Structural health monitoring on a geospatial scale using BIM and point clouds

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Abstract:

Expert-modelled city and building models, in formats such as CityGML and Industry Foundation Classes (IFC), combine geometry with detailed semantics. Their nature is radically different from point cloud scans, in which a labelling or segmentation can be applied, but semantics are not an inherent part of the model as measured.

In the construction domain overlaying building models and point clouds is an actively researched topic. Construction progress and safety can be assessed and after the building has been built, the “as-built” situation can be accurately compared to the “as-planned” model. Furthermore, changes that occur over time, induced by the tenant, damages or gradual deformations by external factors, can be measured by iteratively producing point cloud scans over time.

Point clouds are actively researched in the geospatial domain as well. City models are reconstructed from LIDAR data, such as the AHN dataset in the Netherlands, or reconstructed from areal imagery. However, typically these are static datasets, in which temporal changes can be computed, but are not an inherent part of the model. As such the semantics of these changes are often not related to the semantic concepts of the model.

Due to their inherent nature of communicating design intent, IFC models contain more construction- and behaviour-specific semantics than CityGML models. This information can be used to influence the association to point cloud segments. For example the rotation that door panels can undergo can be taken into account. Critical situations in terms of structural integrity can be detected based on material characteristics, the load on specific elements and building safety codes. By overlaying scans from several time periods, these deviations can be extrapolated.

Mining and harvesting natural resources as well as large-scale underground construction projects have proven to pose long lasting implications on surrounding buildings on the ground surface. Typical examples of this in the Netherlands include the gas extraction in Groningen and the construction of the Amsterdam metro line.

This presentation covers the differences in modelling paradigms in IFC and CityGML, how these influence associations with point cloud scans and the potential to harmonize datasets by embedding efficient point cloud segments into these models. The presentation is intended to disseminate knowledge on point cloud association to individual building elements, focussing on terrestrial laser scanners as that is where the geospatial and building interior intersect. An outlook is presented on how the detailed semantics of building model clusters can lead to new insights on structural health monitoring on a geospatial scale.

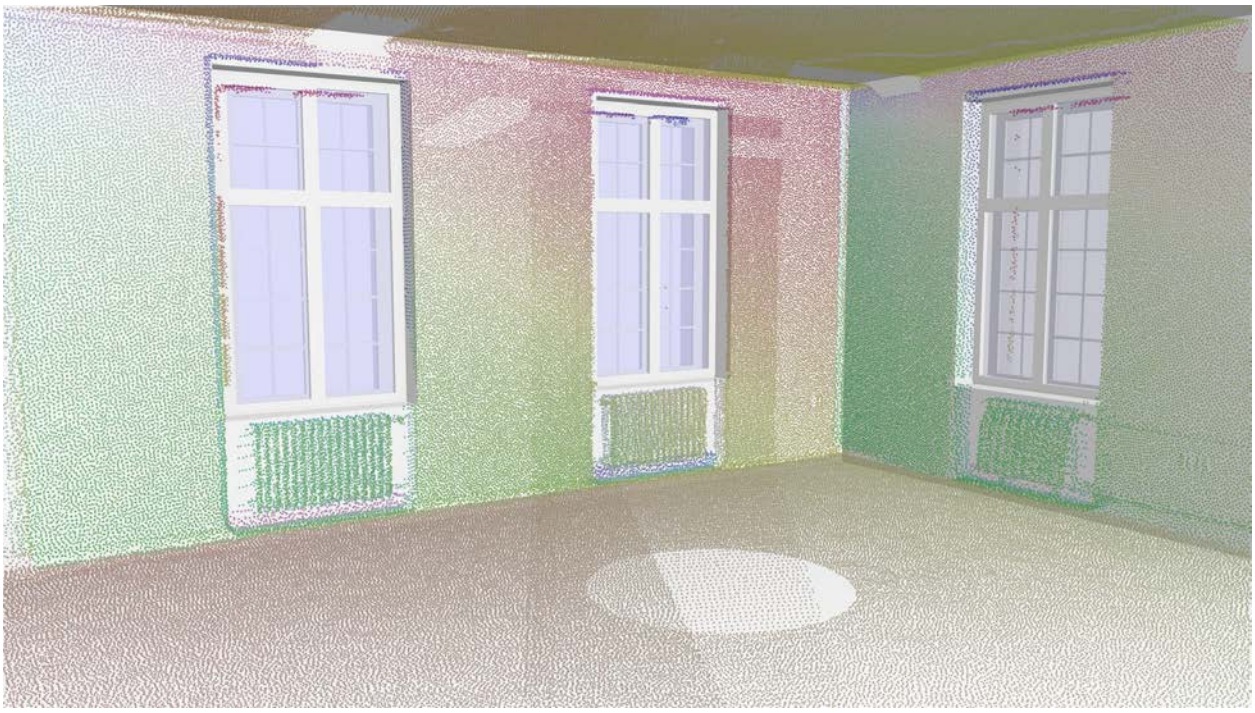

Figure 1. Association of terrestrial interior laser scan to explicit IFC building model. Surface parametrization is used to colour the points. Deviations can be used assess structural health, model completeness and document the changing nature of the built environment.