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Master Thesis Evaluation Report – Advisor Evaluation

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 57-page document, consisting of 7 chapters.

Oleg Shipitko thesis focuses on the development of the algorithm of computer vision of warehouse robot aimed at intelligent box picking and placing. PickToGo project is the world's first mobile platform with manipulator for automation of picking operation. The computer vision (CV) algorithm is needed for detection of the box, that gives the coordinates where to move the manipulator.

Nowadays, the majority of retailer and e-commerce companies such as Amazon, WalMart, Alibaba invest in the automation of goods delivery and warehouses. There is a big need in robotic product that will make possible to automate picking and stowing operationsThe PickToGo project focuses on the warehouse automation through the development of autonomous mobile robotic system capable of object picking, palletizing, and stowing tasks.

Oleg's research goal is to create the computer vision algorithm for robust detection and pose estimation of boxes on a pallet. The thesis is well written, however, it is not well structured, e.g. Chapter 2 has only 2 pages and must be unified with Chapter 1. The relevant literature is referred with 52 sources.

In the Chapter 1, Introduction, Oleg described the market estimation for warehouse automation and problem statment. Chapter 2 deals with the background of research on object recognition and 3D pose estimation. Chapter 3 presents the types of RGB-D sensors and the calibration procedure of depth camera. Oleg describes the proposed approach for indetification of the target box on the aquired image, finding its position, and orientation in the Chapter 4. The Robotic Operation System (ROS) package was employed for specific computer vision transfromations. Chapter 5 focuses on the computer vision algorithm and robot simulation in Gazebo. The experimental data on robot recognition with the presence of noise and occlusion are interesting and valuable. The discussion of the results and evaluation of the proposed pose estimation algorithm are given in the Chapter 6. The number of point clouds must be increased to get more accurate experimental data, the experiment with CV and manipulator motion planning in real-time is needed. Chaper 7 focuses on the conclusion and future work.

The poster, Development of Autonomous Mobile Robot aimed at Warehouse Automation, in *Proc. of the First Skoltech-MIT Int. Conf. Shaping the Future: Big Data, Biomedicine and Frontier Technologies*, Article No. 9, Moscow, 2017, April 25-26, O. Shipitko, D. Tsetserukou received the **Best Poster Award**.

The thesis is a good quality MS research work. The proposed algorithm can be improved with application of machine learning techniques for box detection and classification.

Presented Master Thesis may be considered as complete qualification paper for a Master student.

Recommended grade for the Master Thesis is A (A-E grading scale)

Research (Thesis) Advisor:

Full Name: Dzmitry Tsetserukou
University/Organization: Skolkovo Institute of Science and Technology

Signature:
Date: 8 June 2017