Automatic customization of exoskeleton control during walking

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Exoskeletons and active prostheses promise to improve human mobility, but few have succeeded in enhancing performance. A critical obstacle has been a reliance on intuition and hand tuning when determining device function. We have developed a 'human-in-the-loop optimization' method that automatically customizes assistance patterns for individual humans during locomotion. An evolution-inspired optimization strategy, tolerant of measurement noise and human adaptation dynamics, is used to determine exoskeleton torque patterns that minimize a rapidly-updated estimate of metabolic rate. After optimizing assistance for an exoskeleton worn on one ankle, participants (N = 11) experienced a 24.2 ± 7.4% decrease in metabolic cost compared to a zero-torque condition. This exceptional improvement in energy economy arose from customized assistance patterns, which varied widely across participants, and from facilitating human motor adaptation. Larger improvements were found in single-subject studies optimizing exoskeletons worn on both ankles during slow, normal, fast, uphill and loaded walking, and when minimizing muscle activity rather than energy expenditure, demonstrating the generality of the approach. This talk will address the details of this method, insights from the results, and opportunities for improving this approach to exoskeleton and prosthesis design.

A recent talk by the author:
https://m.youtube.com/watch?v=-lstD3rwiJ8

This material is based upon work supported by the National Science Foundation under Grant No. IIS-1355716 and Graduate Research Fellowships under Grant No. DGE-1252522.