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A Human Centered Design of an Exoskeleton Using Multibody Simulation

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Abstract : Trial and error approaches to adapt wearable support structures to human physiology are time consuming and elaborate. However, during preliminary design, the focus lies on understanding the interaction between exoskeleton and the human body in terms of forces and moments, namely body mechanics. For the study at hand, a multi-body simulation approach has been enhanced to evaluate actual forces and moments in a human dummy model with and without a digital mock-up of an active exoskeleton. Therefore, different motion data have been gathered and processed to perform a musculosceletal analysis. The motion data are ground reaction forces, electromyography data (EMG) and human motion data recorded with a marker-based motion capture system. Based on the experimental data, the response of the human dummy model has been calibrated. Subsequently, the scalable human dummy model, in conjunction with the motion data, is connected with the exoskeleton structure. The results of the human-machine interaction (HMI) simulation platform are in particular resulting contact forces and human joint forces to compare with admissible values with regard to the human physiology. Furthermore, it provides feedback for the sizing of the exoskeleton structure in terms of resulting interface forces (stress justification) and the effect of its compliance. A stepwise approach for the setup and validation of the modeling strategy is presented and the potential for a more time and cost-effective development of wearable support structures is outlined.

Keywords : assistive devices, ergonomic design, inverse dynamics, inverse kinematics, multibody simulation
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