DESIGN OF A POWERED THREE DEGREE-OF-FREEDOM PROSTHETIC WRIST

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ABSTRACT

Development of upper limb prosthetic devices generally focuses on improving the dexterity or functionality of the terminal device. As a result, currently available wrist prostheses tend to be simplistic devices which cannot replicate the function of the unaffected human wrist. Recent studies have shown that the unaffected wrist contributes to manipulation capability as much as the hand. This implies that a prosthetic wrist which is capable of three degree-of-freedom (DOF) motion may be as beneficial to amputees as complex terminal devices.

In terms of mechanical design of wrist prostheses, the vast majority of devices currently available tend to be passive multi DOF or powered single DOF units. Moreover, the multi DOF units tend to be exceedingly long devices, which may be unsuitable for transradial amputees. Many design innovations borrowed from traditional robotic design and implemented in prosthetic hands could serve to improve the mobility of wrist prostheses or aid in creating compact devices. Achieving full 3 DOF wrist motion in a compact volume is an imperative in wrist design. Thus, herein we present the design of a prosthetic wrist which satisfies this design imperative.

Our design consists of a two DOF mechanism responsible for flexion/extension and radial/ulnar deviation in series with a single DOF pronation unit. Majority of our efforts focus on the development of the two DOF parallel mechanism. We chose a U, 2-PSU architecture for the 2 DOF mechanism and optimized the geometric design parameters of the parallel mechanism in order to maximize a novel metric. Whereas typical parallel mechanism optimization would maximize a dexterity or range of motion based metric, our metric encompasses these as well as resultant size of the mechanism, which is particularly relevant for upper limb prostheses. This results in a compact design with reasonable motion capabilities over the workspace.