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Towards Seamless Integration of Active Assistive Devices into the User's Body Schema

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Abstract

Active assistive devices for lower limbs like prostheses or ortheses support the user by providing additional torque to restore and improve locomotion abilities. In order to ultimately achieve their seamless integration into the user's experience of everyday routine locomotion, they must provide a customized, familiar and predictable behavior that autonomously supports versatile locomotions, which describes formidable challenges for research and development. Moreover from a psychological perspective, the user might regard the device as part of his or her own body, which would mean a successful integration into the body schema. We suggest an integrated investigation of related research questions from psychology, biomechanics, and engineering from the beginning of any development of active assistive devices. Several experimental platforms have been developed by an interdisciplinary group of researchers. They serve as novel research methodologies towards seamless integration of active assistive devices into the user's body schema. One of the objectives is to investigate how humans incorporate visual, tactile and proprioceptive perception and how to utilize this knowledge in engineering design. The Int^{2}Bot platform is a robot testbed with the shape of a human leg that mimics squatting movements of subjects in order to investigate rubber hand illusion paradigm transferred to lower limbs. Another setup uses a head-mounted display and a treadmill to give subjects the experience of walking through a virtual park. Measures like proprioceptive drift, feeling of presence and agency, body ownership, and location are assessed. Both platforms contribute to a novel prosthesis-user-in-the-loop concept for a holistic, mechanical and perceptive simulation of human gait with different prosthetic concepts. It aims at a user-centered design of assistive devices by utilizing user experience and assessment. First results indicate that optimized variable stiffness actuation and specific visual and auditory stimuli improve the user's experience.

References

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Short Biography

Janis Wojtusch studied electrical engineering with a focus on mechatronics and control design at TU Darmstadt, Germany, and Nihon University, Japan, and graduated in 2011. Currently, he is a research associate and doctoral candidate at TU Darmstadt.

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