Design of a Bilateral Lower Limb Exoskeleton Emulator

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Various exoskeletons for lower limb assistance have been designed, but there is a limited understanding of how to control these devices to significantly benefit the user. To attempt to solve the problems of gait augmentation, our lab uses emulator systems to provide exoskeleton assistance with low worn mass and low development time, while being able to explore a wide range of control protocols. We now propose a full lower limb bilateral exoskeleton emulator system. This device is designed for both active flexion and extension at the hip and knee, as well as active plantarflexion at the ankle. The applied torques will reach 200 Nm at the hip and ankle, and 300 Nm at the knee; these are values similar to peak joint torques seen in sprinting. With this tethered exoskeleton, we hope to find assistance protocols that will reduce the metabolic cost of walking and running at various speeds, grades, and loads. We will use human-in-the-loop optimization strategies that previously have been effective in our lab to explore different controllers. We hope that by developing an understanding of exoskeleton properties needed to successfully assist walking and running, we can intelligently design mobile systems, as well as develop rehabilitation strategies for clinical settings.