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AN UNDERACTUATED MECHANISM FOR FINGER DESIGNS IN HAND PROSTHESIS

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Finger or hand impairment is a widely occurring limb amputation due to industrial accidents, road accidents and war casualties. Among several levels of amputation, full or partial impairment of the hand heavily limits the performance of the activities of daily living (ADL) of the amputees. This paper proposes an underactuated mechanism to be used for a hand prosthesis which has the ability of automatic adaptation to grasp different geometries (*i.e.* different in size and shape). Human hand is capable of generating 21 Degrees of Freedom (DoF) contributing to different grasping modes during ADL. Metacarphopahalangeal (MP), Proximal Interpahalangeal (PIP) and Distal Interpahalageal (DIP) joints are arranged in different configurations in order to make different grasping modes, especially changing the joint angle for flexion/extension of the finger. Therefore, hand prosthesis should also have the capability of generating the required grasping modes to assist the ADL. Thus, the finger mechanism should have 3 DoF in order to generate varying joint angles similar to the human finger. The proposed mechanism in this paper is evolved from the available cross bar mechanism (CBM), which only has the capability of providing 2 DoF for a finger design. Modified CBM has five links connected with pin joints. Its proximal end is connected to a motor which actuates the whole mechanism. The configurations (*i.e.* different joint angles) of the CBM are determined by the different link lengths of the members of the mechanism. This property of the CBM is used to realize the grasping adaptation during grasping different geometries. Hence, the modified CBM consists of two links which allow the link lengths to change. Such a link is designed as two parts connected together as a sliding joint. Between the two parts of the joint a compression spring is attached parallel to the links to maintain the rigidity of the mechanism during the regular motion. When grasping an object that exceeds the workspace of normal modified CBM, spring facilitates the link joint angles to vary according to the object geometry. Mobility analysis and computer simulations were carried out to validate the proposed mechanism. Mobility analysis proves that one degree of actuation is capable of providing 3 DoF. Further simulation results show that the proposed mechanism is capable of generating different joint angles for the finger joints. Thus the PIP, DIP joints get self-adapted according to the grasping object.

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