

# Design of Stroke Rehabilitation Robots

A. Rahman, S. Mohamaddan\*, J. Annisa, E. Junaidi  
Department of Mechanical and Manufacturing, Faculty of  
Engineering, Universiti Malaysia Sarawak (UNIMAS), 94300  
Kota Samarahan, Sarawak, Malaysia  
mshahrol@unimas.my

N.M. Hamdan, N.Z.Mohamad  
Faculty of Computer Science and Information Technology,  
Universiti Malaysia Sarawak,  
94300 Kota Samarahan, Sarawak, Malaysia

H. Helmy  
Faculty of Medicine and Health Sciences  
Universiti Malaysia Sarawak,  
94300 Kota Samarahan, Sarawak, Malaysia

N.A.C Zakaria  
Faculty of Mechanical Engineering  
Universiti Teknologi MARA  
40450 Shah Alam, Malaysia

C.Y.Low  
Faculty of Mechanical and Manufacturing Engineering,  
Universiti Tun Hussein Onn Malaysia,  
86400 Parit Raja, Johor Bahru

**Abstract**— One of the most frequent cause of limb disabilities worldwide is stroke. In order to achieve high recoverability, stroke patients require repetitive and consistent rehabilitation treatment. However, the increasing number of stroke patients with limited number of therapists and transportation problem among patients from rural places limit the accessibility to have better treatment. Hence, it is important to have a Rehabilitation Robot Devices (RRDs) to minimize the problems. This research is aimed to design an upper limb rehabilitation robot device that is portable and adjustable. In order to ensure that the robot arm design achieve the desired movement, CATIA V5R22 was used to simulate the design with a human builder. Motion analysis in SolidWork 2018 was used to investigate the angular displacement of the robot arm link. The simulation showed that, the robot arm design corresponds with the Malaysian anthropometry dimensions. The motion analysis showed that, the movement pattern of the robot arm achieved the desired angle of movement during rehabilitation process with the wrist extension recorded the highest time cycle which is 16 seconds for 45 degrees of extension.

*Keywords*—Stroke; Rehabilitation; Rehabilitation Robot Devices

## I. INTRODUCTION

Stroke is a clinical syndrome characterized by clinical symptoms caused by blocked or burst blood vessels in the brain, causing the latter to be damaged. As a result, a patient with stroke may experience unilateral weakness of the limbs. A stroke patient can experience sudden numbness on the face, arm and legs. Symptoms like confusion, difficulty in speaking, difficulty in seeing and walking, dizziness and unconsciousness are side effects of stroke.

In Malaysia, stroke is one of the top five leading causes of death after ischemic heart disease, septicemia, malignant neoplasms, and pneumonia and one of the top 10 causes for hospitalization in Malaysia [1]. The consequences of stroke include impaired arm and hand motor functions. Stroke is a life changing event where it impacts on quality of life, cognitive status, functional ability and interpersonal relationship [2].

It is essential for a stroke patient to regain the ability of using arm and hand motor in order to perform activities of daily living (ADL) [3]. Hence, stroke rehabilitation is necessary to restore the ability to move and work. Rehabilitation has been defined in [4] as the combination and coordination of the medical, educational, vocational and social measures to retain a person's moving ability to the highest possible level.

Basteris et al [5] stated that stroke rehabilitation is a process of motor relearning. It was mentioned by Maciejasz et al [6] that it is crucial for an individual to perform ADLs as the movement disorders would reduce a patient's capabilities especially on the upper extremities. Fortunately, various approaches are offered to revive the arm and hand functionality such as physical therapy, orthoses and electrical stimulation. Physical therapy shows an encouraging outcome because it depends on intensity, task-orientation and motivation from patients. However, it causes a burden on the therapists as the number of the stroke patients are increasing. Massive number of post-stroke patients that requires intensive repetitions of coordinated motor activities would deplete the number of available therapists in rehabilitation centers.

Several researchers have initiated the development of upper limb robotic rehabilitation devices (RRDs). This is one of the alternatives in order to minimize the use of physical therapists. The emergence of this option is due to the efficiency of upper limb RRDs on assisting the stroke patients to recover from body impairments. It is stated in [7-9] that the robotic devices produced encouraging results and have high potential to support the rehabilitation process. Upper limb RRDs is acknowledged to produce desired outcomes due to its potential in allowing intensive rehabilitation therapy [10].

For limb RRDs, there are mainly two categories: upper and lower limb. In this research, the focus is on the upper limb, which is from the elbow up to the shoulder. Lu Ec et al [11]