Tunneling Appropriate Computational Models from Laser Scanning Data

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Abstract

Tunneling projects often require computational models of existing structures. To this end, this paper demonstrates the viability of automatically, robustly reconstructing an individual building model from laser scanning data for further computational modeling without any manual intervention. The resulting model is appropriate for immediate importation into a commercial finite element method (FEM) program. The method combines a voxel-based technique with an angle criterion. Initially, the voxelization model is used to represent the façade model, while an angle criterion is implemented to determine boundaries of the façade and its openings (doors and windows). The algorithm overcomes common problems of occlusions or artefacts that arise during data acquisition. The resulting relative errors of overall dimensions and opening areas of geometric models were less 2% and 6%, respectively, which are generally within industry standards for this type of building modeling.

Keywords: Laser scanning, voxelization model, angle criterion, building reconstruction, finite element analysis, building damage, tunneling-induced settlement

1 Introduction

Computational models are especially important in structural engineering, when assessing the status or determining any risk to existing buildings. Commonly, the models are created from manual survey methods or from existing design drawings. However, this approach can be highly problematic when a large volume of building or complex buildings are involved as arises in infrastructure projects such as tunneling, where hundreds (if not thousands) of potentially vulnerable buildings may exist along a single kilometer of the tunnel route. In that circumstance, implementation of traditional, manual surveying for each structure is cost-prohibitive.

In contrast, laser scanning, also known as Light Detection and Ranging (LiDAR), rapidly and accurately acquires three-dimensional (3D) topographic data of visible surfaces of an object. As such, LiDAR has emerged as an alternative tool for collecting 3D information of buildings for creating 3D models. In practice, the laser sensor(s) can operate from the ground (terrestrial laser scanner, TLS), from a vehicle or train (mobile laser scanner, MLS), or from the sky (aerial laser scanner, ALS). TLS and MLS are mostly suitable for relatively small areas (e.g. a building and small road routes) and give dense data points with high accuracy (within 5mm). In contrast, ALS can cover a large area but gives a comparatively low point density with centimeter level accuracy. Thus, TLS or MLS data are appropriate for generating realistic building

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