DEVELOPMENT OF A PROSTHETIC HAND FOR POWER GRASPING APPLICATIONS

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Masters thesis under my supervision.

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DEDICATION

To the most courageous two persons who guided me to great achievements: my beloved father *Somadasa Herath* and mother *Kumari Dissanayake*

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ABSTRACT

The human hand is an is an exceptionally significant part of the human body with a very complex biological system having bones, joints, and muscles, to provide many degrees of freedom. Among all the grasp patterns of hand, power grasping plays a crucial role in daily activities of a human. During the past few years, there was a rapid development in prosthetic limb technology to be used for the upper limb amputees. In this research, a prosthetic terminal device has been developed to assist the power grasping activities of daily living of upper limb amputees. The designed terminal device includes four fingers, which generates eight degrees of freedom. In order to generate finger movements, a novel linkage mechanism has been proposed. Notably, the proposed mechanism can be characterized as a combination of parallel and series links. The mobility of the system has been analyzed according to Chebychev-Grübler-Kutzbach criterion for a planar mechanism. By considering the easy fabrication, the linkage finger mechanism was redesigned based on the design for manufacturing guidelines. With the intention of verifying the effectiveness of the mechanism, kinematics analysis has been carried out by means of the geometric representation and Denavit-Hartenberg parameter approaches. Subsequently, a Matlab program has been developed, in order to proceed with the numerical study. Furthermore, the motion simulation and static structural analysis proved that the mechanism is capable of generating the required finger movements for power grasping. Furthermore, trajectories and the configuration space of the proposed finger mechanism has been determined by using the motion simulations inbuilt with Solidworks software package. The movements of the finger mechanism, which is fabricated by 3D printing was experimentally tested. Experimental results proved the effectiveness of the proposed mechanism to accomplish the expected motion generation. In addition, the finite element simulations exhibited that the finger is sturdy to withstand the standard finger forces.

Key words: Prosthetic hand, Linkage finger mechanism, Kinematic analysis, Power grasp

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LIST OF ABBREVIATIONS

Abbreviation	Description
ADL	Activities of daily living
CMC	Carpometacarpal
CNC	Computer numerical control
DFM	Design for manufacture
DIP	Distal inter phalangeal
DoF	Degrees of freedom
DP	Distal phalanx
EDM	Electrical discharge machining
EMG	Electromyography
FDM	Fused deposition modeling
FEA	Finite element analysis
IPB	Intermediate phalanx bottom
IPM	Intermediate phalanx middle
IPT	Intermediate phalanx top
MCP	Metacarpo phalangeal
PIP	Proximal interphalangeal
PLA	Polylactic acid
PPB	Proximal phalanx bottom
PPM	Proximal phalanx middle
PPT	Proximal phalanx top