

DEVELOPMENT OF A MULTIFUNCTIONAL HAND PROSTHESIS WITH A SELF-ADAPTIVE MECHANISM

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Human hand is a dextrous element of the human body which is essential for any individual to perform various activities of daily living. An amputation would fail any person to be self-reliant due to changed body condition hence the person becomes a dependent. Prosthetic hand is an artificial limb or an assistive device which replaces the missing hand of the amputee. The major problem faced by hand amputees is the unavailability of affordable, electrically powered multifunctional prosthetic hands.

The objective of this research is to develop a multifunctional prosthetic hand with self-adaptation which enables the user to grasp objects with various geometries. The finger mechanism in the proposed prosthesis has the self-adaptation ability. It is capable of generating different angles for the proximal interphalangeal (PIP) and the distal interphalangeal (DIP) joints for a certain rotation of metacarpophalangeal (MP) joint. In addition to that, DIP joint is capable of generating different angles for the same angle of PIP joint as well. The design includes thumb rotation in addition to flexion/extension of the thumb. Design parameters for the hand prosthesis are based on 95th percentile of human right hand. The prosthetic hand in this study uses three fingered configuration with individual controlling of index finger, thumb and combination of other fingers having a total of 9 degrees of freedom (DOF). The prosthetic hand is designed to perform power grasp, spherical grasp, hook grasp, pinch grasp, open palm grasp and key grasp with the additional DOF of the thumb. The finger design has an under-actuation mechanism using one actuator to drive all proximal, middle and distal phalanges. The finger mechanism is designed for the flexion/extension and abduction/adduction is not considered in this study. Thumb rotation, under-actuation and self-adaptation of fingers in this prosthetic hand make it easy to achieve the required grasping patterns.

The validation of the proposed design has been carried out through simulation tests. Considering the available materials, Aluminium was selected as the base material for most of the components due to its high strength to weight ratio and design parameters are validated using static analysis. Kinematic analysis of the mechanism has been performed in MATLAB/Simulink to verify the required range of motions of the joints.

Active hand prostheses are imported in Sri Lanka by spending a large amount of money due to lack of proper manufacturing facilities. Therefore this research will be an initiation for developing hand prostheses in Sri Lanka which will save money spent on importing prosthetic devices.

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