Multi-ray photogrammetry: A rich dataset for the extraction of roof geometry for 3D reconstruction

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ABSTRACT:

Three dimensional (3D) city models are playing a crucial role in disaster management, urban planning, navigation and many other applications. The demand for high resolution, up to date models at a city scale has led to significant research efforts into various data sources and processing techniques in order to try to develop an autonomous solution. Previous research has suggested in order to achieve full automation lidar data needs to be integrated with aerial imagery to utilise high positional accuracy from the imagery and high elevation accuracy from lidar. However, it is costly to capture these two datasets separately and computationally expensive to integrate them. Developments in aerial imagery capture have seen the introduction of multi-ray photogrammetry. Using large format aerial cameras to capture images at a high spatial resolution with large fore and side overlap has increased the number of stereopairs captured. This, with the introduction of pixel-to-pixel matching algorithms from computer vision, can produce elevation data which rivals or in some cases outstrips the spatial resolution and accuracy of that derived from lidar.

The aim of this research is to utilise these photogrammetric developments in order to extract information for the automatic generation of 3D building models, focussing on accurate extraction of roof geometry. High resolution digital surface models (DSM), true orthophotos and photogrammetric point clouds have been used to extract roof geometry within an area delineated by Ordnance Survey MasterMap building topography data. Two dimensional (2D) information has been extracted from the true orthophoto using the Canny operator in order to detect the roof boundary as well as ridge and valley lines. Whereas much research has utilised planar fitting approaches to point clouds for reconstruction of roof models, in the research, 3D information has been extracted from the DSM by measuring along X and Y cross sections across a rooftop. The extracted edges have been used to aid cross section extraction and give an accurate boundary of planar regions. These planar regions may also be affected by trees which either overhang the rooftop or are in close proximity to the roof boundary. Trees have therefore being removed by the fitting of quadratic curves to the point cloud as well as calculating a point’s distance to a least squares fitting plane determined by a local neighbourhood. This 2D and 3D information is being integrated to create 3D building models at the Level of Detail 2 CityGML standard outlined by the Open Geospatial Consortium (OGC). This paper presents the outcomes of 2D and 3D roof extraction and examines how such information can be integrated to produce a more complete roof model.