Laser Scanner Validation Methods for Land Surveyors

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SUMMARY

The current trend of legal surveying is moving toward a 3D interpretation of boundaries, and often surveyors are tasked with performing as-built surveys within urban environments. The land surveyors facing these challenges must incorporate advanced measurement tools into their toolbox, while simultaneously ensuring that their results, and the procedures leading to them, can stand up to rigorous cross examination. There exists a gap in these methods where the measured parameters are indirectly related to the physical objects being measured resulting in "black box" solutions, especially in the case of terrestrial laser scanners. Terrestrial laser scanners typically measure horizontal and vertical angles and distances, but the available data are in the form of a 3D point cloud. The point coordinates are computed by manufacturer software which automatically corrects the measurements, if needed, by an unreported amount. Procedures are required to ensure that the geometrical positions are valid, as should an understanding of the semantic information – i.e. information about the surfaces that have been measured. This paper explores a point-based method of validating lines, planes and their intersection positions as derived from terrestrial laser scanning data in a legal surveying context where 3D information is required. A high-precision total station was used to establish the coordinates of key points on a building where the positions of the walls, floors, and ceilings are required for cadastral purposes. Planar surfaces, which would normally define the boundaries of a property, were extracted in a supervised point cloud segmentation method. Lines were derived from intersecting planar patches in the point cloud, and points were derived from the intersection of extracted planes and lines. The laser scanner was calibrated for additional parameters to the measurement model, using an accepted point-based self-calibration method, which included the rangefinder offset, horizontal circle scale factor and eccentricity, and vertical circle index errors. A review of the derived calibration metrics demonstrated that the measurement parameters were insignificantly correlated, both among themselves and between the exterior orientation parameters. The impact of the additional parameters on the positions of key points was negligible in this instance due to the procedures, instrument, and geometry used. The positions of the key-points were analyzed in terms of precision, accuracy, and reliability and found to be within acceptable standards for cadastral surveying. The determination of key point positions required careful consideration, because of the non-ideal structure of the built form, discrepancies caused by different surfaces scanned, and the stringent requirements of legal-type surveys. The procedures used provide a possible solution to using laser scanners for boundary determination in the context of cadastral surveying in a 3D environment.