



THESIS SUPERVISOR'S REPORT

I. IDENTIFICATION DATA

Thesis title:	Artificial skin calibration for a humanoid robot: comparing or combining "self-touch" and 3D reconstruction from images
Author's name:	Bohumila Potočná
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Cybernetics
Thesis reviewer:	Mgr. Matěj Hoffmann, Ph.D.
Reviewer's department:	Department of Cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	challenging
<i>How demanding was the assigned project?</i>	
The thesis involved work from a number of different areas (3D reconstruction, processing of artificial electronic skin data, optimization), most of which were largely new to the student. Work with a real robot and synchronization between the robot's operating system (NaoQi) and the middleware to retrieve skin data (YARP) was also required.	

Fulfilment of assignment	fulfilled with minor objecti
<i>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.</i>	
The assignment has been fulfilled although the results are largely a product of the "first iteration" and are thus preliminary/inconclusive.	

Activity and independence when creating final thesis	C - good.
<i>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.</i>	
The student did work on the thesis regularly. However, her pace was rather slow and required significant conceptual guidance.	

Technical level	C - good.
<i>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?</i>	
The thesis is technically sound. A big part of the results was produced shortly before the deadline and the results are thus inconclusive and preliminary. Chapter 5 (Results) is often a list of results with proper interpretation lacking. Careful analysis and additional experiments would be needed.	
The results are well documented with links to code and datasets and can thus be reproduced / extended.	

Formal level and language level, scope of thesis	C - good.
<i>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?</i>	
Formalisms/notations are used properly, although a more rigorous treatment (e.g., in the Methods chapters (2-4)) would be desired. The thesis is organized in a logical way and sufficiently extensive. The language level is ok. A number of useful illustrations / schematics facilitate understanding.	

Selection of sources, citation correctness	D - satisfactor
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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 student did not explore the literature much beyond the works prescribed in the assignment. Guidance with related work, including the formatting of references, was needed.

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.

The work is an extension of the Bachelor thesis of Rustler (2019), adding two new aspects: (1) 3D reconstruction of taxel positions and (2) self touch with custom end effector. Results of (1) are a clear contribution to calibrating the electronic skin for this particular platform. The results of (2) and their combination with (1) are not conclusive. Additional work is needed to wrap up the work to prepare a manuscript going beyond the state of the art.

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

My overall recommendation derives from the points described above.

The grade that I award for the thesis is .

Date:

Signature:

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Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Cybernetics
Thesis reviewer:	Alessandro Albini
Reviewer's department:	DIBRIS – University of Genoa

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	challenging
<i>How demanding was the assigned project?</i>	
The project is related to the spatial calibration of a large number of tactile sensors placed over the robot body. Due to the high number of tactile elements, the manual calibration becomes error-prone or infeasible. The problem of developing a (partially or fully) autonomous procedure to calibrate artificial skin is challenging and still open.	

Fulfilment of assignment	fulfilled with minor objections
<i>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.</i>	
The main goal of the thesis was to extend the calibration framework proposed in [16]. The student worked on the following aspects: <ul style="list-style-type: none"> to provide a 3D reconstruction of the skin patches: in [16] the 2D geometry of the sensor was supposed to be known. to collect a new dataset of contact location using a finger-like robot end-effector: in [16] the self-touch was performed between large robot body parts, causing the activation of a higher number of taxels. The student fulfilled both tasks. However, at the end it seems that to use a small end-effector led to a worse calibration. Final results are preliminary, and a deeper analysis is required.	

Methodology	correct
<i>Comment on the correctness of the approach and/or the solution methods.</i>	
The proposed approach is correct. To reconstruct the position of the taxels from a series of images has two advantages with respect to [16]: (i) the curvature of the surface is considered; (ii) there is no need of a model representing the taxels placement in 2D, making the approach more generic. Furthermore, to use a smaller end-effector to collect data, avoid involving a large number of taxels in the self-touch procedure.	

Technical level	C - good.
<i>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?</i>	
The technical level of the thesis is good. The overall work proposed by the student is clear and fairly well described. Some of the contents described in the thesis are usually taught in master courses. The reviewer appreciated the additional effort put by the student to learn advanced topics.	

Formal and language level, scope of thesis	C - good.
<i>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?</i>	

Formalisms and notations are fine. There are minor logical leaps in the “storytelling” of the thesis. For example, in Equation (2.2), M is defined as “the number of activations in the dataset” but the dataset was not yet mentioned or defined as well as the meaning of “activations” was not formally defined.

Selection of sources, citation correctness

D - satisfactory.

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 use of large area tactile sensing technologies is limited to few labs in the world. Therefore, the number of works addressing the topic of the calibration is not so high. I found at least two missing references:

1. Cannata, Denei and Mastrogiovanni Towards automated self-calibration of robot skin (ICRA 2010)
2. Mittendorfer and Cheng 3d spatial self-organization of a modular artificial skin (IROS 2014)

Although the goals of the thesis are explained in a proper section of the manuscript, the contributions and the differences with respect to the current state of the art are not highlighted.

For example, the missing work of Mittendorfer (1) uses a technique based on image processing to estimate the positions of the skin patches. The student proposed a method that uses cameras to reconstruct the positions of the sensors which has some advantages to the one proposed in (1). These kinds of discussions are missing in the manuscript.

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.

In the reviewer's opinion, this thesis introduces very good ideas to extend and to possibly improve the method described in [16].

The 3D reconstruction technique brought interesting and promising results. It allows to reconstruct the skin patch with a minimal error.

However, it appears that the final calibration performs better when the self-touch is performed without the fingers. As stated in the conclusion, bad taxel activations could corrupt the dataset. Maybe, a deeper analysis or more experiments should have been performed to assess it.

Overall, the quality of the work is good.

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

Possible question:

From the results, it seems that the 3D reconstruction is convincing. However, the position of the taxel is picked manually which could be an intensive procedure when the number of taxels increases. Do you think it would be possible to automatically retrieve the taxel position by processing the photos of the skin?



THESIS REVIEWER'S REPORT

Date: **23.8.2020**

Signature: