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Interdisciplinary topics in Mining, Geology and Geomatics

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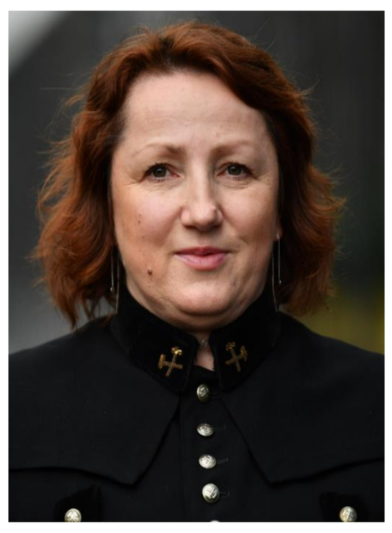
Analysis the quality of MESH representing the underground excavation



Natalia Walerysiak [1] **Justyna Górniak-Zimroz [1]**

[1] **Wrocław University of Science and Technology, Faculty of Geoengineering, Mining and Geology, Departament of Geodesy and Geoinformatics**
Stanisława Wyspiańskiego 27 Street, 50-370 Wrocław, Poland

INTRODUCTION

3D laser scanning is a technology widely used in many fields, such as surveying and mining. This technique makes it possible to acquire point clouds and create excavation models [1]. The models can be used for various purposes, such as assessing the stability of a pit, planning mining operations, or creating geological documentation [2]. The object under study is part of the Gontowa adit (fig. 1), which is part of the much larger "Riese" project located in the Góry Sowie in Poland.

There are a number of survey techniques and laser scanning equipment. This study focuses on comparing three devices: Riegl VZ-400i, Velodyne VLP-16 and ZEB-Horizon. Various metrics are used to assess the quality of the mesh. This study focuses on three key parameters: SICN (signed inverse condition number), Gamma (inscribed radius / circumscribed radius) and Sige (signed inverse gradient error).

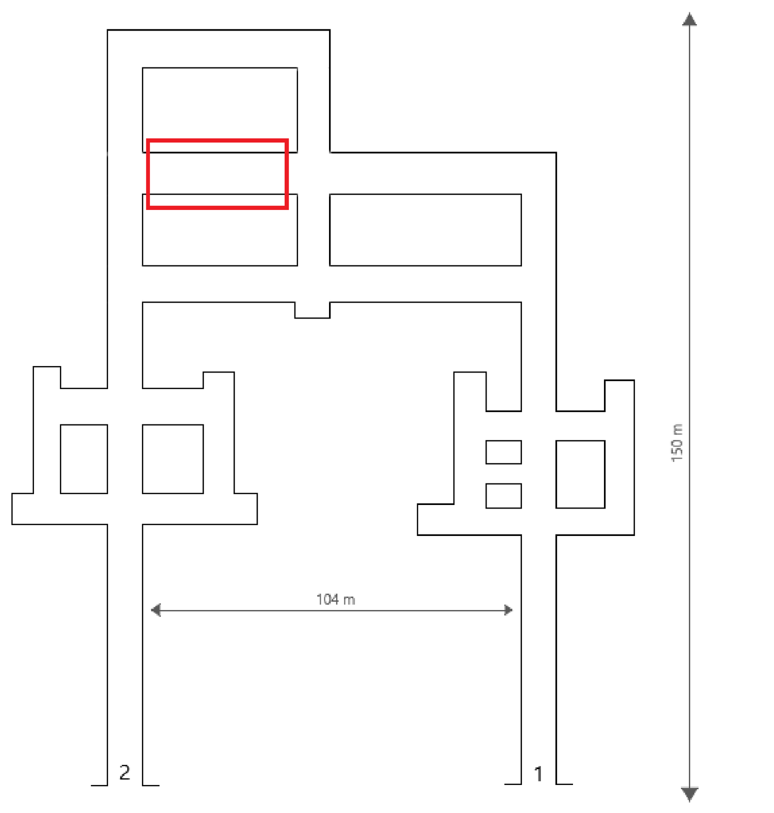


Figure 1. Map of the Gontowa drift with the surveyed tunnel marked.

