Multibody & Mechatronic Systems Laboratory
Department of Aerospace & Mechanical Engineering
www.ltas-mms.ulg.ac.be

Liège, March 1st, 2024

Job Announcement

"Dynamic simulation of human walking with robotic assistive devices"

Fig. 1. Left: Musculo-skeletal model from OpenSim. Right: X-Leg prosthesis designed by VUB.

Practical aspects

- **Laboratory**: Multibody & Mechatronic Systems Laboratory (www.ltas-mms.ulg.ac.be) and Laboratory of Movement Analysis (LAM, www.lam-motionlab.uliege.be), University of Liège, Belgium.
- **Supervisor**: Prof. Olivier Brüls (o.bruls@uliege.be).
- **Duration**: full-time PhD position starting from August 1st, 2024 (this date is, however, flexible) until September 30, 2026.
- **AidWear project**: the position is offered within the BOSA-funded project "AI-driven wearable robotics for healthcare".
- **Salary**: the salary will take the form of a PhD grant.

Background

The AidWear project aims to develop the artificial intelligence frameworks that are necessary to enable Robotic Assistive Devices (active prosthetics and lower-limb exoskeletons) that give individuals with an amputation a better quality of life. The project, which relies on a collaboration between VUB, ULiège, and KULeuven, will advance three areas of interest: intention detection, mid-level optimization, and dynamic simulation.

The machine learning-based approaches proposed in AidWear require large amounts of experimental data from the prospective user, which are very costly to obtain. Numerical modelling and simulations can play a pivotal role in solving this issue. However, existing software falls short of representing a human body with robotic assistive devices. Therefore, we will develop a novel framework for numerical

modelling and simulation of the human musculoskeletal system that streamlines the design and optimization of robotic assistive devices.

Research

Numerical simulations can provide valuable information about interactions between the human body and wearable robots, that would otherwise have to be acquired through costly testing campaigns. State-of-the-art musculoskeletal simulation software packages have important limitations in this regard. In AidWear, we intend to solve these by developing our own novel simulation framework, which we will use to streamline the design and optimization of assistive devices.

The new multibody-mechatronic simulation framework will combine 1) the ability to modularly describe arbitrary topologies featuring intricate deformable components and to deal seamlessly with kinematic loops; and 2) the utilization of efficient numerical solution techniques.

Firstly, simple state-of-the-art models will be used to validate the framework. Then, a numerical model of the prosthesis will be developed and validated by comparing numerical simulations against experimental data. Afterwards, the framework will be used to propose improvements for the prosthesis controllers. Finally, the framework will be used to produce simulation data, tailored for training AI algorithms. To achieve this, a comprehensive software interface will be established, facilitating access to all model parameters, which will enable both offline and online (RL) training of the algorithms.

Requirements

- MSc in Computational Engineering, Computational Mechanics, Biomedical Engineering, or related fields is preferred (all backgrounds are welcome to apply).
- Experience in numerical software development is highly desirable.
- Experience in modelling methods in biomechanics is desirable.
- High standard of spoken and written English.

Advisory and work environment

The researcher will be supervised by Prof. Olivier Brüls, who is an expert in multibody dynamics and numerical simulation methods for mechatronic systems. He/she will benefit from close interactions with other PhD students and post-doc researchers of the group for the development of the modelling and simulation tool. He/she will also benefit from the expertise of Prof. Cédric Schwartz in biomechanics and movement analysis and from the expertise of Prof. Pierre Sacré in intelligent robotics (both are involved in the project).

Applications

Please submit your application until **April 30, 2024,** by email to Prof. Olivier Brüls (o.bruls@uliege.be). Applications must include a motivation letter, a curriculum vitae, a digital copy of the highest academic degree (e.g. master's), and the names of two scientific references. The recruitment procedure will guarantee a fair and equal treatment of all applications. Please contact Prof. Olivier Brüls for any further information or preliminary contact.