Toward an Active Exoskeleton with Full Energy Autonomy

Yakir Knafo [1], Avi Manor [2], Alon Osovizky [2], and Raziel Riemer [2]

[1]tel aviv university
[2]Affiliation not available

December 7, 2023

Abstract

Exoskeletons aim to enhance human performance and reduce physical fatigue. However, one major challenge for active exoskeletons is the need for a power source. This demand is typically met with batteries, which limit the operational time of the device. A novel solution to this challenge is a design that enables the generation of electricity during motions where the muscles work as brakes, with the energy stored and subsequently returned to assist when the muscles act as motors. This could lead to a fully autonomous exoskeleton. To achieve this goal, a knee exoskeleton design with a direct drive and a novel electronic board was designed and manufactured to capture the energy generated by the wearerâ\euros movements and convert it into electrical energy. The harvested energy is stored in a power bank, and, later, the motion is used to power the exoskeleton motor. Further, the device has torque control and can change the assistive profile and magnitude as needed for different assistance scenarios. Sit-to-stand (STS) motion was chosen as a test case for the exoskeleton device. It was found that, during rising (from sit to stand), the exoskeleton provided up to 7.6 Nm and harvested 9.4 J. During lowering (from stand to sit, (it provided up to 10 Nm and was able to return 6.8 J of the harvested energy. Therefore, the cycle efficiency of the exoskeleton system (return divided by harvesting) is 72.3%. The results show that this technology has the potential to revolutionize exoskeletons and reduce the need for external energy sources.

Hosted file

`IEEE Transactions toward an exoskeleton with full energy autonomy_V14.docx` available at https://authorea.com/users/706935/articles/692017-toward-an-active-exoskeleton-with-full-energy-autonomy