Comparison of distributed architectures for LiDAR-based change detection

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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.

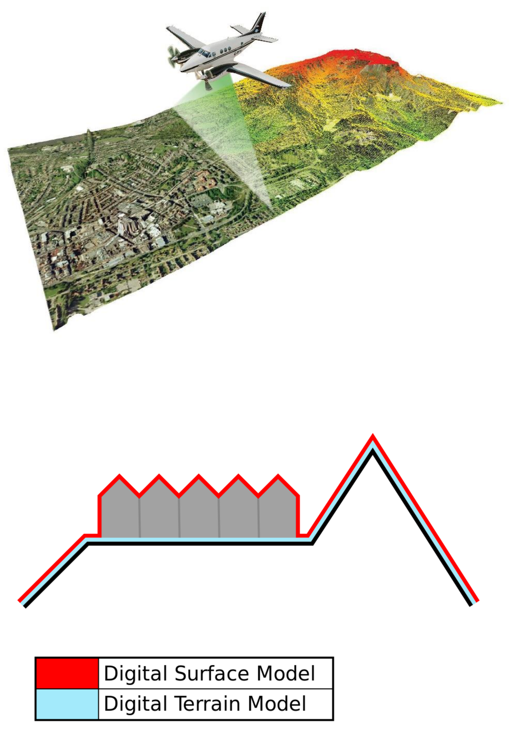
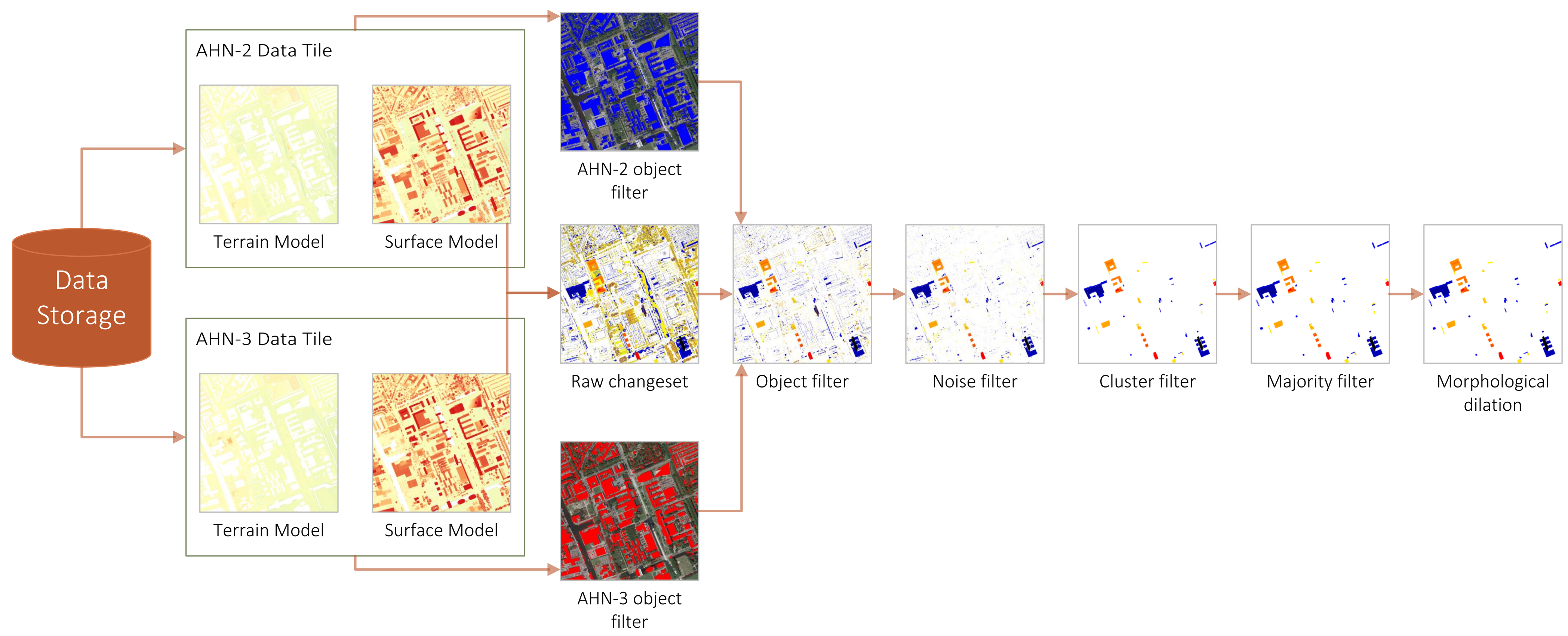


Figure 2. LiDAR and DEM models.

