THESIS SUPERVISOR'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Virtual hand guiding of industrial robots**
Author's name:	**Annea Futko**
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Control Engineering
Thesis reviewer:	Pavel Burget, Ph.D.
Reviewer's department:	Czech Institute of Informatics, Robotics and Cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **ordinarily challenging**

How demanding was the assigned project?

The topic covers fields of industrial robotics, 3D modelling and programming in Unity, and industrial communications. By combining these fields, an application is created that offers new ways how to do visual robot programming in industrial environment. It is also a way how to bring setup and programming of industrial robots to people with not-so-deep knowledge of industrial robotics. The student had to learn all these fields and integrate them together into a working application. She used the knowledge learned during her studies and combined it with new knowledge she had to study herself during her work on the master thesis.

Fulfilment of assignment **fulfilled**

How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.

The assignment was fulfilled.

Activity and independence when creating final thesis **B - very good.**

Assess whether the student had a positive approach, whether the time limits were met, whether the conception was regularly consulted and whether the student was well prepared for the consultations. Assess the student's ability to work independently.

The student approached the work with a very positive attitude. She learned the Unity environment for the creation of AR applications very quickly and in a relatively short time was able to connect the robot model and make it move. She was working independently and heading towards reaching the goal. However, sometimes she got stuck in a topic for a long time and did not consult it with the supervisor. This fact delayed the work to a certain extent. On the contrary, the student got involved in cooperation with other teams working in Testbed and extended her work to deal with another robot in a robotic cell for 3D printing. This fact showed a universality of her solution in the sense it can be easily extended to additional robotic environments.

Technical level **B - very good.**

Is the thesis technically sound? How well did the student employ expertise in his/her field of study? Does the student explain clearly what he/she has done?

The core of the thesis lies in chapter 5, where the implementation is described. She managed to connect the Unity environment with the environment of the physical robot and integrated the OPC UA communication in the Unity environment successfully. The transfer of robot data allows among other functionalities to display the robot working space, which is safe for movements with respect to the environment. However, more details about the actual implementation could be provided by showing the key code snippets from both the Unity as well as from the robotic environments.

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Formal level and language level, scope of thesis	**B - very good.**
Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?	
The language quality is very high, and the thesis is easy to read. However, some fonts in the figures are too small to be easily understandable.	

Selection of sources, citation correctness	**A - excellent.**
Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?	
All sources are selected and cited correctly.	

Additional commentary and evaluation (optional)
Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.
Please insert your comments here.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Summarize your opinion on the thesis and explain your final grading.

The presented thesis describes an approach how augmented reality can extend industrial robotics. Annea Futko has proven her ability to analyze a given problem and to come up with a solution that is feasible. She implemented the solution using available tools, which are both from the IT world as well as from the field of industrial robotics, which is going to be required in such a kind of applications more and more. She also proved her ability to work in a team with other collaborators.

The grade that I award for the thesis is **B - very good.**

Date: **26.6.2023** Signature:

THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Virtual hand guiding of industrial robots**
Author's name:	**Annea Futko**
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Control Engineering
Thesis reviewer:	Ing. Štěpán Pšenička
Reviewer's department:	Company Kuka CEE GmbH

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **challenging**

How demanding was the assigned project?

The assigned project was more than average demanding. It required a big amount of effort, resources, and time to complete successfully. The project presented numerous challenges and complexities that required careful planning, coordination, and problem-solving skills. The workload and requirements exceeded what would be considered typical or average for a project of similar nature. Completing the project required going above and beyond the usual level of effort and dedication. Overall, the project was considerably demanding, requiring a higher level of commitment and expertise to achieve the desired outcomes.

Fulfilment of assignment **fulfilled with minor objections**

How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.

The thesis has been fulfilled almost completely, successfully achieving its primary goals. However, there was a minor aspect related to safety that was not fully addressed. Specifically, the part concerning securing the robot against interaction with humans during movement, as outlined in ISO 10218-1 and ISO 10218-2, was not entirely prepared. This particular aspect could be further developed or expanded upon to ensure compliance with the safety standards mentioned. Nonetheless, the majority of the assigned task was effectively completed, demonstrating a strong level of accomplishment in the thesis.

Methodology **outstanding**

Comment on the correctness of the approach and/or the solution methods.

The approach and solution methods employed in the project were generally correct. The methods chosen were appropriate and aligned with the objectives of the project. They demonstrated an understanding of the problem and were effective in addressing the key challenges.

Technical level **A - excellent.**

Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?

Yes, the thesis is technically okay. The student demonstrates a reasonable level of expertise in their field of study. She shows a sufficient understanding of the subject matter and utilize appropriate technical knowledge to address the research problem. The student also explains their work adequately, providing clear explanations of their research methodology, experimental procedures, data analysis techniques, and the outcomes obtained.

Formal and language level, scope of thesis **B - very good.**

Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?

Yes, the thesis is organized in a logical way, providing a clear structure that allows readers to follow the flow of ideas and arguments. However, it should be noted that there are some instances where paragraphs are repeated in the text. Language is understandable.

Selection of sources, citation correctness **A - excellent.**

Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?

The selection of sources was adequate.

Additional commentary and evaluation (optional)

Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.

Please insert your comments here.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.

The thesis is well done, demonstrating a solid understanding of the subject matter. Based on this excellent achievement, I assign the thesis a grade of A.
However, it is worth considering the practical aspects of robot programming in industry, where logic coding plays a significant role. In trajectory planning, there is often a need for detail work, requiring the programmer to work closely with the robot, its effector, and the target. Based on my experience, it seems that this approach may have limited applications, particularly in the context of industrial robot programming. However, it could potentially find suitable use in certain tasks such as painting. Are you aware of any other specific applications in industry where this trajectory planning method could be effective?

The grade that I award for the thesis is **A - excellent.**

Date: **15.6.2023** Signature: