

## Bachelor Thesis Description – FS 2019

Title: User-centered Design of crutches to Control and Maneuver a Lower Limb Exoskeleton  
Candidate/Dept.: Xenia Eja Magdalena Voellmy, B.Sc. Student, D-MAVT Legi Nr.: 13-113-576  
Assistant(s): Jan Meyer, Department of Health Sciences and Technology  
Workplace: Balgrist Campus, BAA

Start Date: 25.02.19

Intermediate Presentation: 15.05.2019

Submission Date: 12.07.2019

### Background

The VariLeg enhanced team is currently developing a race exoskeleton to participate at the CYBATHLON 2020. As a part of the developed system, crutches will again be used as human-machine interface to control and manoeuvre the exoskeleton through the obstacle loaded race-course. The crutches thus function as a crucial interface between the exoskeleton and the user (pilot) not only electronically, but also physically. Therefore, it is crucial that the interaction is user-oriented, ergonomic and reliable. Based on the experience from the VariLeg project originating from the CYBATHLON 2016, it has shown that there is a yet unmet potential for improved ergonomics of the crutches and in supporting the usability with different additional features. Consequently, the goal is to improve the existing design of the crutches according to continuous user feedback within a user-centered design approach.

**Goal and Required Tasks** (15% literature research, 15% user needs and requirements, 30% prototyping and development, 20 % evaluation through user feedback, 20% report and presentation)

The goal of this project is to achieve a high usability of the crutches used for the VariLeg exoskeleton. To achieve this, a first step will focus on the ergonomics of the control unit (control interface) and the crutch handle. In a next step, a handful of new features will be developed and evaluated to their potential to increase the usability of exoskeleton control and maneuvering. In order to achieve an iterative, user-centered design, the pilot's feedback will be assessed in every step of the development of each added feature. As this is a shared project, the contribution in many attributes and aspect to be investigated are shared with Laura Tassari (D-MAVT). The specific contributions of this thesis therefore include:

- a. Ergonomic design of the crutches (control unit, handle, base, etc.) (30%)
- b. Haptic feedback integration for ground contact information (40%)
- c. "Click"-mechanism for one-handed crutch usage (20%)
- d. Automatic length adjustment (10%)

The following work packages should guide the student through the work:

- Background research on crutches of the VariLeg and other exoskeletons
- Background research on evaluation of usability and comfort/ergonomics
- Derive concept of the crutches (several options)
- Choose most promising by testing the prototypes and collect user feedback
- Reiterate the design to achieve a satisfying feature implementation

### Instructions:

A **project plan** shall be established and presented to the assistants within the first month of the project.

An **oral defense** of 30 minutes (20 minutes of presentation and demonstration, followed by a discussion) will be held a week before the end of the project. An **oral defense** of 30 minutes (20 minutes of presentation and demonstration, followed by a discussion) will be held a week before the end of the project. A **complete report** (two copies in English; passport photograph of the candidate on the title page; color print only if absolutely necessary for comprehension), including the present document at its beginning, followed by a one-page summary, introduction (context motivation, state of the art, your contribution), methods (design, experiments, data analysis), results (performance, quantitative information), discussion (interpretation of results, possible improvement) and conclusions/outlook (take home message, next steps) shall be handed in. The report shall focus on the accomplished work and obtained results, and should aim at engineers without specialization in the field of the project. A declaration of originality should be signed and included in the printed version of the report.


A **preliminary version of the report** shall be provided to the assistants at least a week before the oral defense. The **final version of the report** is due within two weeks of the oral defense. A **USB stick** containing the report (source and PDF version), presentation slides and all documents relevant to the project shall be provided together with the final version of the report. **The printed version of the final report, the USB stick and your Balgrist Campus badge should be handed in in person to the secretary (Maya Kamber) before leaving the lab.**

Zürich,

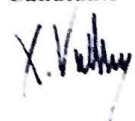
Professor  
Prof. Roger Gassert



Assistants

Jan Meyer  


Candidate

X. Voellmy  




## Bachelor Thesis Description - FS 2019

Title: User-centered Design of crutches to Control and Maneuver a Lower Limb Exoskeleton  
Candidate/Dept.: *Ada Laura Johanna Tissari, B.Sc. Student, D-MAVT* Legi Nr.: 16-945-206  
Assistant(s): Jan Meyer, Department of Health Sciences and Technology  
Workplace: Balgrist Campus, BAA

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Assistants

*Jan Meyer*  
*[Signature]*

Candidate

*Ada Tissari*  
*[Signature]*