Cooperative Ankle-Exoskeleton Control Can Reduce Effort to Recover Balance After Unexpected Disturbances During Walking

Cristina Bayón (c.bayoncalderon@utwente.nl)
Universiteit Twente https://orcid.org/0000-0003-1825-1265

Arvid Q.L. Keemink
Universiteit Twente

Michelle van Mierlo
Universiteit Twente

Wolfgang Rampeltshammer
Universiteit Twente

Herman van der Kooij
Universiteit Twente

Edwin H.F. van Asseldonk
Universiteit Twente

Research

Keywords: Balance, Control, Exoskeleton, Ankle, Human-Robot interaction, Gait

Posted Date: July 1st, 2021

DOI: https://doi.org/10.21203/rs.3.rs-634479/v1

Version of Record: A version of this preprint was published at Journal of NeuroEngineering and Rehabilitation on February 17th, 2022. See the published version at https://doi.org/10.1186/s12984-022-01000-y.

Abstract

Background

In the last two decades, lower-limb exoskeletons have been developed to assist human standing and locomotion. One of the ongoing challenges is the cooperation between the exoskeleton balance support and the wearer control. Here we present a cooperative ankle-exoskeleton control strategy to assist in balance recovery after unexpected disturbances during walking, which is inspired on human balance responses.

Methods

We evaluated the novel controller in ten able-bodied participants wearing the ankle modules of the Symbitron exoskeleton. During walking, participants received unexpected forward pushes with different timing and magnitude at the pelvis level, while being supported or not by the robotic assistance provided by the controller.

Results

The results show that the controller was able to reduce participants' effort while keeping similar ability to counteract and withstand the balance disturbances (average reduction of 10.09% in soleus activity, 5.20% in gastrocnemius medialis activity and 6.67% in gastrocnemius lateralis activity for the stance leg).

Conclusion

The proposed controller was able to cooperate with the able-bodied participants in counteracting perturbations, contributing to the state-of-the-art of bio-inspired cooperative ankle exoskeleton controllers for supporting dynamic balance. In the future, this control strategy may be used in exoskeletons to support and improve balance control in users with motor disabilities.

Full Text

This preprint is available for download as a PDF.