

Master Thesis Evaluation Report

University: Skolkovo Institute of Science and Technology (Skoltech) Student Full Name: Oleg Shipitko Master Thesis Topic: 3D pose estimation algorithm for intelligent box picking of warehouse automation robot

Note: The presented Master Thesis is a 58-page document, consisting of 7 chapters.

The Thesis of Oleg Shipitko presents a novel approach to pose estimation - widely used in a computer vision operation aimed at identification of a position of an object of interest in space. The importance and actuality of this work are justified both by novel approach proposed by the student and by area of application of the proposed algorithm, which is logistics robot for warehouse automation. Logistics in general and logistics robots, in particular, is currently a hot topic attracting the attention of professionals from all over the world. It is confirmed by rapid growth of the logistic robots industry. It is forecasted to reach \$31.3 billion by 2020, which is also indicated in student's work.

The introduction of the work clearly presents the importance of the chosen area of research. Since the developed algorithm is a part of a big project aimed at development a robotic system for order picking automation, the author explains the structure of the whole system, shows how his algorithm fits into it and proves the importance of the pose estimation algorithm for detecting boxes on the pallets. The literature review is concise, covering the main relevant approaches in the area of research. It explains the drawbacks of existing algorithms of pose estimation and indicates that the proposed method will address these issues. In Chapter IV the author formulates the problem to be solved in scientific terms and also explains the specific requirements set to the computer vision algorithm related to warehouse facilities. Since the proposed approach is a combination of several algorithms, Oleg first presents an overall developed pipeline and then explains in details all parts of each step. It allows the reader to easily follow the development process and proves a good structure chosen for the Thesis. Chapter VI presents the experimental results, which prove the efficiency of the developed algorithm. The metrics chosen to evaluate the efficiency of proposed approach are widely used in computer vision and big data research communities, which indicates that the student is familiar with state-of-the-art scientific practices. The presented results prove that after some minor improvement the algorithm can be used for a real-life problem. In the future work section, Oleg proposes several improvements of the developed algorithm. He shows a deep understanding of modern approaches to computer vision in general and pose estimation algorithms in particular. It is worth to mention that the work conducted in the reviewed thesis has a big potential for commercialization as a part of the overall project.

All fulfilled work, both theoretical and practical is performed thoroughly and qualitatively. It demonstrates the excellent level of knowledge in chosen research area. From reviewed Thesis, I can draw a conclusion that Oleg has a deep understanding of the chosen research area. He is able to design and conduct scientific experiments and critically assess the obtained results. Also, Oleg has proved that he can explicitly determine the direction of the future work. The thesis is well written and structured. Below is a list of suggested revisions, however, they are not critical and just indicate potential areas of improvement:

- Even though it is not particularly the topic of the Thesis, it might be beneficial to present existing logistic robots designs in Related work section.
- The more detailed explanation of the benefits brought by using 3D sensor instead of a typical camera could be added.
- The justification of the chosen sensor is not obvious. Although the comparison with existing sensors is exhaustive, it is not clear which parameter played a crucial role in the final choice.

Recommended grade for the Master Thesis is \underline{A} (A-E grading scale)

External Reviewer:

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