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DESIGN AND FABRICATION OF FINGER REHABILITATION DEVICE FOR STROKE PATIENTS - A PROTOTYPE DEVELOPMENT

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Abstract

Fingers are important parts of human body. Major daily life activities are performed by using fingers. Stroke is an example of problem that can cause fingers malfunction. In order to have a chance for recovery, stroke patient need rehabilitation courses at the early stage of stroke. However, since the number of therapist is inadequate, there is a need to develop the home-based finger rehabilitation device to support the rehabilitation courses. In this project, the design and fabrication of the finger rehabilitation device is presented. The device was developed based on the wire-driven extension and flexion mechanism and controlled by a single on/off switch.

1 Introduction

Stroke is the third largest cause of death in Malaysia [1]. There are about 17,909 patients reported in the year 2005 and the figure is expected to exceed 25,000 by the year 2020 [2]. Apart from death, most of the stroke patient is suffering with body malfunction. In order to have a chance for recovery, the stroke patients need an intensive focus at the early stage of stroke. The stroke patient needs a consistent rehabilitation courses supported by the therapist. However, most of the patients are not able to accomplish the rehabilitation courses due to the limited number of therapist. Besides, in some areas of Malaysia the hospitals or medical centres are not accessible by the patients due to the transportation problem etc. (some patients live in the rural or remote area).

There are two types of motion exercises exist in the rehabilitation process known as the passive and active-assisted movement. In passive movement, the therapist rehabilitates the patient's joint by moving the joint passively. The patients are able to move the fingers and remain to maintain the range of motion of the fingers. In active-assisted movement, external assisting forces are applied to move the patients' joint or limb because the patients could not complete the desired movement independently. The active-assisted movement is required at the early stage of stroke.

In general, there are different types of approaches, techniques and devices developed to support the rehabilitation process. The usages of Electromyography (EMG) with robotics knowledge [3-8] are example of application available for finger rehabilitation. In those researches, the aim was to achieve repetitive movement of the fingers (fingers exercises). The EMG will recognise the signals from the limb and transmitted it to the microcontroller. The microcontroller will then drive the

actuating system and controlled the position of the fingers using appropriate sensors.

Besides the EMG, research in [9-10] focusing on the mechanical mechanism that can be applied to move the fingers. Compared to [3-8], the focus of [9-10] is more on the active-assisted system and emphasize is on the pre-treatment period during the rehabilitation courses where the fingers are stiff and numb. It is the period of time where the patients need support from therapist or other devices to assist the movement. [9-10] was based on design and robotics knowledge application. In [10] the mechanical mechanism was developed to move the fingers based on actuators while in [9] wire driven mechanism was applied to actuate the fingers.

In this research, the home-based rehabilitation device was developed to support the rehabilitation courses and to minimize the burden of the therapist. The device applied the active-assisted movement and the focus is on the patients' fingers. The fingers become significance due to their functions in daily life activities (manipulating things etc.). This project focusing on the low cost device and the main objective is to gain the 'know-how' in developing the medical appliance.

2 Design Consideration

Design and fabrication of finger rehabilitation device was started with the design consideration phase. It refers to the conceptual design of the device, ergonomics and technical factors. In this project, the advantages and disadvantages from the previous research in [9] and [10] were referred in order to improve the 'know-how'. It is important to ensure better device can be produced from this project.

2.1 Conceptual Design

Conceptual design refers to the general concept that applied for the device. This project employed the semi-automatic cable driven mechanism for finger extension and flexion similar with the research in [9]. Two groups of wire; the upper and lower are used to move the finger as shown in Figure 1 and Figure 2. The fingers are moving inward or bending when pulling the lower cable (Figure 2) and moving back to the normal position by tightening the upper cable (Figure 1). The concept was applied to all fingers.

The concept gives more flexibility to the device to move and control each fingers. The main different between this project compared to [9] is the wires arrangement and the improvement of the wristband (discussed in Section 3).