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Datum:
3. Juni 2024
Ihre Nachricht

Review of the PhD thesis

Topic of the Dissertation

"3D Surveying of Mining Environments using Simultaneous Localization and Mapping"

submitted by Pawel Trybala, Wrocław University of Science and Technology
Supervisors: Jan Blachowski, Fabio Remondino

Reviewer: Prof. Dr.-Ing. Dorota Iwaszczuk, Technical University of Darmstadt

In his dissertation, Pawel Trybala, M.Sc. dealt with development, analysis and evaluation of LiDAR-based mobile mapping systems (MMS) for mining environment. The chosen field of work is very interesting and relevant for multiple mining applications.

Main Contributions

The PhD thesis focuses on development, testing and evaluating of MMS for Mining Environments. Multiple aspects are here performed and discussed. First, the Candidate identifies the challenges of the underground conditions. Second, he investigates and further develop algorithms performing Simultaneous Localization and Mapping (SLAM). Then, he develops own mapping solutions which are then critically assessed under consideration of different MMS and SLAM strategies. The developed methodology is evaluated in various scenarios using predominantly self-acquired data. The attention is paid to comparison with reference data obtained according to the best practice approaches in surveying. In addition, a benchmark dataset has been released based in Candidate's research work.

The PhD thesis is a cumulative thesis as a collection of published and thematically related six scientific articles. Three papers have been published in indexed journals and three in indexed proceedings at

conferences. Journal papers underwent a full-paper peer review, while conference papers were accepted based on (partially extended) abstract peer review.

Thesis structure

The thesis is divided into two parts, which can be summarized as follows:

Part I (with 69 pages) including:

Chapter 1
This chapter introduces the topic of the thesis and outlines the motivation for this research.

Chapter 2
This chapter contains a comprehensive literature review and covers a wide state-of-the-art, particularly on different SLAM approaches. The literature review was automated by using appropriate tool and the results of these automatic analysis are clearly presented. Evidently, the usage of the tool was supportive for the literature review and helped to cluster the and analyze this very wide area of research. The Candidate shows, nevertheless, a deep knowledge of the topic and in-depth understanding for diverse SLAM approaches.

Chapter 3
This chapter highlights the main contributions of each paper in the context of the entire thesis. This part of the thesis is very essential to understand the contribution of each paper separately as well as see the meaning of these papers to fulfill the objective of the thesis.

Chapter 4
This chapter provides main conclusions of the thesis. As summary of entire work, a recommendation for action is provided, which considers various mobile mapping solutions for specific mining use cases. The Candidate indicates also some possible future works to continue his work.

The literature review and thesis contributions contain over 200 references which fulfills or even exceeds a standard of a PhD thesis and at the same time is a valuable contribution on compiled information for the SLAM community.

Part II
Consist of the collection of the six papers with the topic of the thesis published during the PhD phase.

Assessment of the thesis

Presented thesis is a high-quality piece of scientific work fulfilling international standards. The methodical procedure is well presented and the individual steps are easy to follow. The work is clear and easily accessible. In the introductory part of the thesis the Candidate proved that he has a deep knowledge of the foundations and current trends in the area of his research. All presented published scientific articles bring

clear contributions and improvements to the state-of-the-art of in SLAM for the mining sector as well as 3D data processing.

Possible improvements

Some minor improvements and further possibilities can be mentioned regarding this work. Learning based SLAM haven't been investigated in this work. It would be interesting to see, whether these methods are applicable in underground conditions. Furthermore, it could be investigated, how other LiDAR devices influence the SLAM procedure in a mine.
Regarding the format, the Candidate could stress out a bit more, what was exactly his contribution in each of the attached papers. In particular, including the contribution of other authors and a bit of quantification (for example %) would make the amount of the contribution more transparent.

Layout and editorial remarks

The language of the thesis is very good and easy to understand. Layout decent and helping the reader to gather the information and navigate in the thesis. The illustrations are carefully prepared and easy to read, the formulas are uniform and described in detail. The technical sketches also facilitate understanding.
The reviewer found only one minor language issue: on page 47, second paragraph: in "… 3D reconstruction of the underground tunnels. where the highly unstructured geometry…" the full stop should be replaced by comma.

Final recommendation

Considering the overall assessment of the work, I conclude that the PhD dissertation of Mr. Pawel Trybala entitled "3D Surveying of Mining Environments using Simultaneous Localization and Mapping" meets the criteria of Art 187 item 1 and 2 of the Act of 20th July 2018 Law on Higher Education and Science.

The doctoral dissertation presented by the PhD Candidate contains general theoretical knowledge for the scientific discipline of environmental engineering, mining, and energy, as well as the Candidate's ability to conduct scientific research independently.

The Candidate proposed an original solution to a scientific problem including recommendations for practical solutions in different use cases.

Therefore, I submit the motion to the relevant scientific council to allow the dissertation for a public defense and recognize this work as outstanding.

Merit-based justification

In his dissertation, Pawel Trybala, MSc, proved his ability to work scientifically fully independently. He is able to present complex contents in understandable way and summarize his research in appropriate manner to emphasize the main achievements. He is able to structure his work and find relations and dependencies in different articles published by him and make them visible to the reader. He is very structured in his elaborations which helps the reader to get the message quickly and in a focused way. Besides, his literature review, compiles conveniently information on very wide SLAM-topic being a win for the community. This all shows exceptional scientific maturity of the Candidate.

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Moreover, the Candidate co-authored during his PhD multiple further articles not directly included in the thesis, but related to the field of his thesis. Six of them where published based on full-paper peer review in indexed journals. This shows his broad knowledge and ability to work on different scientific topics in cooperation with other scientists coming from different environments.

Darmstadt, 03.06.2024

D. Iwaszczuk

Prof. Dr.-Ing. Dorota Iwaszczuk