

I. IDENTIFICATION DATA

Thesis name:	Artificial Skin Calibration for the Nao Humanoid Robot Using "Self-touch"
Author's name:	Lukas Rustler
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>Evaluation of thesis difficulty of assignment.</i>	
<p>The thesis proposes a method to calibrate the position of tactile elements with respect to the robot body frame. The problem is relevant since the majority of applications using artificial skin require to associate a contact location to a given stimulus.</p> <p>When the skin is composed of thousands of taxels the manual calibration becomes error-prone or infeasible. The problem of developing a (partially or fully) autonomous procedure to calibrate large area robot skin is still open. Due to the complexity of the task, all the approaches presented in the literature, propose solutions applicable under some assumptions rather than in a generic case.</p>	

Satisfaction of assignment	fulfilled
<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>	
<p>The main goal of the thesis was to develop a framework that allows to spatially calibrate large-area tactile sensors placed on the robot body.</p> <p>The core of the framework has been successfully implemented. Any possible extension of the thesis (e.g. autonomous self-touch procedure) can be developed on top of this work. For the reviewer, the goal of the thesis has been completely achieved.</p>	

Method of conception	correct
<i>Assess that student has chosen correct approach or solution methods.</i>	
<p>The proposed approach is based on two major assumptions: (i) the 2D positions of the sensors are known; (ii) the 3D positions and normals of the center of each skin module are known from cad models.</p> <p>The reviewer opinion is that the methodology applied is definitely correct and consistent with the methods proposed in the literature.</p>	

Technical level	A - excellent.
<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>	
<p>The student showed to be capable of applying the knowledge learned in the bachelor courses. Furthermore, he made an additional effort to learn more advanced concepts, usually taught in master courses.</p> <p>Considering that this is a bachelor thesis, the reviewer opinion is that this is high-quality work.</p>	

Formal and language level, scope of thesis	A - excellent.
<i>Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.</i>	
<p>I have no major comments. The thesis is well written, the notation is correct, and the algorithms are well documented.</p>	

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 importance and the problems related to the skin spatial calibration problem are well explained. Citations are adequate.

All the relevant works already proposed in the literature are cited and summarized in the thesis, showing that the student is acquiring deep knowledge of the fields related to large-area tactile sensing.

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 reviewer opinion is that the results are very good and outperform most of the approaches proposed in the state of the art.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.

The aspects that the reviewer considered for the final evaluation are summarized in the following:

- The student showed that he put a lot of effort, not only in the technical part of the work but also while writing the thesis. The description of the problem and of the solution are explained clearly, making the thesis understandable to people who are not experts in the field.
- The proposed method is novel, and it is not tied to a specific platform. This means that it can be implemented on different robots, provided that the initial requirements are fulfilled.
- The method has been tested on a real robot rather than on a simulated environment. The theoretical part has been validated in different scenarios, proposing a relevant number of experiments. The final results outperform most of the approaches presented in the literature.

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

Questions:

- The triangle is made with flexible PCB allowing to adapt the sensors to the shape of the robot body. During the calibration procedure, the single module is considered flat and rigid. This is fine when the curvature radius of the surface is very low, but in other cases, this will lead to an approximation of the robot body which is not smooth. Can the procedure be extended in order to optimize the position of the single taxel rather than the whole triangle?

Date: **30.5.2019**

Signature: