Distributed processing of Dutch AHN laser altimetry changes

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1. Introduction

Detection of alterations in human-made structures in urban areas can provide useful information for government agencies on several fields ranging from land usage through urban planning and civil engineering to disaster management. Our research proposes a methodology to automatically evaluate altimetry change detection of massive multitemporal datasets in a distributed or cloud computing environment.

2. Dataset

As example measurements, the multi epoch nation-wide AHN (*Actueel Hoogtebestand Nederland*) altimetry archive of The Netherlands was selected, covering 40.000 km^2 and containing trillions of XYZ points. We decided to compare the second data acquisition performed between 2007-2011 and the already available parts of the ongoing third one – planned to be accomplished between 2014-2019.

Figure 1: Available parts of AHN-3
Source: www.ahn.nl

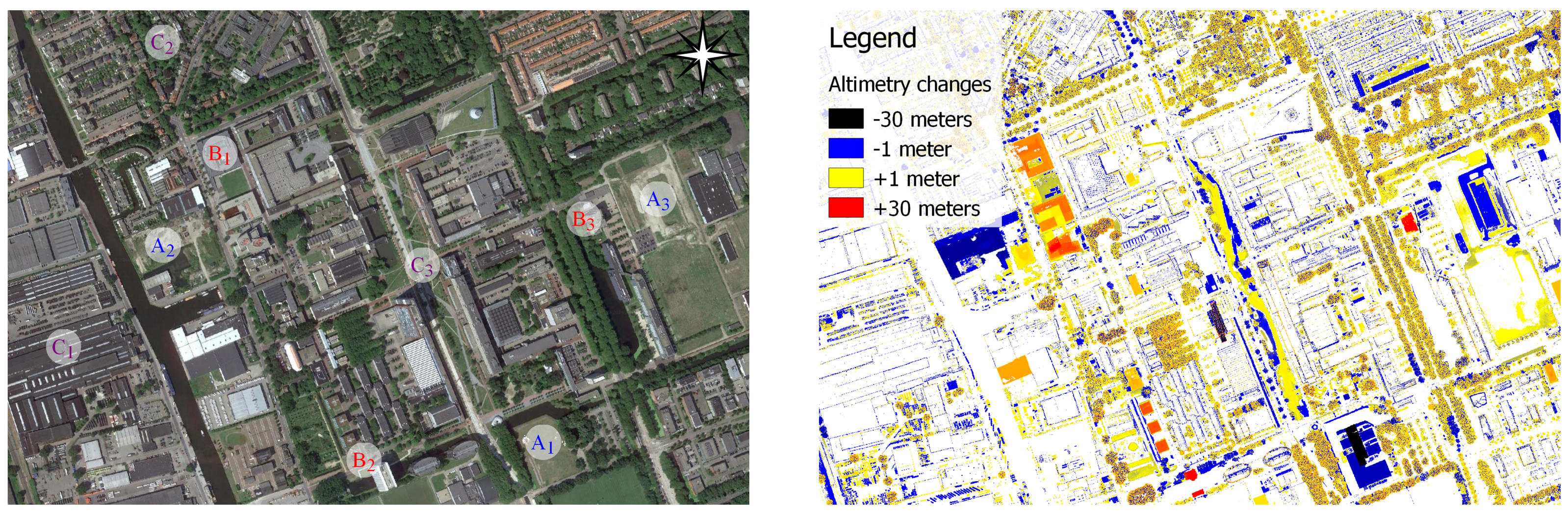
To retrieve elevation changes, DEMs generated from the point clouds were compared at a 0.5 meter resolution. The choice of raster grids instead of the raw point clouds enabled and algorithmically faster, simpler and in computation time and storage space requirement more efficient evaluation while maintaining an adequate resolution for change detection in the built-up area.

4. Implementation

The implementation was carried out in C++ based on the open-source GDAL/OGR geospatial and geoprocessing software library. Since the evaluation of terabytes of input data on a single CPU core would take multiple days to complete, the algorithm was developed with distributed and cloud computing in mind. The parallelization – implemented through the MPI protocol – required a thoughtful design and benchmarking of scenarios, taking the I/O operation sensitivity of the computation into account to avoid a bottleneck on the data storage access. Utilizing the Dutch national supercomputer *SURFsara LISA* sponsored by *NWO Physical Sciences* we managed to provide a processing time below 30 minutes.

