Geophysical Research Abstracts
Vol. 16, EGU2014-9397, 2014
EGU General Assembly 2014

DTM generation using land cover classification based on low density lidar data

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While the point density of local LIDAR surveys continues to increase, most regional or national LIDAR campaigns are carried out with medium or low density, and have the main purpose of DTM generation. Many different point selection and filtering algorithms are already established. Depending on land cover and vegetation, some perform better than others, but no algorithm exists that works perfectly for all types of land cover. Therefore, our method applies several different DTM generation and filtering algorithms for different spatial units depending on their land cover and vegetation. Land cover and vegetation are mapped based on the original raw LIDAR dataset.
Two discrete echo airborne LIDAR measurements were used, one with 1 point/m2 and a larger area with 0.4 point/m2 density. The datasets were used together for DTM generation after relative georeferencing by strip adjustment.
We defined several land cover categories depending on how they influence vertical distribution of LIDAR points: buildings, waterways, grasslands, crop fields, wetlands, and forests. The study area was classified to these categories based on a decision tree algorithm using parameters calculated from the original LIDAR dataset (sigmaZ, reflectance, aspect, slope, echoratio, roughness), at resolution identical to the output DTM. For the points within spatial units belonging to each of these categories, we implemented different filtering and interpolation methods to select ground points.
For buildings, roof and wall points were removed and the resulting gap filled by interpolated based on the neighbouring data. In forests we calculated a first smooth approximate surface based on minimum points every 10 meter cells. We calculated a residual value for every point of this surface in this class. Then we analysed the point cloud based on residuals value and made an optimum threshold which classified the datasets for non-ground and ground points. In wetlands and croplands, the point height range within 10 meter cells was calculated as a proxy of vegetation height, and was subtracted from the surface derived from the top of the canopy. In grasslands or other low vegetation, all points were kept, while open water was excluded from DTM generation. After some iteration and error analysis steps we integrated the ground points from different classes, interpolating the final DTM.
Accuracy was checked against a set of GPS-surveyed ground points for all used land cover categories, and compared with standard (land-cover independent) DTM generation algorithms. DTM generation algorithms implemented in the OPALS software packages.
As the result we created a 5 meter accuracy DTM over an area of 5307 km2, which is considered to be the most detailed available in Hungary. This DTM can be used as input data for further analysis for geomorphological and geological information, which can help to understand surface evolution of the study area.
These studies were carried out ZsK was partly funded by Campus Hungary Internship TÁMOP-424B1.