Quality control of digital elevation models.

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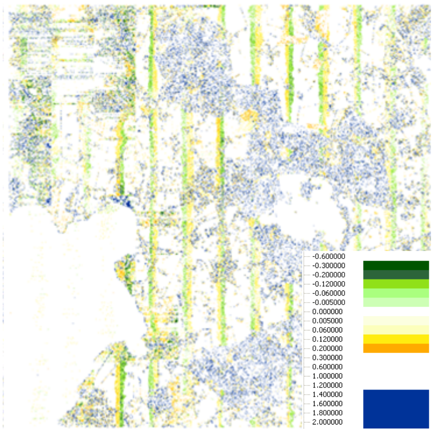
Introduction

The KMS (National Survey and Cadastre – Denmark) uses a method based on normalized digital surface models, to check the quality of the strip adjustment for lidar point clouds. Lidar point clouds are the raw material for digital terrain models (DTMs), and strip adjustment is used in order to fit the height observations from overlapping flight tracks.

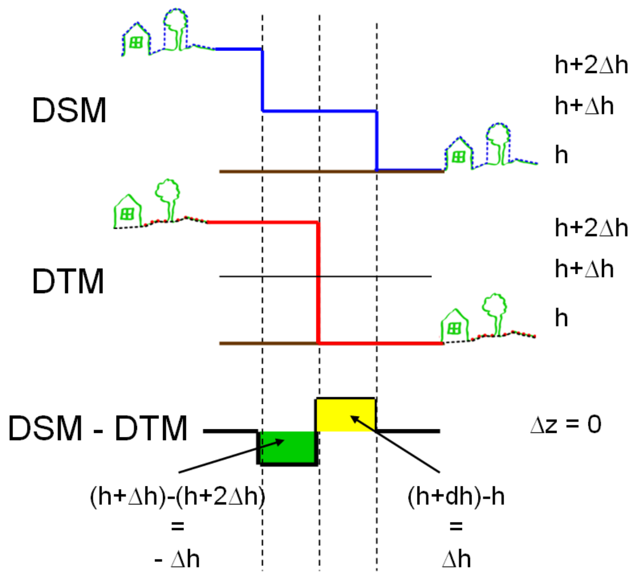
The method used is independent of any external data, but utilizes the classification of the point clouds into ground/above ground reflections, which is a common step in most lidar processing procedures.

The figure to the right shows how the normalized surface model (nDSM) highlights an area with remaining strip adjustment errors (shown as green/yellow fringes). Caption unit is metres.

The dual range (±0.6 m and above 1.5 m) ensures that building outlines are included as blue patterns in the image as a visual guidance for the human interpreter.



Method



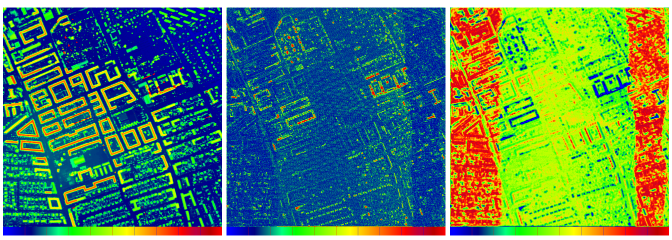
The mechanism for detecting strip adjustment residuals: The DTM is generated from points classified as terrain (i.e. local minimum values). The points classified as terrain will be the *lowest points of each strip until the border line*. At the border line the lowest points of the next strip will be classified as terrain.

In cases where one strip is systematically lower than the other (due to adjustment imperfections) the terrain model will have a step at the border.

In the cross over regime, a surface model (which is based on interpolation including *all* points) will differ from the terrain model by an amount of approximately half the adjustment residual, since approximately half of the points used will come from either strip. The result will be the mean value of both strips.

Subtracting the DTM *(half of the terrain points)* from the DSM *(all points)* will result in zero where they are equal and plus or minus Δh where they differ.

PINGPONG



Left to right: Digital Surface Model (0 m–35 m), and corresponding variance estimates (0 m–4 m), and point cloud density ($0/m^2$–$1/\mathrm{m}^2$) measures. A suburban landscape of mixed high/low buildings, streets, gardens, et cetera. Computed from raw lidar data, using the PINGPONG program.

Fundamentally, PINGPONG is a high speed gridding program for scattered geodata. It uses a simple, but efficient, data management technique to speed up the gridding procedure.

The speed of PINGPONG makes it feasible to include a large amount of gridding in our quality control procedure, even for national scale datasets (in our case involving in the order of 20 billion data points).

Effectively, we are generating two interim elevation models in order to test one point cloud for its suitability for generating a final model. While this may seem somewhat extravagant, experience shows that it is actually both useful and efficient.

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