3. Methodology

The campus and the surroundings of the Delft University of Technology was selected as a sample area of demonstration. This site contains locations both where buildings were demolished (marked with *A*), constructed (marked with *B*) and where no notable change was performed (marked with *C*).



(a) Satellite image and reference locations. (b) Changeset between AHN-2 & AHN-3.

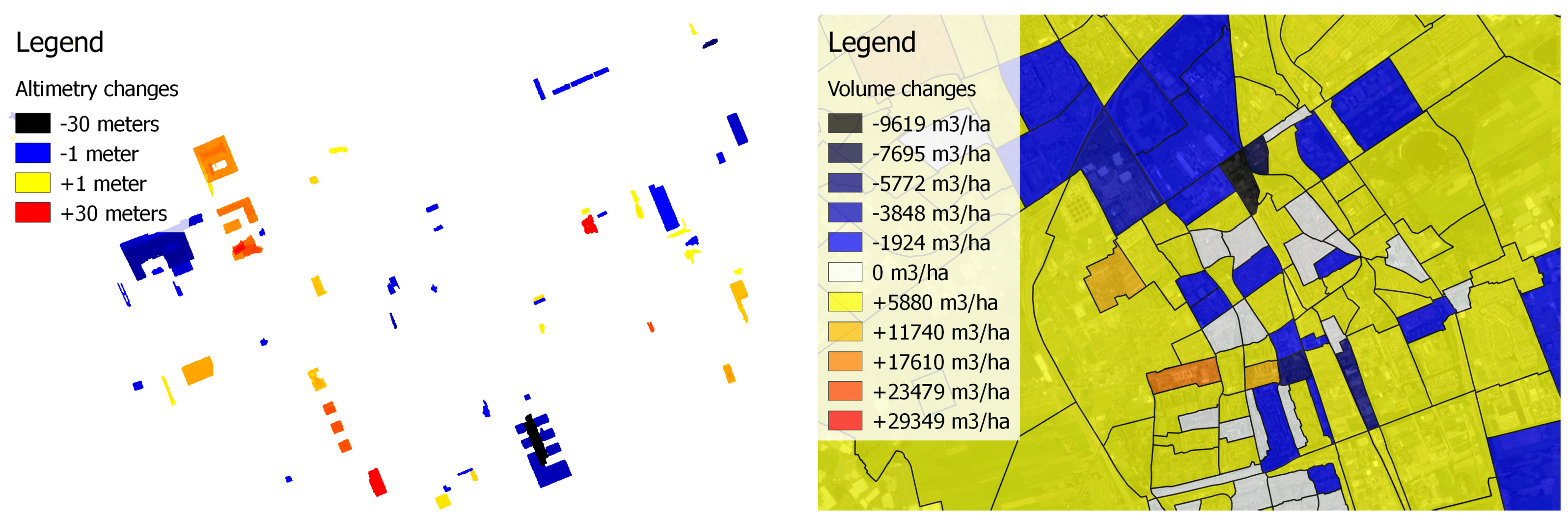
Figure 2: Demonstration area of the TU Delft campus neighbourhood.

The algorithm developed to filter out changes in the built-up area solely based on the AHN datasets consists of 7 major steps:

1. Surface-terrain DEM comparison both on the AHN-2 and AHN-3 datasets to identify non-ground level areas.
2. Creating an initial changeset between the datasets.
3. Threshold filtering with 1 meter of elevation change to focus on alterations on a larger scale.
4. Noise filtering with 50% relative threshold to remove most changes in the green vegetation.
5. Cluster filtering with 100 m^2 threshold size to cleanse negligible modifications and small movable objects like vehicles.
6. Morphological dilation operator to restore building boundaries severed by the noise filter.
7. Majority filtering to correct minor irregularities of the input.

5. Results

The final results are visualized on a building-level or by aggregating the volume difference based on administrative units.



(a) Building level results at TU Delft. (b) Aggregation on the districts of Delft.

Figure 3: Various type of visualizations for the results.

Digital

NWO Netherlands Organisation for Scientific Research

TU Delft Delft University of Technology

View results online: `http://skynet.elte.hu/tudelft/vgc2016.html`

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