Mapping Matters

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

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

Q: How do we deal today with the issue of the spot height accuracy requirement that the ASPRS map accuracy standard calls for when most of our terrain modeling techniques are changed from photogrammetric compilation to lidar, IFSAR and auto-correlation technologies?

Anonymous

Dr. Abdullah: The spot height requirement in some map accuracy standards is totally different, and usually much higher, than for contours. The American Society for Photogrammetry and Remote Sensing (ASPRS) standard for example, mandates that spot height accuracy meets twice the accuracy of the contours generated from the same source data.

Historically, it was standard practice to model the terrain using only contours, mass points, and spot heights. The contours were generated directly from the 3D stereo compilation by technicians in a process called "pulling contours". In contrast, most contour generation today is created from a triangulated irregular network (TIN) that is generated either from breaklines and masspoints, a lidar point cloud, or an autocorrelated surface from digital imagery.

Based on the old method of generating contours (pulling contours), some map standards utilized the contour interval (C.I.) in their estimate for the vertical accuracy of elevation data. But since the process of pulling contours is relatively less accurate than the process of determining heights of discrete points in the terrain, the ASPRS standard, for example, required collected spot heights to posses twice the accuracy of that for the contours generated from the same stereo model. There was no scientific justification given at the time for this strict quantification of doubling the accuracy requirements.

This differentiation between the accuracy of spot heights and contours was acceptable at the time considering the standard practice of stereo-compiling the elevation data. However, with the introduction of new techniques and different acquisition technologies such as digital autocorrelation, lidar, and radar imaging, discrepancies in the different components of the DEM accuracy is diminished if not completely resolved. All lidar points, for instance, have the same accuracy and dense lidar point clouds are the only feature used to model the terrain. The same is true for auto-correlated surfaces modeled using digital imagery.

If we take the ASPRS standard for example, the spot height is required to be accurate to within an RMSE = 1/6 * C.I., while the contour accuracy is required only to meet an RMSE of 1/3 * C.I. What this means is that for a digital camera, projects with a 15 cm ground sample distance (GSD) must meet an accuracy of 10 cm for the 2 ft C.I. DEM. This is very tight accuracy considering the increased flying heights associated with flying digital sensors and the current performance of the GPS/IMU technologies.

Given this, a better measure of digital elevation data accuracy is the root mean squares error (RMSE), especially since most DEM users now want elevation data for 3D modeling and not contour generation. For users who still require the contour interval as a vertical accuracy measure, elevation data providers should refrain from referring or committing to the spot height accuracy. In fact, many DEM users have already accepted the fact that new technologies have rendered the spot height measure irrelevant to the accuracy of DEMs created using new sensors that produce one level of high quality mass points. Terrain data modeled using mathematical modeling concepts, such as the one used in TIN construction, maintains the same accuracy throughout the project; there is no reason to believe that one place of a lidar-generated surface model is more or less accurate than others unless it is more obscured by trees or other obstructions, in which case one is not required to meet the same accuracy of an open terrain.

The National Spatial Data Accuracy Standard (NSSDA) uses only one accuracy figure in expressing the tested accuracy of the DEM, unlike the ASPRS, which calls on two figures of accuracy, contours and spot height. The reason behind this is obvious; the NSSDA was developed during a period where non-conventional sensors were already utilized in production while the ASPRS standard was developed decades ago. In my opinion, the ASPRS and any other authority in the field of map accuracy using two different accuracy figures in expressing the vertical accuracy of an elevation dataset should be revisited and revised to eliminate any discrepancies or disagreement between elevation data users and the providers of such data and to embrace the new concepts in elevation data modeling and collection.

Finally, more cooperation between both private and governmental data users, sensor manufacturers, and perhaps the Federal Geographic Data Committee (FGDC) and/or ASPRS is needed in order to address the performance of the new technologies and the 3-D modeling methodologies and to settle this specific issue of spot height requirement. Such cooperation may very well result in revising some of the current accuracy standards governing the accuracy of the elevation data.

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