To retrieve elevation changes, DEMs (both DSM and DTM) 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. The complete AHN dataset is provided in 1372 tiles, our input dataset of the available 426 tiles allocated approx. 852 GB disk space.

3. Algorithm workflow



4. Results & Visualization

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 in the built-up area (marked with *C*). Online, interactive visualization of the results are available at: http://skynet.elte.hu/tudelft/ahn_urban_nl.html

Figure 3. Satellite image of the TU Delft campus area.

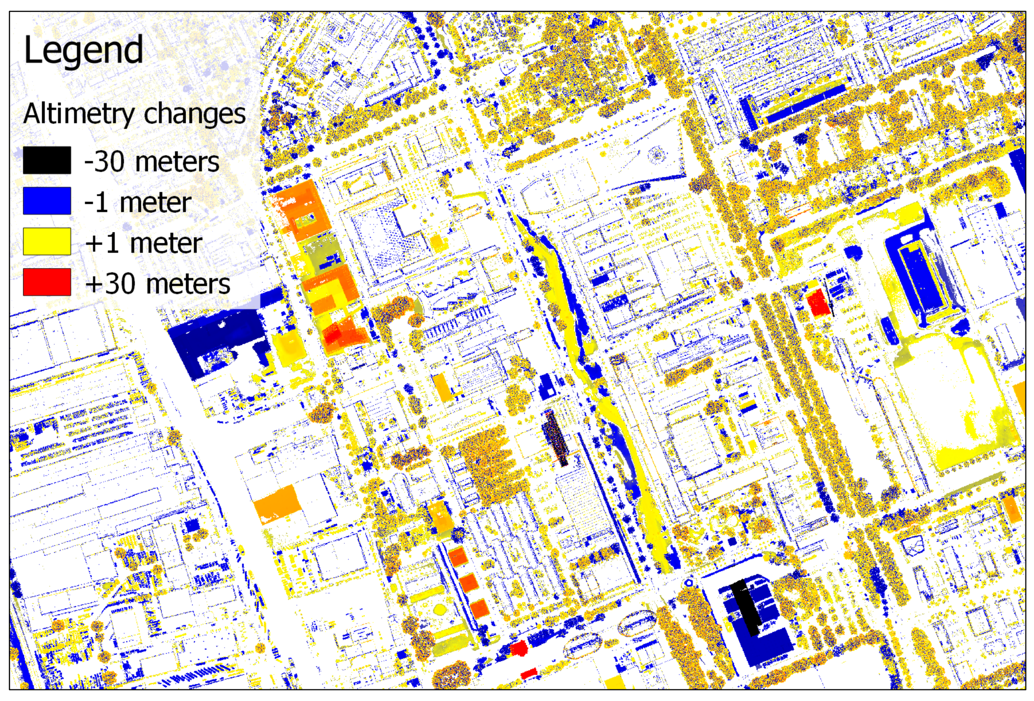


Figure 4. Altimetry changes of the area between AHN-2 and 3.