QUALITY PARAMETERS

SICN is one of the most universal metrics for assessing grid quality. This measure refers to the numerical condition of the grid elements, where values close to 1 indicate good quality grid elements, and values approaching 0 suggest that the grid element is degenerate or highly distorted [3].

Gamma, is a measure of the quality of grid elements based on the proportion of their radii inside and outside. This ratio relates the radius of the inscribed sphere to the radius of the sphere described on the grid elements. High Gamma values suggest a better quality grid [4]. SIGE is a measure of how well gradients are approximated in the grid elements. High SIGE values indicate potential mesh quality problems [5].

RESULTS

Point clouds measured by various techniques were modeled. The created MESH was analyzed in the freeware Gmsh. Graphical results for the SICN parameter are shown in Figures 2-4.

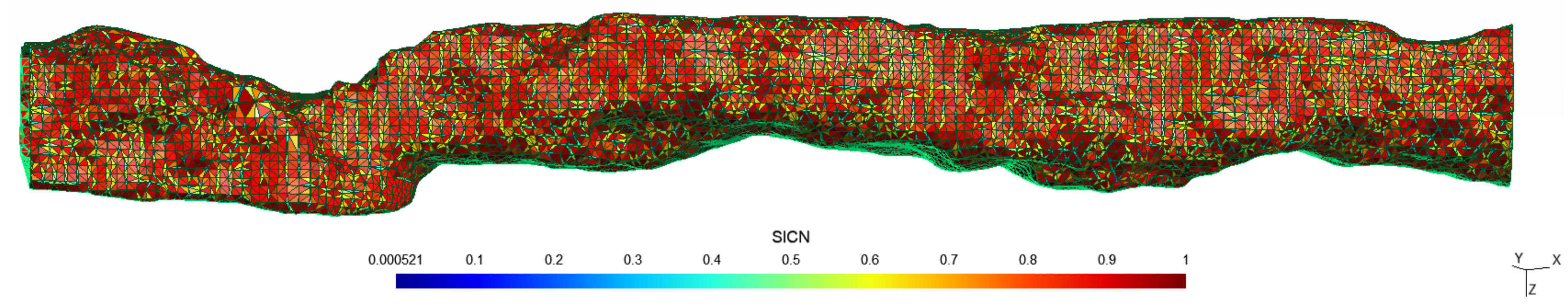


Figure 2. SICN parameter for each face (MESH built from the point cloud obtained with the Riegl VZ-400i).

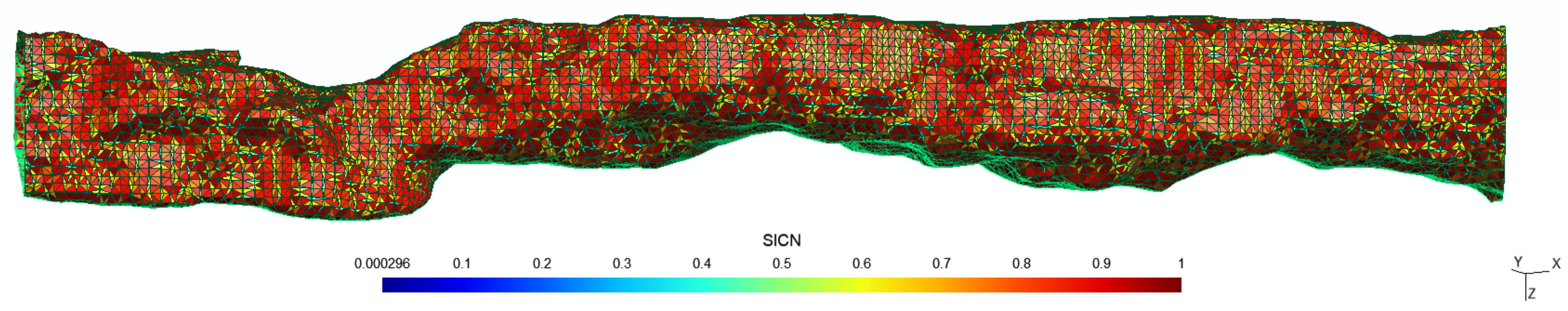


Figure 3. SICN parameter for each face (MESH built from the point cloud obtained with the Velodyne VLP-16).

