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INTRODUCTION

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Towards active lower limb prosthetic systems: design issues and solutions

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Background

A prosthesis is a crucial technical substitute that should restore biomechanical function and body integrity for people with lower limb loss or congenital limb absence [1]. Within the last decades, lower limb prostheses developed from passive mechanisms to adaptive mechatronic systems [2]. Contemporary, such prostheses evolve to robotic systems providing powered locomotion support by drives as shown in [3, 4]. According to the review in from [5], 21 different active lower limb prostheses are found in the research literature. With such technologies, various new research questions arise and the idea of prosthesis technology simulation is being discussed [6, 7].

Technically, the mechatronic design of actuators and kinematics as well as the development of suitable control algorithms are challenging tasks [3, 4]. A promising approach to actuation is found in compliant actuators and kinematics that store and transfer energy between gait phases [8]. To command those actuators, controllers that mimic biological function during different gait situations, speeds, and transitions as the one propose by Grimmer et al. [9] are required.

Analyzing human biomechanics with and without considering the prosthetic system is a crucial basis for design and control that provides requirements and constrains [10]. Further, biomechanical studies can be used to assess the utility of active prostheses and indicate that those improve amputee gait [3, 11].

As prostheses are not only used by people, but aim at replacing lost parts of amputees' bodies, human factors show significant impact on prosthetic development from a psychological perspective [12–14]. Those comprise aspects such as acceptance [15] and integration to the body schema [16–20].

Those human factors impact technical design [21, 22] and need psychological methods to be surveyed [23–25] and considered in design [26]. Additionally, insights regarding human factors can be used to develop and improve novel techniques for movement rehabilitation, e.g., gait training in virtual reality environments [27–29].

The articles in this supplement contribute to those topics by tackling elastic actuation, gait recognition and control, biomechanical analysis and simulation, human factors, and virtual reality rehabilitation.

Authors' contributions

Oliver Christ and Philipp Beckerle were both responsible for carrying out the literature search and writing the article. Both authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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