

UNIVERSITI TEKNOLOGI MARA

**INTEGRATION OF PROGRAMMABLE
LOGIC CONTROLLER (PLC) INTO
PART-TASK TRAINER
OF UPPER LIMB SPASTICITY
SIMULATOR**

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ABSTRACT

During rehabilitation phase, therapist is the one responsible in aiding patients with spasticity to regain their normal movement. However, without skill and experience, the therapist may cause serious injury to the patients. Thus, this study was conducted with a main focus of developing the alternative technique to improve therapists' education skills through the benefits of transferring industrial robotics precision into medical and healthcare education. Quantitative study of spasticity characteristics and behaviour is one of the efforts to help trainee therapists to gain new knowledge. Other than that, Part-task Trainer of Upper Limb Spasticity Simulator can be used as a training method before the trainee therapists engage with the real patient. In order to illustrate the characteristics and behaviour of spasticity using quantitative values, the clinical data of 19 patients with various spasticity levels were analysed. Later, the patients' profiles were brought forward as guidelines for system integration development. This system was developed to integrate the hardware and software using components from Beckhoff and TwinCAT PLC system to be functional. As the prototype was properly functioning, the processes continued with evaluation phase by an expert physician to acquire the level performance, qualities and suitability Part-task Trainer of Upper Limb Spasticity Simulator. At the end of the study, the characteristics of each MAS level were classified based on quantitative values to visualise its spasticity. In addition, the Part-task Trainer of Upper Limb Spasticity Simulator has successfully emulated the spasticity characteristics and behaviour according to Modified Ashworth Scale (MAS). Ultimately, the response from the evaluator can be utilised as a good benchmark for the innovation of applying robotics in the healthcare field.

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CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

Spasticity can be defined as hypertonia with several signs, which are the resistance to externally imposed movement that increases with increasing speed of stretch and varies with the direction of joint movement as well as the resistance to externally imposed movement that rapidly rises above a threshold speed or joint angle. From both signs mentioned, spasticity creates stiffness and tightness [1]. The resistance is the reason why the muscles are unable to complete their Range Of Motion (ROM) since it gives the sign of increased muscle tone [2]. Commonly, stroke, cerebral palsy, brain traumatic injuries, spinal cord injuries and multiple sclerosis can lead to spasticity problem. If left untreated, the muscles can freeze permanently and can affect normal human abilities such as walk, eat and talk [1]. One side of human body will be weaken or paralysed and needs time to recover from spasticity [3]. At this stage, the patients suffering from spasticity need rehabilitation process to regain their normal movement.

Rehabilitation session must be handled by eligible therapist to avoid injuries. Since every patient has different stiffness and resistance, a therapist must possess a very good skills and experience on how to handle the patients. This is why trainee therapist needs enough clinical training before encountering real patients.

In the recent decades, robotic has become a potential option for assisting trainee therapist to get the experience of handling different levels of spasticity before having a physical contact with real patients. The study on advanced application robotic research in helping and facilitating therapist showed a promising result and can be further developed.

Limited resources on research and development in this area pertaining to the application of advanced technology and robotics in improving training devices for therapists could be one of the factors leading to the slow movement of the study in this area. Nevertheless, the collaboration between technical people and clinical people as a