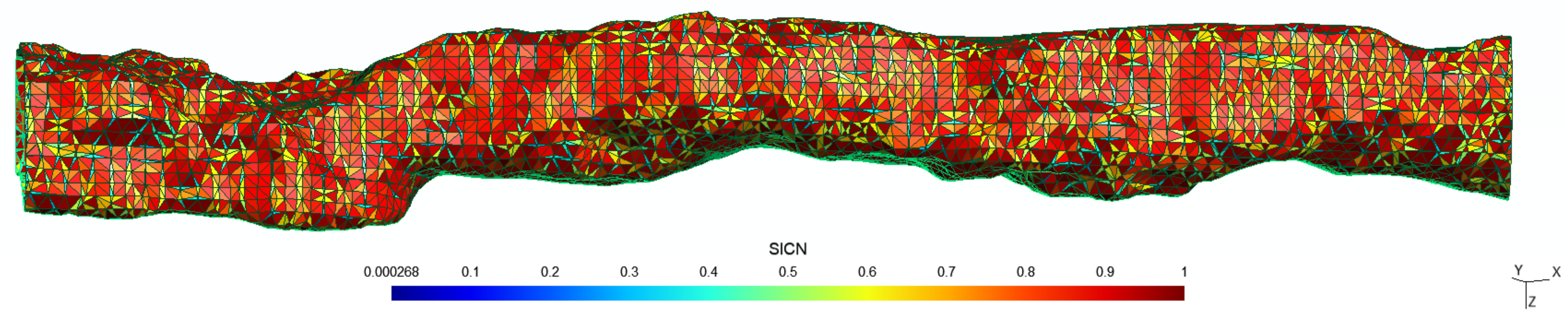


Figure 4. SICN parameter for each face (MESH built from the point cloud obtained with the GeoSLAM ZEB-Horizon).

The obtained models are not visually significantly different from each other. For this reason, it was necessary to determine the average values of the parameters and compare them. The results are summarized in Table 1, with the best values in bold.

Table 1 Average parameter values for different grids.

	Riegl VZ-400i	**Velodyne VLP-16**	**GeoSLAM ZEB-Horizon**
SICN	**0.7129**	0.7059	0.7065
Gamma	**0.6919**	0.6851	0.6859
SIGE	0.8935	0.8914	**0.6859**

CONCLUSIONS

Based on the conducted analyses, point clouds measured and modelled using three different techniques showed minor differences in the quality of the MESH. The visual assessment of the models did not reveal significant differences, which affirmed the necessity for a detailed analysis of the quality parameters.

SICN, Gamma, and SIGE, were similarly averaged across all three devices. The SICN indicator, which evaluates the numerical condition of mesh elements, was the highest for the model measured by Riegl VZ-400i (0.7129), and the lowest for the model measured by Velodyne VLP-16 (0.7059). In the case of the Gamma parameter, an indicator describing the ratio of the inscribed radius to the circumscribed radius, the model from Riegl VZ-400i also had the highest value (0.6919), whereas Velodyne VLP-16 had the lowest (0.6851). However, the SIGE parameter, which measures the gradient error, was highest for the model measured by Riegl VZ-400i (0.8935) and lowest for the model measured by GeoSLAM ZEB-Horizon (0.6859).

In summary, the results suggest that the Riegl VZ-400i provides slightly better MESH quality compared to Velodyne VLP-16 and GeoSLAM ZEB-Horizon, although the differences are minor. However, it is crucial to underscore that the quality of the MESH is only one of many factors to consider when choosing a measurement technique. The selection of the optimal method will depend on the specifics of the task, equipment availability, as well as other factors such as cost, time, and complexity of measurement procedures.

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