

## I. IDENTIFICATION DATA

<b>Thesis name:</b>	Real-Time Teleoperation of a Robot Arm for Self-Contact
<b>Author's name:</b>	Adam Rojik
<b>Type of thesis :</b>	master
<b>Faculty/Institute:</b>	Faculty of Electrical Engineering (FEE)
<b>Department:</b>	Department of Cybernetics
<b>Thesis supervisor:</b>	Doc. Mgr. Matej Hoffmann, Ph.D.; Msc. Jason Khoury
<b>Supervisor's department:</b>	Department of Cybernetics

## II. EVALUATION OF INDIVIDUAL CRITERIA

<b>Assignment</b>	<b>challenging</b>
<i>Evaluation of thesis difficulty of assignment.</i>	
The thesis was challenging since a real-time system had to be delivered, combining sensing using a motion capture system and robot control in human proximity. Moreover, the setup is designed to serve in psychological experiments and additional constraints had to be considered.	

<b>Satisfaction of assignment</b>	<b>fulfilled</b>
<i>Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.</i>	
All the required points have been fulfilled, including the optional ones such as conducting a pilot experiment and developing a graphical interface.	

<b>Activity and independence when creating final thesis</b>	<b>A - excellent.</b>
<i>Assess that student had positive approach, time limits were met, conception was regularly consulted and was well prepared for consultations. Assess student's ability to work independently.</i>	
The student had a very proactive time management and was actively seeking for communication and validation from the supervisors. The technical work has been developed and tested in an independent manner. He started with the high-level Python API to control the robot. After realizing that this will not be sufficient for real-time control, he switched to low-level C++ API and independently discovered and deployed a library for inverse kinematics. The student autonomously sought expert support raising multiple GitHub Issues and interacting with the online community.	

<b>Technical level</b>	<b>A - excellent.</b>
<i>Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.</i>	
Throughout the thesis, the student applied knowledge from his studies in robot control, robot kinematics and coordinate transformations, safety in human-robot interaction, network communication etc. Working with several hardware (Qualisys Motion Capture, Kinova Gen3 robot arm, additional peripheral devices for the experiment) and software components and integrating them into a single real-time system was challenging and after several iterations, the student delivered a working system.	

<b>Formal and language level, scope of thesis</b>	<b>B - very good.</b>
<i>Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.</i>	

The language level of the thesis is clear. Schematics and pseudo-code are appropriately employed. A more formal mathematical description of the robot parameters and variables, frames of reference, etc. would have allowed a clearer description of the robot control strategy.

**Selection of sources, citation correctness**

**A - excellent.**

*Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.*

The student managed to find and get the additional study materials necessary to perform the real-time tele-operation on the robot even-though the online documentation of the Kortex API was far from complete. The source citations in both psychology and robot control are very good and well used in the text.

**Additional commentary and evaluation**

*Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.*

The goal of the thesis was fully achieved, with excellent management from the student and very good communication skills. The technical and software conception was of very high quality and provides a foundation for future work on the subject including running the already piloted psychological experiment.

**III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION**

*Summarize thesis aspects that swayed your final evaluation.*

The student's work may lack some rigor – he did not attempt to use for example control theory tools to identify the system – but he used a pragmatic approach and succeeded – delivered a system that works, which we deem most important.

The student has responded positively in the moments of pressure and managed to work in a multidisciplinary team.

We evaluate handed thesis with classification grade **A - excellent**.

Date: **8.6.2023**

Signature: