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Exo-BiomechSim2– part of EVO-MTI

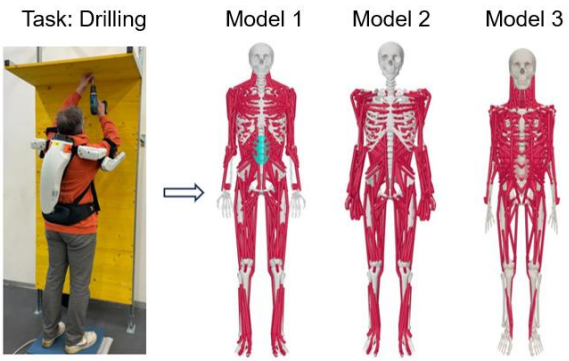
Quality optimization of biomechanical human models and simulations for human–machine tasks

BACKGROUND

Musculoskeletal disorders caused by repetitive and physically demanding activities, particularly work above head level, pose a major challenge in industrial environments. Shoulder exoskeletons have emerged as assistive systems aimed at reducing physical strain through external mechanical support. Within the EVO-MTI project, digital biomechanical human models are used to investigate human–exoskeleton interaction in a virtual environment. Following the initial establishment of a data-driven simulation framework, the project has transitioned to a second phase focusing on the development and evaluation of specialized musculoskeletal model configurations to support industrial above head level use cases.

FOCUS OF WORK

The development of a biomechanical human model for simulating human–exoskeleton interaction, particularly for above-shoulder industrial tasks, represents a key aspect in understanding and optimizing assistive systems for physically demanding work. Within the Exo-BioMechSim2 project, a musculoskeletal model is developed and evaluated to represent upper-body biomechanics relevant for exoskeleton-assisted movements in a virtual simulation environment. Recorded motion capture data are processed and used as input for biomechanical simulations in OpenSim. The resulting simulation outputs are analysed in terms of joint torques, muscle activation patterns and muscle force profiles. Validation is performed by comparing simulation results against experimental measurements, including EMG-based muscle activity and expected biomechanical trends under assisted and unassisted conditions. These results provide insights into internal biomechanical effects and support the development of a validated model for human–exoskeleton interaction. The obtained model contributes to improving exoskeleton design, support characteristics, and long-term biomechanical compatibility with the human body.



KEY MESSAGES

The Exo-BiomechSim2 project establishes a validated musculoskeletal model for human–exoskeleton interaction during industrial tasks. Integrating motion capture with OpenSim simulations provides a rigorous framework to quantify internal biomechanical effects. This validated approach delivers the precise insights required to identify optimal support and refine exoskeleton design. Ultimately, the model ensures ergonomic compatibility and enhanced physical assistance for above-head level work.

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