UNIVERSITI TEKNOLOGI MARA

FINGER EXOSKELETON FOR EARLY ACUTE STROKE REHABILITATION: CONTROL DESIGN AND PERFORMANCE ANALYSIS

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of the requirements for the degree of
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(Mechanical Engineering)

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AUTHOR'S DECLARATION

I declare that the work in this dissertation was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

The number of stroke patients suffering from upper extremity hemiparesis increases from year to year. Manual repetitive therapy applied to stroke patients by trained therapists is limited by the number of therapists available. Many types of rehabilitation devices are invented to help patients recover their hand functions including exoskeleton devices. These devices can deliver high intensity therapy for a longer period of time. Every exoskeleton rehabilitation device is made up of three components: exoskeleton mechanism, actuator and control system. Control system is central to rehabilitation devices. The accurate control algorithm implementation is very crucial for the rehabilitation aspect. The performance of the control algorithm for rehabilitation must be investigated to assess the efficiency of the devices for rehabilitation. This research aimed to apply different Proportional Integral and Derivative (PID) controller configurations for position control of the index finger exoskeleton in rehabilitation. The second objective was to assess the performance of position control for index finger in rehabilitation. The control algorithm utilized was PID control algorithm. The parameter controlled was position of index finger measured through Metacarpophalangeal (MCP) joint angle. PID parameters were tuned using heuristic method and Ziegler Nichols' closed loop method. In order to assess the performance of the control system, desired or reference values were used. The actual data from position control were compared to reference values to investigate the performance. This study suggested that the PID controller managed to control the parameter according to the set point better than Proportional (P), Proportional and Integral (PI), and Proportional and Derivative (PD) controllers. The device could be manipulated to move to any position within the range of exoskeleton motion accurately. The results of the study also suggested that the performance of the control system for rehabilitation was very good as the error (difference between actual value and reference value) was less than 10%. Hence, the objectives of the research project were successfully achieved.

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