State of the Art in Robotic Leg Prostheses: Where We Are and Where We Want to Be

Workshop website: https://belab.mech.utah.edu/iros2020/

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In this talk, Dr. Robert Gregg will discuss about the design, control, and human testing of his custom quasi-direct drive prosthesis. Actuators for lower-limb orthoses and prostheses must balance the requirements of high output torque and low weight. This is typically achieved using a small (high-speed) motor with a high-ratio transmission, e.g., ball screw or harmonic drive. However, higher ratio transmissions tend to be less efficient, resulting in energy losses and less accurate torque control. The use of a high transmission ratio also results in high mechanical impedance, which means that the user cannot move (or "backdrive") the joint without help from the actuator. Backdrivability may not be necessary for patients who cannot contribute to their walking gait, e.g., patients with spinal cord injuries. For patients who still have some control of their legs, backdrivable actuators can promote user participation and provide comfort. We are designing compact, lightweight, wearable actuators using custom high-torque motors with custom low-ratio transmissions (24:1 or less) to achieve high output torques with very low backdrive torques. This class of actuators can also swing freely, absorb forceful impacts, and regenerate energy during human locomotion. All of these features are desirable in powered prosthetic legs for lower-limb amputees. These actuators will also enable the design of partial-assist orthoses and exoskeletons that encourage user participation during stroke rehabilitation or enhance performance of able-bodied users.

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