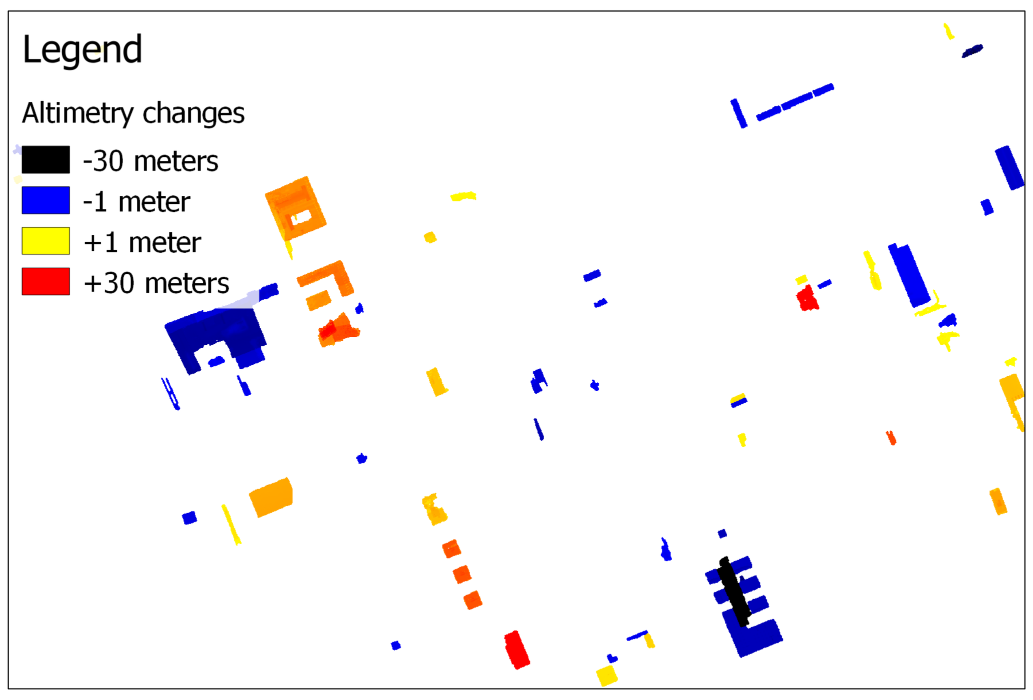


Figure 5. Building level results at the TU Delft campus area.

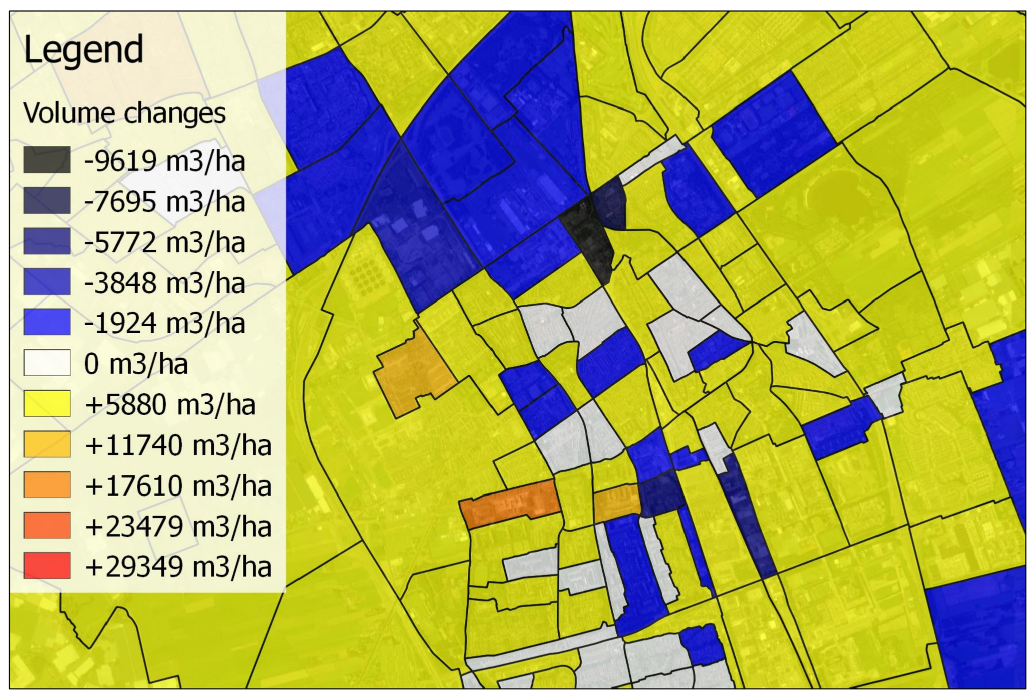


Figure 6. Aggregated visualization by the districts of Delft.

5. Distributed processing

Low-budget dekstop PC	Lenovo Y-700 notebook	SURFsara LISA HPC	Hadoop cluster of desktop PCs
Processor: 4 cores, 1200 MHz Memory: 4 GB DDR3 Storage: SATA II (3.0 Gbps) Optimal performance: 1 process Execution time: 28.54 hours	Processor: 8 cores, 2600 MHz Memory: 12 GB DDR4 Storage: SATA III (6.0 Gbps) Optimal performance: 3-4 processes Execution time: 9.96 hours *(with 3 processes)*	Setup: 10-30 nodes, 100-200 processes Node: 16 CPU cores, 32 / 64 GB RAM Storage: shared network file system Network: InfiBand FDR, 56 Gbps bw Parallelization through MPI protocol Completion time: below 15 mins *(varied by allocation and workload)*	Setup: 1 Master + 40 Slave Nodes Storage: 4 TB HDFS Network: 100 Mbps bandwidth Utilizing the MapReduce framework I/O managed by Hadoop Streaming 1 Hadoop job per node at a time Average completion time: 40.23 mins

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