CZECH TECHNICAL UNIVERSITY IN PRAGUE

I. IDENTIFICATION DATA

Thesis title:	**Image Processing Methods for Long-TermTeach-and-Repeat Navigation of Mobile Robots**
Author's name:	**Pavel Linder**
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Cybernetics
Thesis reviewer:	Keerthy Kusumam
Reviewer's department:	School of Computer Science, University of Nottingham, UK

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	challenging

How demanding was the assigned project?

Please insert your comments here.

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.

Please insert your comments here.

Methodology	correct

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

Please insert your comments here.

Technical level	B – very good.

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?

Please insert your comments here.

Formal and language level, scope of thesis	A – excellent.

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?

Please insert your comments here.

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?

Please insert your comments here.

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 grade that I award for the thesis is | A – excellent.

Date: | 06/01/21

Signature:

Review of Bachelor Thesis - Pavel Linder
Image Processing Methods for Long-Term
Teach-and-Repeat Navigation of Mobile Robots

Opponent: Keerthy Kusumam

June 1, 2021

The thesis focuses on improving the stability and robustness of teach-and-repeat navigation systems, specifically, bearing-only navigation systems. To do so, the author conceptualises, designs, implements and evaluates a system that estimates the alignment between images captured by the robot, one during the teaching phase and the other during a traversal.

The thesis is well structured and clearly presented. The author follows two approaches to solve the problem, one is a feature selection approach to increase the robustness of the existing system and the other uses a Siamese neural network to predict the displacement for image alignment. I especially appreciate the motivation of the two hypotheses which are clearly defined in the introduction.

The author provides a good review of the state-of-the-art while also emphasising the importance of teach-and-repeat navigation systems as opposed to other approaches such as SLAM. Therefore the author shows good grasp of the general approaches used in localisation scenarios.

The proposed feature selection methods, including the sky region removal and region selection using selective search to improve feature matching are both intuitive and well integrated through a heatmap mask approach. The experiment reports the lack of improvement of these techniques over the baseline method. The author could provide some more insights into why the feature selection approach did not contribute towards improvements in the conclusion section.

The author trains the Siamese network with image pairs created using the center crop of the base image and a sliding window on the target image to predict the displacement. The author then transforms the similarity scores from the image pair to an offset value. This method could be elaborated better, along with the details of how the histogram with similarity scores and pixel offsets is constructed.

The questions for the author are:

- Can you use your Siamese neural network system to predict the horizontal offset/displacement directly, instead of using a post-processing to convert the similarity scores into displacements? I understand that you have the ground-truth.

- As mentioned above, could you list out how the feature selection method affects the performance of different features that you have used?

The experiments are well defined and statistical tests are also carried out to show the significance of the improvements over the reference method. The author shows excellent technical knowledge of the methods used in the thesis. Algorithms are clear and makes it easier to follow.

Overall this work is very well written and demonstrates great technical comprehension. The author could elaborate a bit more on the points mentioned above for a clearer communication of the proposed methods. Therefore I would like to grade the author:

<div align="center">A.</div>

Cambridge, UK

<div align="right">Miss Keerthy Kusumam, opponent</div>