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Accuracy and Applicability Evaluation of an Underground Geomonitoring Robot System Using SLAM Methods

Jing Li [*1], Jörg Benndorf [2],

[1] *TU Bergakademie Freiberg, Department of Mine Surveying and Geodesy.*

[2] *TU Bergakademie Freiberg, Department of Mine Surveying and Geodesy.*

*Corresponding author: jing.li@doktorand.tu-freiberg.de

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Quantitative and reliable information provided by geomonitoring helps to dentify hazards and to timely adopt appropriate measures. However, doing this job inherently exposes monitoring staff to a dangerous environment, especially in the field of underground geomonitoring. Since 2000, as robots are widely used in various fields, many studies have focused on the establishment of automated robotic systems as well as underground navigation and mapping. Only a few studies have conducted quantitative evaluations of the proposed or used methods, and almost none have provided systematic and comprehensive assessment of suitability of mapping robot for underground geomonitoring areas. In this study, the accuracy and precision of the selected Simultaneous Localization and Mapping (SLAM) method, implemented on the designed robot system, were systematically and quantitatively evaluated using mine surveying methods. In order to assess accuracy, the design of an underground test site, including the configuration of the control points, selection of targets and optimization of the design was conducted. Measurement experiment was performed by a robot equipped with various sensors in conjunction with the selected SLAM method. The obtained result point cloud was compared with the reference point clouds measured by a total station, a handheld scanner, and a terrestrial laser scanner. The accuracy and precision of the selected SLAM methods as well as the verifiability and reliability of the results were evaluated using the German Ordinance on the Survey Work and Observations of the Surface Markscheider Bergverordnung (MarkschBergV) as a regulation.