UNIVERSITI TEKNOLOGI MARA

SPASTICITY SIMULATED MODEL (SSM) FOR HIGH-FIDELITY SPASTICITY PART-TASK TRAINER ACCORDING TO MODIFIED ASHWORTH SCALE

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ABSTRACT

Clinical trainees often struggle with accurately assessing spasticity due to the subjective nature of the Modified Ashworth Scale (MAS) and the lack of effective training tools. This study aims to bridge these gaps by developing and validating a Quantitative Modelling Framework and an Upper Limb Spasticity Training Device (ULSTraD). The research focuses on quantifying spasticity characteristics aligned with the MAS. The Simulated Spasticity Model (SSM) was developed to replicate various MAS levels, emphasizing the catch phenomenon and muscle tone behavior. The model's accuracy was validated through R-squared values where MAS 1, 1+, 2, and 3 are 0.99, 0.99, 0.96, and 0.92, respectively. It is demonstrating a strong correlation with real patient data. ULSTraD was designed to simulate spasticity scenarios, particularly in the elbow extensor, providing clinical trainees with hands-on experience in a controlled environment. Evaluation of the device involved both laboratory and clinical settings, revealing strong alignment between ULSTraD's measurements and established MAS scores. More experienced clinicians showed higher Intraclass Correlation Coefficient (ICC) scores, indicating better alignment with the device's outputs. However, the device faced challenges in accurately replicating MAS 1+ scores, highlighting the need for further refinement. User feedback was generally positive, though suggestions were made for improving system stability and user-friendliness. The study concludes that ULSTraD holds significant potential as a training tool for spasticity management, but further enhancements are needed to improve its reliability and educational value, especially for clinicians with varying levels of experience.

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INTRODUCTION

1.1 Research Background

Spasticity is a complex motor disorder characterized by increased muscle tone, involuntary contractions, and movement impairments commonly observed in individuals with neurological conditions such as stroke, multiple sclerosis, and cerebral palsy (Bhimani & Anderson, 2014). One defining characteristic of spasticity is its velocity-dependent nature, meaning that the resistance to passive movement of a limb increases as the speed of movement increases (Decq, 1994). Spasticity is also associated with alterations in muscle tone, leading to hypertonia or increased muscle tone, which further contributes to difficulties in movement and motor control (Bhimani & Anderson, 2014).

The Modified Ashworth Scale (MAS) is a widely used clinical tool for assessing spasticity (Li et al., 2017). It involves an ordinal rating system where a clinician evaluates the resistance encountered during passive movement of a joint. The scale typically ranges from 0 to 4, with 0 indicating similar to normal muscle behaviour and 4 indicating rigid limbs (Charalambous, 2014).

Although the MAS is frequently used, understanding, and interpreting the scores can be challenging to clinical trainee. This difficulty arises because MAS relies on subjective judgments (Ahmad Puzi et al., 2017) (Santos et al., 2016) (Malhotra et al., 2008). Clinical trainees involved in spasticity management, including physical therapists (PTs), occupational therapists (OTs), and physicians, face challenges in understanding and interpreting the differences between MAS scores.

Understanding qualitative concepts such as the "catch" phenomenon, which refers to a sudden increase in resistance during passive joint movement in individuals with spasticity is challenging without practical exposure and hands-on experience (Pandyan et al., 1999)(Ganguly et al., 2021). Unfortunately, due to limitations in student-patient interactions during medical training, many trainees may graduate without fully comprehending this crucial aspect of spasticity assessment. This lack of understanding can have significant implications for patient care, potentially leading to inappropriate treatment approaches. For example, misinterpreting spasticity as muscle