Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Viktor Rakhmatulin

PhD Program: Engineering Systems

Title of Thesis: DNN-driven robotic system for automatic charging of electric vehicles in complex lighting conditions and human presence

Supervisor: Associate Professor Dzmitry Tsetserukou

Name of the Reviewer: Gonzalo Ferrer, Associate professor at Skoltech

I confirm the absence of any conflict of interest	**Date: 06-11-2024**

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

The main topic of the present PhD thesis, by V. Rakhamtulin, is related to assistive robot manipulators by three main content-chapters each of them providing a different kind of functionality, from automation, to interaction.

The thesis is motivated by the necessity to develop robot chargers, which are defined as the automatic of the process of setting systems based on batteries on a charging status, by plunging in connectors, similarly to what human do, and hence, without any alteration of the design.

The manuscript has been improved sine last time I reviewed as an IDC member, expanding the introduction and some materials in the motivation, problem statement as well as content chapters. It is adding more references to relevant works trying to give a wider view of the problem studied.

Chapter 1 provides a clear introduction to the topic and related the a priori very distinct topics in a unified vision. This is an effort by the student and the result is an homogeneous view of the thesis draft.

Chapter 3 studies the development of the automated robotic charging system which uses computer vision, robust to the environment changes, as the main sensing modality to locate the charging socket, with high accuracy and the serial manipulator plugs the charger. To this end, the chapter proposes a customized and learnable landmark (keypoint in the thesis) detector for the socket by a neural network. Some different alternatives are studied, and then classical model to image alignment is calculated.

Overall, plenty of data collection, annotation and experiments are carried out, which is valuable by itself. The methodology and results obtained are sound and with improved material the whole method is much clearly described.

Chapter 4 introduced the concept of the Haptic potential field, a simple yet effective strategy to ensure safety on close human-robot interaction. The main contribution here is the haptic volume indicating closeness to the manipulator and the system integration required to combine a wearable and a serial manipulator and run real-world experiments. This result was published in the SMC2021 as the main author of the work.

Chapter 5 proposes a step forward in the interaction of human-robot serial manipulator by removing active wearable devices and instead use an airflow from a fan as a signal by the robot and an infrared marker on the person. The main contribution in this chapter is the integration of these systems, quite complex all of them.

The student has published 3 conference papers in a Core rank B conference, and 2

Q1 journal papers, which fulfills the requirements for PhD graduation.
Provisional Recommendation
☒ *I recommend that the candidate should defend the thesis by means of a formal thesis defense*
☐ *I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report*
☐ *The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense*