The Identification and Control of a Finger Exoskeleton for Grasping Rehabilitation

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Abstract. This paper evaluates the efficacy of different classical control architectures in performing grasping motion. The exoskeleton system was obtained via system identification method in which the input and output data was measured by means of current sensor (ACS712) and encoder attached to a DC geared motor (SPG30e-270k). The data obtained is split with a ratio of 70:30 for estimation and validation, respectively. The transfer function of the system is evaluated by varying the number of poles and zeros that are able to fit well with validation data. The performance of the classical P, PI, PD and PID control techniques were then evaluated in its ability to track the desired trajectory. It was demonstrated from the study that the PID controller provides the least steady state error as well as a reasonably fast settling time.

Keywords: Grasping Exoskeleton, PID, Rehabilitation.

1 Introduction

The inability to perform grasping motion is often caused by stroke and spinal cord injury amongst others [1, 2]. This inability somewhat affects their capability to carry out activities of daily living (ADL). Studies have shown that continuous passive motion (CPM) may regain their basic hand and finger functions [3–9]. Conventional rehabilitation therapy is often deemed too laborious to the physiotherapist and in turn, limits the duration of the therapy sessions as well as the number of patients that could be catered. Rehabilitation robotics, in particular, exoskeletons, appear to be a plausible candidate in addressing the aforementioned problems.

To date, there has been a number of hand exoskeletons that have been developed to carry out either CPM or assistive modes [2, 10–15]. Different types of actuation mechanisms, as well as control strategies, have been investigated. Nonetheless, it is worth mentioning that for the initial phase of rehabilitation CPM has been demonstrated to be sufficient as the primary aim of the aforesaid rehabilitation phase is merely to allow the unresponsive limbs to regain its mobility. The present study aims