UNIVERSITI TEKNOLOGI MARA

ROBUST DATA QUALITY ASSURANCE FOR PHASE-SHIFT TERRESTRIAL LASER SCANNER (TLS)

MOHAMAD AIZAT ASYRAFF
BIN MOHAMAD AZMI

MSc

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Mohamad Aizat Asyraff bin Mohamad Azmi
Student I.D. No.	:	2016536811
Programme	:	Master of Science (Built Environment) – AP781
Faculty	:	Architecture, Planning and Surveying
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Signature of Student	:	……..
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ABSTRACT

The latest utilisation of terrestrial laser scanner through adaptation of 3D measurement has tremendous impact in various surveying scopes, particularly for the applications that demand high-accuracy data. Similar to other Geomatics devices, the uncertainties in measurement of terrestrial laser scanner can be embraced by errors coming from numerous sources. Furthermore, the external measurement conditions also can affect the magnitude of errors in terrestrial laser scanner measurement. This information has led to the necessity of on-site data quality assurance procedure. Previous study has proved the capability of point-based self-calibration for on-site implementation. However, due to dimension constraints for targets distribution, the calibration procedure has limited for indoor on-site implementation. Thus, this research has investigated the capability of minimising network configuration requirements to robustly enhance existing calibration approach for both indoor and outdoor on-site applications using phase-based scanner. Investigations began by appraising the significance of scaling element in pre-processing procedure of terrestrial laser scanner (as there is a need to resolve on the external orientation, i.e. datum transformation) via three rigorous experiments which comprises of multi-network configurations (i.e. number of scan stations, number of surfaces, and number of targets), samples of distance (including medium and long range measurements), and georeferencing procedure. The identification on reliability of lowering network configurations (i.e. surface dimensions) was demonstrated by pre-analysis study through the error ellipses against the area of surface on which targets are distributed. For realisation purpose, the final experiment has been conducted through shrinkage process over the surface dimensions by gradually 10% to 60% reduction. The results from the scale experiments have statistically proved on no significant effect of scale factor in pre-processing procedure of terrestrial laser scanner using time-of-flight and phase-based scanners, even though the largest value of scale error obtained was 0.00904 in multi-network configurations (number of scan stations) experiment. With simulation of surfaces dimension reduction via error ellipses analysis, the results have positively indicated on stability to minimise the dimension without compromising the quality of data, whereby the 60% configuration shows the lowest value of 0.00864 for combined targets errors. With the aid of close-range photogrammetry technique for benchmarking, the research found that a minimum configuration of 3.6 m (width) × 1.2 m (height) for surfaces dimension able to provide accuracy of 3 mm which is significantly similar to the accuracy yielded from optimal configuration. By referring to those findings, this enhanced calibration approach is expected to benefit on improving the convenience in validation of terrestrial laser scanner data through wide variety of applications.

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