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Passive Upper Limb Assessment Device

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Abstract

Stroke is the leading cause of disability. Reaching movement is the most important movement for many daily activities routine. Rehabilitation is to encourage and enhanced recovery process. Conventional rehabilitation is one-to-one intervention where labour intensive and lack of repeatability. In addition, the stroke assessments by physiotherapist are subjective and not independent. Thus, this paper will describe the design and development of non-motorized system for assessing the patients' motor function. This system will be used in the future to find the correlation between conventional assessments scales such Fugl-Mayer Assessment (FMA), Chedoke-McMaster Stroke Assessment Scale (CMSA) and Motor Assessment Scale (MAS) and robotic assessment.

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Keywords: Stroke; assessment scale; robotic; upper limb; rehabilitation.

1. Introduction

Reaching motion of a person is one of the most important and crucial for many daily activities such as eating, drinking and simply pick and place a book on the table so as to make them independent. Besides, the ability to reach enables support to increase the person safety and mobility[1]. This ability could be reduce when a person having stroke because of the death of the related brain cells that govern the activity. Rehabilitation is to encourage and enhanced

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the recovery process. Besides traditional physical therapy, repetitive and task-oriented movement can improve the motor outcome and prevent secondary complication[2].

Dedicated robotic device can fulfill these possibilities. In addition, the used of robotic devices for neurorehabilitation can lead to similar or larger improvement motor function that traditional therapy[3]. In particular, MIT-Manus[4] and two degree of freedom (DOF) elbow-shoulder robot[5], which were developed for unrestricted unilateral shoulder and elbow movements in horizontal plane, show that additional therapy aided by robot technology can improve motor function. The ARM Guide[6] robot train reaching movement in a straight line trajectory. The ReachMAN[7] was developed to simplify the complexity of the mechanical design that is able to train combination of the reaching movement in straight line and hand manipulation. The Haptic Knob[8], which is enables to train active practice of forearm and grasping, show also that use of simple devices makes possible intensive training of post stroke patient. These devices have built-in technology to measure position, displacement, velocity, force and quantify other derived parameters. Besides train the patient to improve the motor function, the quantitative assessment of motor recovery should include in order to define a custom-built and effective rehabilitation procedure.

Most of the stroke patient will undergoes conventional assessment by the physiotherapies before and after the rehabilitation process. However, there have several limitations with this assessment such as the scoring systems are relatively coarse, making it difficult to quantify impairment and disability, the measurement is always subjective, lack in reliability and depends on the ability of the rehabilitation professional. Thus, this paper will describe the design and development of non-motorized system for assessing the patients' motor function. This system will be used in the future to find the correlation between conventional assessments scales such Fugl-Mayer Assessment (FMA)[9], Chedoke-McMaster Stroke Assessment Scale (CMSA)[10] and Motor Assessment Scale (MAS)[11] and robotic assessment.

2. System design

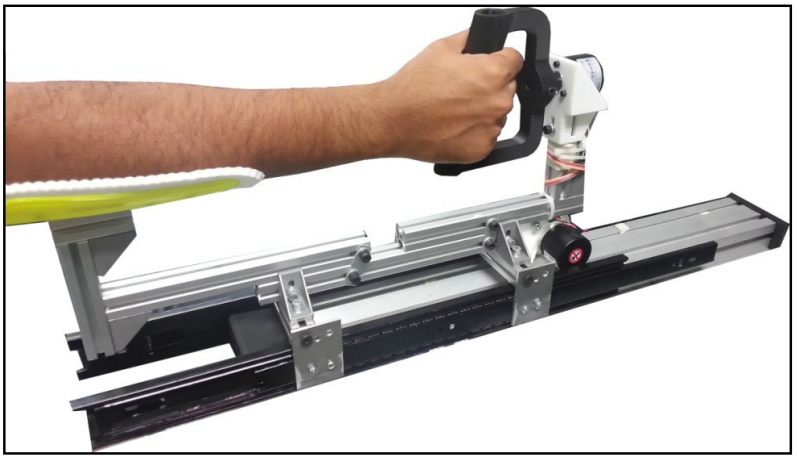

Fig. 1. Passive Upper Limb Assessment Device

This project aims to develop a simple assessment device for assessing upper limb of stroke patient before and after rehabilitation process. This system includes reaching and forearm pronation and supination movements as shown in Fig. 1. This system is non-motorized system, hence the safety of this system is much higher than motorized system. This system equipped with two optical encoders to record position during movement. The design of this system is similar to ReachMAN[7] except the grasping part. Game-like virtual reality are included in this system to indicate the movement while increase the motivation of the stroke patient. Different handles or knob are easily interchanged by using a custom-made coupling attached to the optical encoder. The handle of this system was design based on the biomechanics of the hand for comfortable grasping.