Finding and fitting wall planes in airborne point cloud data

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Abstract:

A key problem in automated 3D modelling of buildings in airborne laser scan data or points clouds from aerial imagery, is the modelling of walls. Due to the airborne acquisition, only a limited number of points will cover the vertical parts of buildings and sometimes no points will be actually on a wall at all. The usual solution to this problem is the use of already available 2D maps. However, for new buildings 2D maps might not be available and 2D maps only contain the walls of the outline of the building and no other height jumps that might be present in the building. Such height jumps are not only present in buildings with parts with different heights, but structures like dormers also contain vertical parts. Detecting height jumps in point cloud data is not that difficult. The challenge is automated recognition of wall planes and to estimate the location and orientation of each wall plane accurately.

Segmenting roof planes in point cloud data is quite common. To segment walls planes together with roof planes, we use a region growing algorithm that segments a triangulated surface. Therefore, we first filter out trees and other problematic points from the point cloud to enable the use of a 2D Delaunay triangulation. Due to the lack of points actually on the wall, the walls are present in the triangulation as long triangles between the points on the ground closest to the building and the points on the roof closest to the edge of the roof (figure 1). These triangles are more difficult to segment than those of roof planes, since the orientation of the triangles is very irregular. Therefore we adapted the method in such way that it allows more noise in vertical planes, to segment walls too. In this way we can identify all walls of a building of significant length (compared to the horizontal spacing of the point cloud). However, fitting a plane trough the points of a wall segment would give a slanted plane. Therefore, another method to estimate the precise location and orientation of the wall is needed. We use least-squares fitting of a smooth S-curved height jump (figure 2). The S-curve enables the use of points on the ground and roof to estimate the parameters of the wall. In this way we obtain a nearly-complete segmentation of buildings in planes with precise plane parameters, including the vertical walls.

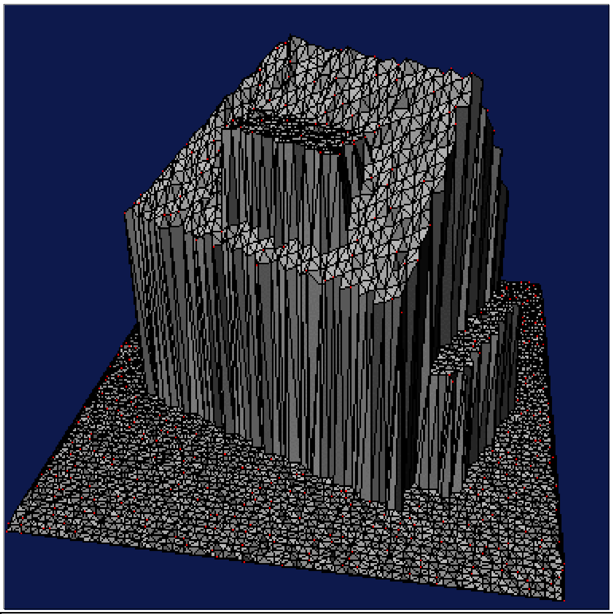

Figure 1. Triangulated surface with long triangles between the ground and roof that represent the walls.

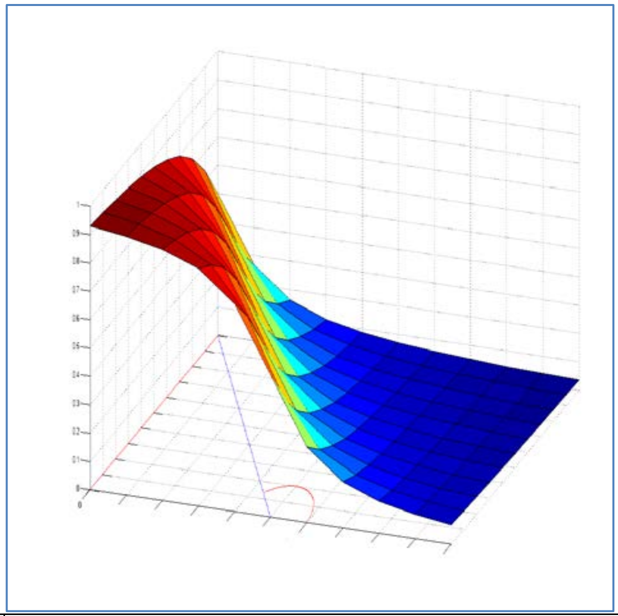

Figure 2. S-curved function to fit in point cloud data to estimate the vertical plane parameters of a wall.