EU-US FOE
EU-US Frontiers of Engineering Symposium
October 19-22, 2022
Bled, Slovenia

Soft Bionic Limbs: from Research to Real World

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Abstract

Compensating for losing fine and coordinated function of upper extremities with artificial limbs is still a medical and technological challenge. Current commercial solutions range from simple body-powered systems to more advanced self-powered rigid hands, commonly anthropomorphic in appearance. The former are most typically hook-like grippers and can be controlled using a shoulder harness. The latter, also referred to as bionic hands, try to replicate the extraordinary functionalities of biological limbs thanks to the combination of multiple actuators and sensors.
The preference for one option over the other can be influenced by several factors, e.g. level of limb loss, personal preferences, cost, current occupation, and hobbies, but always results in a trade-off between system performance and users' needs. Despite recent technological advancements open up the prospect of restoring some missing capabilities, there is still a wide gap between available commercial devices and the perceived demands of prosthesis users, which often leads to limited acceptance. To address current limitations, clinical and engineering research is investigating new strategies to improve the level of acceptability of these advanced devices, e.g. minimizing the cognitive effort or increasing their robustness.
While commercial prostheses present rigid mechanical structures, emerging trends in the design of robotic hands are moving towards soft technologies. Composed of soft parts and flexible joints, these hands take inspiration from biology and promote anthropomorphic characteristics beyond mere aesthetics. The introduction of compliance, e.g. soft robotics, in hand architecture has led to an innovative approach for grasping and manipulation, and a growing interest in these technologies is already evident in the field of human–robot interaction. These devices can functionally adapt to the shape of the object and exploit environmental constraints to get advanced configurations and increase grasping success. This talk discusses the potential of these emerging trends in the field of prosthetics and proposes new strategies to optimize the performance of artificial hands, achieving a useful trade-off between grasping performance and complexity. To evaluate and assess the role and the benefits of soft robotic technologies, poly-articulated hands with rigid and soft characteristics have been tested with non-expert myoelectric prosthesis users in pre- and post-therapeutic training conditions, to evaluate functionality and usability.