EXOSKELETON DESIGN BASED ON SIMULATION: DESIGN WOLKTROUGH AND MISTAKES IN CURRENT DESIGN PRACTICE

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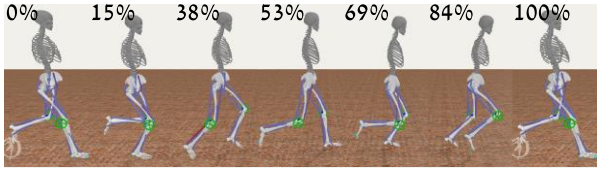
Introduction: Exoskeletons aim to enhance human capabilities, the design of an exoskeleton is a non-trivial task, especially because of lack of ability to predict human interaction . The design typically relies on trial-and-error experiments in which the design is modified and tested experimentally until the goals are met. An alternative approach is a process known as human-in-the-loop optimization. Yet, regardless of the method chosen, both demand extensive hours of device construction and laboratory testing. An alternative method for developing exoskeletons is to use simulations for identifying the optimal design within a broad range of parameters. Most previous exoskeleton simulation studies have used trajectory from experimental data obtained while walking or running, without exoskeleton to determine the gait in the simulation with the exoskeleton. However, the assumption is not in line with previous studies. Furthermore, it has been demonstrated that utilizing exoskeleton assistive torques derived from simulations based on typical joint kinematics as a benchmark leads to considerable discrepancies between predicted and observed performance in experimental settings. A new approach for simulation without experimental trajectories was implemented on walking. No known research found on running. This research focus on running and test the effect of tracking and offer alternative formulation of the optimization problem.

Methods: In this study, we use a 2D OpenSim model consisting of 10 degrees of freedom and considering 18 muscles, together with the Moco optimization tool, with a cost function that is multi-objective. Utilizing this model, we used a cost function that combines cost of transport (COT) and tracking objectives, to test the effect of a tracking objective with different weights. Next, we developed a multi-objective cost function without trajectory tracking that achieves trajectories similar to experimental running data. Finally, using this cost function we investigate the effect of different stiffness from 0 to 2.8 Nm/deg for clutch-based passive knee exoskeleton.
Results: The findings highlight the significance of employing a tracking-free objective when designing exoskeletons through simulations.



Bio:

Barak, a final-year PhD student in Industrial Engineering, completed both his Bachelor's and Master's degrees at in mechanical engineering at BGU in 2005. His Master's thesis delved into the fracture mechanics of tank cannons. Since then, he has been employed at NRCN, specializing in numerical methods utilizing Finite Elements. With a profound affinity for computers and coding, Barak has been talented in multiple programming languages since high school. Presently, he holds the position of Head of Research in a prominent department at NRCN. Alongside his professional activities, Barak is a devoted family man, blessed with three daughters, the eldest of whom recently celebrated her marriage.