Assessment of Masters' Thesis as an External Examiner

Title: **Deep Learning for Autonomous Control of Robot's Flippers in Simulation**
Author: **Teymur Azayev**
Supervisor: **doc. Ing. Karel Zimmermann, Ph.D**
External examiner: **Dr. Gaël Écorchard**

Fulfillment of Assigned Tasks

All assigned tasks were entirely fulfilled. I evaluate the difficulty of the assigned tasks as very high.

Resolution Methods

The thesis is divided into three main parts, imitation learning, reinforcement learning, and transfer to the real World. In each of these parts the student applies several machine learning methods with several types of input. The used methods are complex and appropriate. The potential issues, such as covariate shift and multimodality, are verified against or an explanation is given why the issues do not affect the learning much, if not at all. Solutions are provided for issues that were encountered during the learning, thus improving the overall result, such as state hashing, reward shaping, and GRAM matrices. Moreover, the neural networks are trained with various optimization criteria.

Obtained Results

The results obtained by the student are numerous and of high quality. Each of the presented results is accompagnied with an analysis. What I miss though is a partial conclusion for each of the three main parts, to sum up the different methods and results.

An important part of this work is the application of the obtained neural network on a real robot. Though I'm totally aware of the difficulties this brings, the presentation of the results for this part is not as satisfying as the rest of the thesis. At first, the result is vaguely described as "successfully navigates [...] roughly half of the times". I would expect here to see at least the number of attempts done and a few images of the robot in situations where the semi-autonomous navigation fails. A quantitative approach of the success rate during the different navigation phases would have been appreciated. Also, some explanation would have been welcome why the model of the Kinect camera, which I presume is open-source, could not be forked to model the R200 camera with a higher fidelity. It is also surprising that only one palette was available given their ubiquity, but the student may probably not be taken responsible for this.

Practical Requirements

Overall the thesis is very clear and well written. The different thesis' parts are well defined and clearly separated. There are a few points that could have been improved with a last thorough proofreading. Some sentences are malformed, for example. The caption of Fig. 6.12 is a copy of the one of Fig. 6.11. The term GP in Fig. 7.6 is not defined in the text. Typographic errors are practically absent, though British and American typographies are mixed.

The bibliographic references are numerous and adequate but I would expect the bibliography to be part of the work and not an appendix.

The source code provided as attachment is also clear and well written. Further work will surely be possible with this code but probably only within the Research Group as some dependencies are missing and not referenced, such as the Python modules *src* and *safe_exploration_msgs*.

General Comments and Conclusion

The presented work is of very high quality. A large number of algorithms are presented and applied. The results are numerous and always associated with an analysis. The application in the real World was realized but the presentation of the results could have been deepened.

As a conclusion, I advise the commission to evaluate the presented Masters' thesis with the grade

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A - Excellent.

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Prague, January 24, 2018   Dr. Gaël Écorchard
ČVUT, CIIRC