Mapping Matters

By Qassim A. Abdullah, Ph.D., PLS, CP**

Your Questions Answered

The layman's perspective on technical theory and practical applications of mapping and GIS

question 1

I am looking for information on photogrammetric accuracy standards and classifications for photogrammetric flights executed with digital sensor (digital frame). I am also looking for technical specifications for flights and expansion factor for digital mapping (flight scale versus cartographic scale).

Viviana Castro Tapia,
Geomatics Department, Aerial Photogrammetric Service, Air Force of Chile

Dr. Abdullah: The subject of associating map accuracy, photo scale and map scale with the Ground Sampling Distance (GSD) of digital camera systems has been a focus of attention by users and camera manufacturers alike, ever since the release of the first large format metric digital cameras at the beginning of the last decade. I have published several articles on this topic in my column. Please refer to the previous issues of "Mapping Matters" articles in the *PE&RS* journal, specifically May 2009 which addresses your concerns. Other "Mapping Matters" articles published in July 2007, June 2008, May 2009, March 2010, August 2010, September 2010, October 2010 also discuss related topics. An archive of past issues of "Mapping Matters" can be found on the ASPRS web site: http://www.asprs.org/mapping_matters.

"The ground sampling distance in lidar, or post spacing, is a function of several factors such as the mirror scan rate (for mirror-based systems), the laser pulsing rate, the aircraft speed, flying altitude, and the scan field of view."

question 2

Is there any reference for algorithms and/or available code/software for filtering out man-made and vegetation features from a lidar dataset?

Asked by an attendee of the ASPRS webinar "Lidar Fundamentals and Applications" on September 16, 2010

Dr. Abdullah: Currently, there are numerous commercial and open source software and tools available for lidar data users to enable them to process lidar data intelligently and efficiently. Most notably, commercial packages such as TerraScan (by Terrasolid Ltd. of Helsinki, Finland), eCognition Software (by Trimble of Sunnyvale, California, USA), ArcGIS (by ESRI of Redlands, California), LP360 (by QCoherent Software, LLC of Colorado Springs, Colorado, USA), LIDAR 1 CuePac (by GeoCue Corporation of Madison, Alabama, USA), and VG4D (by Virtual Geomatics, Inc. of Austin, Texas, USA), just to a mention few. Open source and free software are also available to users, such as GRASS 6 GIS (open source software by GRASS Development Team) and Polyworks (by the U.S. Army Corps of Engineers). By mentioning brand names, the author does not endorse or recommend specific software as it is up to the reader to evaluate the suitability of different packages for their specific needs.

"...the density of lidar points and the 'multi-returns capability' are the most critical factors in determining the effectiveness of lidar in mapping forest floor beneath the tree canopy."

question 3

What is the relation between post spacing, and "ground spot size"?

Asked by an attendee of the ASPRS webinar "Lidar Fundamentals and Applications" on September 16, 2010

Dr. Abdullah: No direct relation exists between the post spacing and ground spot size (or footprint) of a laser pulse from a lidar system. As a matter of fact, you could have a situation where the laser ground spots overlap each other.

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This situation happens when, for example, the acquisition parameters result in a lidar post spacing of 0.20 meters and ground spot size of 0.50 to 0.60 meters. The footprint of a laser pulse is a function of the aperture size of the laser source. This in many ways resembles the Instantaneous Field of View (IFOV) of other sensors. While the field view (IFOV) of a single Charged Couple Device (CCD) in digital cameras determines the sensor ground resolution or the Ground Sampling Distance (GSD), it is not the case with lidar. In lidar, the pulse's footprint on the ground does not equate to the traditional ground sampling distance used in imagery. The ground sampling distance in lidar, or

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question 4

post spacing, is a function of several factors such as the mirror scan rate (for mirror-based systems), the laser pulsing rate, the aircraft speed, flying altitude, and the scan field of view.

Is a large or small footprint better for canopy mapping? Which gives better penetration?

Asked by an attendee of the ASPRS webinar "Lidar Fundamentals and Applications" on September 16, 2010

Dr. Abdullah: First of all, I would like to clarify the term "penetration" when used in "lidar penetration". Lidar does not penetrate the canopy but it can see through voids and gaps that exist within the canopy. It is like looking up to the sky when standing under thick canopy on a sunny day. You will most likely see glimpses of the sky (or the sun light) through the canopy despite the dark and shady environment of the forest floor where you stand. Lidar pulses behave the same way as your eyes but looking down through the gaps in the canopy instead of you looking up. For these reasons, the density of lidar points and the "multi-returns capability" are the most critical factors in determining the effectiveness of lidar in mapping forest floor beneath the tree canopy. The more lidar points that hit the canopy, the better chance that some of them will go through gaps in the canopy and ultimately reach the forest floor. In addition, most lidar systems available on the market today are equipped with what is called the "multi-returns capability". That is when the lidar system is capable of receiving multiple returns for the single emitted pulse. In layman's terms, the pulse will be fragmented upon collision with ground objects if the object has multiple depths such as hitting a building edge or tree canopy. When the pulse falls on the center of a large gap in the canopy and the pulse reaches the ground without obstruction, it will bounce back to the sensor as one and only return. However, if the pulse falls at the edge of the gap or if the gap is smaller than the laser spot size, the pulse will break into pieces, some of which will bounce back to the sensor after hitting the canopy while other parts continue until they reflect off branches in the lower canopy or ultimately the forest floor. Not all portions of the pulse will eventually make it back to the sensor as it depends on the path it takes. But for those that make it to the sensor, the system will acknowledge and record the arrival time of that return, which is eventually converted to a geospatial position. Having some laser pulses reach the forest floor and bounce back to the sensor is crucial to the success of any manual or automated processes to detect and remove vegetation in lidar data in order to obtain bare-earth terrain data.

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Please send your question to Mapping_Matters@asprs.org and indicate whether you want your name to be blocked from publishing. Answers for all questions that are not published in *PE&RS* can be found on line at www.asprs.org/Mapping Matters.

***Dr. Abdullah is the Chief Scientist at Fugro EarthData, Inc, Frederick, Maryland. He is the 2010 recipient of the ASPRS Photogrammetric (Fairchild) Award.*