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Displacements Determination Based on the Analysis of Point Clouds from TLS Using the M_{split} Estimation

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1 Introduction

Terrestrial laser scanning (TLS) technology allows to obtain a large amount of information about an object in a short time. For this reason, this technology is becoming increasingly popular also in buildings monitoring. Terrestrial laser scanning allows to obtain data as a point cloud of varying accuracy form millimetres to decimetres Each measured point finally has three coordinates X, Y, Z and the intensity parameter. Thus, very detailed data about the object is obtained, that can be in the next step analyse. Because some structures of building objects can be represented as vertices, lines, planes or others and can be described by a mathematical function. This gives the opportunity to automate the data processing what was also discussed in Janowski and Rapinski (2013), Wang and Hsu (2007) and Zheng (2008). This paper presents the possibility of fitting planes into one point cloud form TLS using the M_{split} estimation.

2 M_{split} Estimation

M_{split} estimation was developed by prof. Wiśniewski (Wiśniewski 2008). It assumes that every measurement result can be a realization of either of two or more different random variables, so the functional model can be split into two competitive model: Y_α or Y_β. In this paper the functional model $\mathbf{V}=\mathbf{AX}+\mathbf{L}$ is split into two competitive ones which concern the same vector of observation $\mathbf{L}$:

$$\boldsymbol{split}\ (\boldsymbol{V}=\boldsymbol{AX}+\boldsymbol{L})=\begin{cases}\boldsymbol{V_\alpha}=\boldsymbol{AX_\alpha}+\boldsymbol{L}\\ \boldsymbol{V_\beta}=\boldsymbol{AX_\beta}+\boldsymbol{L}\end{cases} \tag{1}$$

where $\mathbf{A}$ is a common coefficient matrix, $\mathbf{V}_\alpha$ and $\mathbf{V}_\beta$ are competitive vectors of random variables, $\mathbf{X}_\alpha$ and $\mathbf{X}_\beta$ are competitive parameter vectors. To achive this task the cross weighting procedure must be introduced what is widely described in (Wiśniewski 2008). The weights of observations are modified and finally can be written in the following form:

$$\omega_\alpha(v_\beta)=v_\beta^2, \qquad \omega_\beta(v_\alpha)=v_\alpha^2 \tag{2}$$

3 Application of M_{split} Estimation in Terrestrial Laser Scanning.

The selected area of two concrete slabs were measured using terrestrial laser scanner and one point cloud was obtained as a result. Figure 1 shows the selected area of the retaining wall supporting the scarp and a TLS point cloud. This concrete slabs, as a result of the heavy rain, were displaced and a crack was formed.

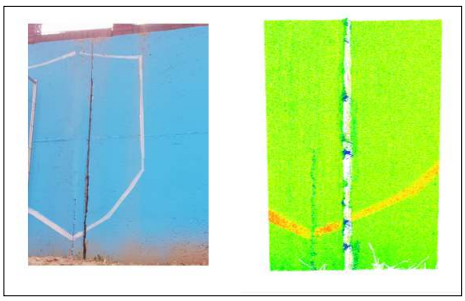

Figure 1. The photo of two concrete slabs and a TLS point cloud of the measured area.

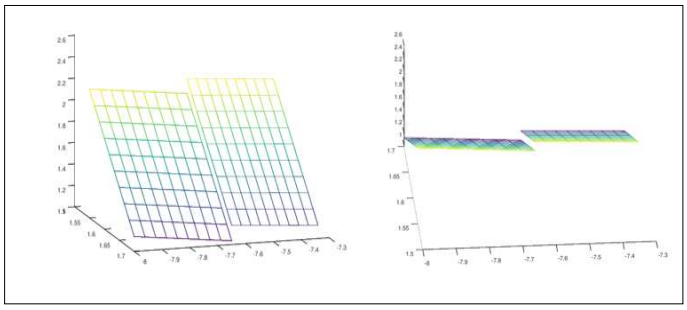

Figure 2. The result of fitting two planes into one point cloud representing two slabs of a retaining wall. Front (left) and rotated (right) view.

The classical approach would lead to fitting each plane separately with either manual selection of points or some search algorithm. To automate the process of fitting individual planes into the measured point cloud the M_{split} estimation method was used. Figure 2 present the result of fitting two planes using proposed method. The correct fit of the planes into one point cloud was obtained.

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References

Janowski A. and Rapiński, J. (2013). M-Split Estimation in Laser Scanning Data Modeling. Journal of the Indian Society of Remote Sensing, 41(1) (2013) 15-19, , DOI: 10.1007/ s12524-012-0213-8

Wang, C. and Hsu, P. (2007). Building detection and structure line extraction from airborne lidar data. Journal of Photogrammetry and Remote Sensing, 12(4), 365– 379.

Wisniewski, Z. (2008). Split estimation of parameters in Functional geodetic models. Technical Sciences, 11, 202–21.

Zheng, J., McCarthy, T., Fotheringham, A. S. and Yan, L. (2008). Linear feature extraction of buildings from terrestrial LIDAR data with morphological techniques. *International Archives of the Photogrammetry Remote Sensing and Spatial Information Science, 37*(part B1), 241–244.