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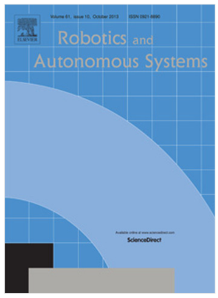

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A Human-Centered Design Optimization Approach for Robotic Exoskeletons through Biomechanical Simulation

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Abstract

A design optimization approach for exoskeletons on the basis of simulation of the exoskeleton and a human body model is proposed in this paper. The human-centered approach, addressing the problem of physical human-exoskeleton interactions, models and simulates the mechanics for the exoskeleton and the human body in concern. It allows designers to efficiently analyse and evaluate exoskeleton functions. A simulation platform is developed by integrating a musculoskeletal human body and an exoskeleton. An assistive exoskeleton for the symptom of brachial plexus injury is simulated and analyzed. Two types of passive exoskeletons with gravity-compensating capability are evaluated, and the optimal spring stiffnesses are obtained. The design analysis and optimization results demonstrate the effectiveness of the approach.

Keywords: assistive exoskeleton, human-centered design optimization, biomechanics, human-robot interaction

1. Introduction

Exoskeleton robots have prospective applications in rehabilitation and patient assistance. They can help weakened and paralysed patients regaining independent life by restoring their mobility and ability to perform activities of daily living (ADL). Designing assistive exoskeletons, however, is challenging and complicated as the human factor plays a key role. It is realized that a successful design of an exoskeleton depends on a better understanding of the biomechanics of the human body motion and sensory mechanisms, which is a critical problem in the physical human-robot interaction.

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