Exploiting big point clouds

Unveiling insights for sustainable development through change detection in the built environment

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Exploiting big point clouds: unveiling insights for sustainable development through change detection in the built environment

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Extended Abstract

Change detection in the built environment is essential for sustainable development practices including Urban Planning and Development, Environmental Monitoring, and Conservation. Change detection provides valuable insights into dynamic processes, facilitates informed decision making, and supports sustainable development initiatives. Point clouds serve as foundational data sources for change detection in built environments, enabling analysts to detect, quantify, and interpret spatial changes with unparalleled accuracy and granularity. By leveraging the inherent characteristics of point clouds, researchers and practitioners can gain valuable insights into dynamic processes, inform decision making, and foster sustainable development in an ever-evolving built environment. We present the preliminary results of cloud-to-cloud (c2c) distance calculations for further change detection analysis of the entire Netherlands. This study utilises point cloud data from AHN2, 3, and 4 (Actueel Hoogtebestand Nederland[1], The Netherlands). A method based on a 3D space-filling curve (SFC) was developed to calculate the c2c distances between AHN2, 3, and 4. This SFC method will allow change detection analysis to be carried out for the entire Netherlands. The change detection analysis outcomes can be accessed for future analysis in Potree[2], a web-based point cloud rendered for large point clouds. The final implementation will allow the visualisation of AHN point clouds and their attributes, among which is the change in detection-related information. This research contributes to sustainable development practices by offering enhanced spatial insights and informed decision-making tools for further analysis and monitoring of the (built) environment in the Netherlands.

Various sustainable development practices, including urban planning and development and environmental monitoring and conservation, benefit from the information that comes with change detection analysis. Point clouds, comprising large collections of 3D points representing the surfaces of objects, have emerged as crucial data sources for change detection in the built environment. Leveraging the inherent characteristics of point clouds allows analysts to detect, quantify, and interpret spatial changes with unparalleled accuracy and granularity.

[1] https://www.ahn.nl
[2] https://potree.github.io

We present herein preliminary findings on utilising cloud-to-cloud (c2c) distance calculations for change detection analysis across the Netherlands. Our study utilises point cloud data sourced from the AHN2, 3, and 4 datasets. By employing these datasets, we aim to enhance spatial insights and provide informed decision-making tools built into Potree for development, monitoring, and further analysis to help carry out the aforementioned sustainable development practices in the Netherlands (Figure 1).

The methodology was based on a 3D space-filling curve (SFC), which was developed to calculate the c2c distances between AHN2, 3, and 4. The accuracy of the c2c distances depends on the accuracy and density of each AHN point cloud. Typically, the density was approximately 10 points/m^2. A true change is likely to occur when the c2c distance is greater than 10 cm. The outcomes from the c2c distance calculations will be visualised in Potree, a free, open-source Web Graphics Library (WebGL)- based point cloud renderer for large point clouds. This tool will help extract insights into the dynamic processes that shape the (built) environment.

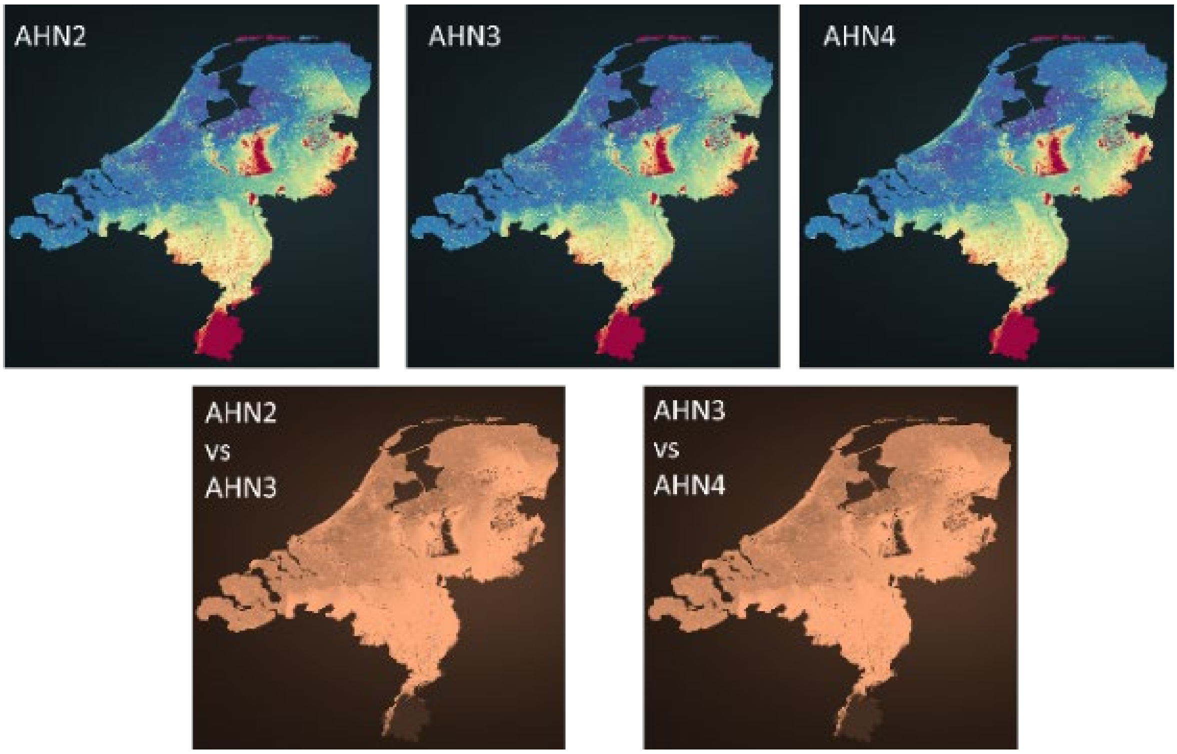

Figure 1. Schematic representation of the point clouds used for all of Netherlands and the changes that are being calculated.

Change detection within the built environment is essential for several reasons, particularly for urban planning and development. Monitoring changes in urban areas helps to identify patterns of urban expansion or invasion into other spaces.
Although this project initially focuses on the outside (built) environment, because of the nature of the point cloud databases, in the future, it will be possible to include analyses with other point clouds, such as the interiors of buildings, thus allowing a more complete analysis of the changes.
Regarding integration with the digital twin framework, although our work may not directly align with traditional digital twin methodologies, it serves as a preliminary step in generating

valuable outputs that can be further integrated into digital twin models. By providing information on spatial changes within the (built) environment, our approach contributes to the broader goal of enhancing digital representations for decision support and simulation purposes.

In conclusion, this research highlights the significance of change detection in the (built) environment and demonstrates the value of c2c distance calculations for facilitating sustainable development activities. By leveraging big point cloud data and advanced analytical techniques, we aimed to provide actionable insights and decision-making support tools for urban planning, infrastructure management, and environmental conservation stakeholders.