THE YALE MULTIGRASP PROSTHETIC HAND

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ABSTRACT

The last decade has seen significant advancements in upper limb prosthetics, specifically in the myoelectric control and powered prosthetic hand fields. Notwithstanding the improvements in functionality and control of myoelectric prosthetic hands, upper-limb amputees continue to prefer body-powered terminal devices. These body-powered systems have a purely mechanical cable driven actuation scheme that is nominally paired with simple single-grasp terminal devices.

The Yale Multigrasp Prosthetic Hand bridges the gap between body-powered and electric hands. The Yale Hand, a novel body-powered terminal device, is a low-cost anthropomorphic prosthetic hand that incorporates the advantages of multiple grasp types seen in many myoelectric hands. Our body-powered system provides the benefit of proprioceptive force feedback when grasping, requires purely mechanical control, and improves on overall system robustness with no required electrical components. The Yale Hand has three grasp types: power, precision, and lateral grasp that the user can select with a simple movement of the thumb. A single body-powered cable drives all three of the hand's grasps and a modified whiffletree allows the force distribution for each finger to vary depending on the grasp used. The design of the asymmetric whiffletree allows for decoupling and passive compliance in the fingers during grasping. The fingers utilize a pin MCP joint and flexure PIP joint to provide out of plane compliance and an underactuated grasp response. The hand is anthropomorphic, sized to the specifications of a 50th percentile female hand, and features a 3d printed or carbon fiber/epoxy foam chassis. Our novel prosthetic hand preserves the durability, reduced cost and weight, and proprioceptive feedback of a body-powered split hook while encompassing the multi-grasp functionality and aesthetic appeal of more complex robotic hands.

The functionality of the Yale Multigrasp Prosthetic Hand was evaluated through benchtop testing and a twelve-subject able-body study. One unilateral trans-radial amputee and one bilateral trans-radial amputee performed evaluation studies to determine the level of dexterity achieved with the hand. Results show comparable performance to existing commercially available terminal devices on both the Box and Blocks and Southampton Hand Assessment Protocol for the able-bodied and amputee subjects.