THE SOFTHAND PRO-H: A PROSTHETIC PLATFORM FOR WORK-ORIENTED APPLICATIONS

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ABSTRACT

Body-powered prostheses are typically favored for heavy-duty use and employed in hostile environments, such as farm or factory work. With adequate training and practice, individuals with limb loss can become proficient in the usage of body-powered hooks (BPH) to accomplish a wide variety of tasks. Despite this versatility, there are drawbacks to this type of technology [1]. In this work, we present a novel prosthetic platform to address three of the most common issues in the use of BPH: 1. The need to frequently change terminal devices to task-specific solutions. 2. The loading of the shoulder due to the use of the figure-of-nine harness (the typical control system of body-powered prosthetic systems for users with unilateral limb loss). 3. The lack of functional, anthropomorphic solutions for users who prefer body-powered prosthetic solutions.

In contrast, myoelectric prostheses (MPs) are externally powered and controlled by muscle activity in the residual limb. Further, unlike the body-powered devices described above, they are typically anthropomorphic but more fragile, costly, and heavy. The most advanced versions offer multiple grasp postures, but are more difficult to control. Indeed, controlling even single degree of freedom (DOF) MPs can be challenging for some individuals, either because of their physiology or because of environmental factors [2].

The Pisa/IIT SoftHand [3] is a 19 DOF anthropomorphic robotic hand that combines intuitiveness, adaptivity and robustness. The mechanical design is based on studies on human kinematic synergies and leverages underactuation to simplify control and imparts adaptability to the grasp pattern. A previous prosthetic implementation of the Pisa/IIT SoftHand, the myoelectrically-controlled SoftHand Pro, has been developed and is being tested with individuals with limb loss [4]. This work presents the possibility of applying the SoftHand technology to tackle the issues identified above.

For this reason, we examined the feasibility of combining the benefits of both body-powered and myoelectric prostheses in a hybrid solution focusing on work-oriented applications. This solution uses a shoulder harness to control an externally-powered anthropomorphic prosthetic hand. We started by analyzing the placement of the main moveable components of the prosthesis (motor, battery pack and electronics) on the terminal device, socket, or user's body. Eight potential configurations were selected as feasible solutions, depending on situational requirements. This work presents this analysis as well as one of these solutions, which has been implemented as a functional prototype, the body-controlled, servo-assisted SoftHand Pro-H and featured in the Cybathlon 2016 Powered Arm Prosthesis Race.

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