aero-Metric= Applanix - POSGPS and POSProc; Surdex= GravNav GNSS and Leica IPAS 2. Maximum baseline length - Not greater than 30km. 3. Number of base stations during LiDAR collection - A minimum of 2 MnDOT CORS stations were occupied during any of the lifts to acquire the LiDAR data. The following were the occupied base stations: BLUE, CLDN, DDGC, ELKT, EYTA, LCHI, LCRS, NALB, PRSP, REDW, RSHF, STWV, TWNL, WBSH, WINO, and WSCA. 4. GPS and IMU processing monitored for consistency and smoothness - Yes. Point Cloud Processing: 1. Program - Aero-Metric= Optech Dashmap; Surdex= Leica ALS Post Processor 2. Horizontal Datum - NAD83(2007) 3. Horizontal Coordinates - UTM, Zone 15, in meters 4. Vertical Datum - NAVD88 5. Geoid Model used to reduce satellite derived elevations to orthometric heights - NGS Geoid03. LIDAR Processing: 1. Processing Programs and versions - TerraSolid TerraScan (version 009.010), TerraModeler (version 009.002 and TerraMatch (version 009.003) and Intergraph MicroStation (version.08.01.02.15). 2. Point Cloud data is imported to TerraScan in a Microstation V8 (V) CAD environment on a ILDOT specified 2000 meter by 2000 meter tiling scheme. 3. The data is projected to the horizontal project coordinate system of UTM - Zone 15 in meters. 4. Analyze the data for overall compleness and consistency. This is to ensure that there are no voids in the data collection. 5. Inspect for calibration errors in the dataset using the TerraMatch software. This is accomplished by sampling the data collected accross all flight lines and classify the idividual lines to ground. The sofware will use the ground-classified lines to compute corrections (Heading, Pitch, Roll, and Scale). 6. Orientation corrections (i.e. Calibration corrections) are then applied to the entire dataset. 7. Automatic ground classification is performed using algorithms with customized parameters to best fit the project area. Several areas of varying relief and planimetric features were inspected to verify the final ground surface. 8. AERO-METRIC, INC. provided Quality Assurance and Quality Control (QAQC) data for this project. AERO-METRIC captured 127 QA/QC points in multipled land cover categories that were used to test the accuracy of the LiDAR ground surface. TerraScan's Output Control Report (OCR) was used to compare the QAQC data to the LIDAR data. This routine searches the LIDAR dataset by X and Y coordinate, finds the closest LIDAR point and compares the vertical (Z) values to the known data collected in the field. Based on the QAQC data, a bias adjustment was determined, and the results were applied to the LIDAR data. A final OCR was performed with a resulting RMSE of 0.109m. 9. Once the automatic processing and the testing of LiDAR is complete, AERO-METRIC meticulously reviews the generated bare-earth surface data to insure that proper classification was achieved as part of a Quality Control process. 10. Final deliverables are generated and cut out according to the MnDNR tiling and naming scheme (1/16 USGS 7.5 minute Quadrangles). Geodatabase Creation: 1. The final geodatabase for each of the 1544 tiles (1/16 USGS 7.5 minute Quadrangles) was created using ESRI ArcInfo software. 2. Each MicroStation contour file was converted into shapefile format. 3. The shapefile was inserted into the geodatabase as a feature class named “Contours” inside the defined feature dataset "Contour\_Data". 4. Topology checks were done to look for dangles, crossing and intersecting contours, as well as other anomalies. All errors were fixed and a second topology check was done to verify an error free dataset. 5. The contour features have two attributes, “Contour\_Type”, which identifies the contour type (index, intermediate, depression, and depression\_index) and “ELEVATION” which indicates the contour elevation in US FOOT. 6. The BareEarth data within the LAS point files was imported into a feature class named “Bare\_Earth\_Points” inside the defined feature dataset "Terrain\_Data". The points are created as multipoint features which groups the LAS points into blocks of data in order to reduce the number of records in the geodatabase. 7. The breaklines are imported as polylines into a feature class named “Hydro\_Breaklines” inside the defined feature dataset "Terrain\_Data". 8. The 1.0 meter DEM data was imported as raster points into the defined feature dataset "DEM01". Each point in the DEM file becomes a pixel with an assigned elevation in meters. Final Deliverables: 1. One paper copy of the LiDAR Accuracy Assessment Report. 2. One firewire hard drive containing the following data: a. Point Cloud Data in LAS 1.1 format for each of the 1544 tiles (1/16 USGS 7.5 minute Quadrangles). x=Easting (0.01 resolution), y=Northing (0.01 resolution), z=Elevation (0.01 resolution), i=Intensity (0.1 resolution) LAS data classified using the following codes: 0, 2, 5, 6, 8, 9, 10, 12 according to ASPRS LAS format classification table. Units in meters b. Geodatabase files for each of the 1544 tiles (1/16 USGS 7.5 minute Quadrangles) including the following feature classes: i. Bare\_Earth\_Points - LAS Point Cloud Data ii. Hydro\_Breaklines - Water/shoreline breakline data iii. Hydro\_Breaklines - Enhanced breakline data to include but not limited to retaining walls, road edges, ridge lines, dams for Project Area B only. iv. DEM01 - Bare-Earth DEM raster at 1.0m resolution per tile. Vertical units in meters at 0.01m resolution. v. Contours - Vector contours at 2ft intervals represented in US FOOT vertically and meters horizontally. 3. FGDC Compliant metadata for the Point Cloud Data LAS delivery. 4. FGDC Compliant metadata for the Geodatabase delivery. MnDNR reviewed the deliverables for content and accuracy. Any needed corrections to the content of the dataset were addressed and corrected by AERO-METRIC and redelivered. Accuracy of the dataset was verified by a second set of ground control points provided and tested by MnDNR. The Consolidated Vertical Accuracy (CVA) of the TIN as tested by MnDNR achieved a 0.287 meters at a 95% confidence level of all land cover categories. 1009 control points covering the 5 land classes were used in this evaluation. The vertical RMSE and sample count per county as tested by MnDNR is as follows: Dodge 0.129m 121 Fillmore 0.155m 128 Houston 0.110m 134 Mower 0.161m 115 Olms 0.117m 125 Steele 0.125m 137 Wabasha 0.106m 97 Winona 0.161m 176

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Metadata imported.

C:\Documents and Settings\tiloesch\Desktop\1081001.xml

20090923

08120700

Unknown

Point

North American Datum of 1983 (2007)

Clarke 1866

Semi-major Axis > 0.0,6378137.0

>0.0,298.25722210088

North American Vertical Datum of 1988

0.01

meter

Explicit elevation coordinate included with horizontal coordinates

20090910

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FGDC Content Standard for Digital Geospatial Metadata

FGDC-STD-001-1998

{806D8749-A96E-49C8-9248-6A7467703919}

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08120700

TRUE

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