

Low-cost haptic glove for grasp precision improvement in Virtual Reality-Based Post-Stroke Hand Rehabilitation

Mostefa Masmoudi
Center for Development of Advanced
Technologies (CDTA)
Algiers, Algeria
masmoudicdta@gmail.com or
masmoudi@cdta.dz

Nadia Zenati
Center for Development of Advanced
Technologies (CDTA)
Algiers, Algeria
nzenati@cdta.dz

Samir Benbelkacem
Center for Development of Advanced
Technologies (CDTA)
Algiers, Algeria
sbenbelkacem@CDTA.DZ

Zineb Hadjadj
Research Center in Scientific and
Technical Information (CERIST)
Algiers, Algeria
hadjadj_zineb@yahoo.fr

Oualid Djekoune
Center for Development of Advanced
Technologies (CDTA)
Algiers, Algeria
odjekoune@CDTA.DZ

mohamed amine guerroudji
Center for Development of Advanced
Technologies (CDTA)
Algiers, Algeria
mguerroudji@cdta.dz

Yousra Izountar
Computer science, University of Ferhat
Abbas Setif 1, And CDTA, Algeria
yousra.izountar@univ-setif.dz

Abstract— Stroke in Algeria is one of the most important causes of severe physical disability. Upper limb paralysis is also most common in stroke patients, which severely affecting their daily life. Therefore, it is important to help stroke patients to improve the quality of their life. In this article, we have proposed a novel system based on virtual reality for fine motor rehabilitation. Because the sense of touch is essential to the patient's daily activities, we have integrated haptic feedback into our system (vibrating glove), this is to help the patient to perform rehabilitation exercises. The proposed vibrating glove is equipped with five small and flat vibrating motor discs (one on each finger); these motors are controlled by ESP8266 board. This system has been tested on two patients with stroke. The preliminary results show that the system can help patients recover fine motor skills.

Keywords— Rehabilitation, Haptic, virtual reality, vibrating gloves.

I. INTRODUCTION

Stroke is an increasingly common phenomenon in Algeria, and is a leading cause of long-term disability, with several patients with stroke experiencing a paralysis of the upper limbs at onset (arms and hands); according to a recent statistic published by the Algerian Society of Neurology and Clinical Neurophysiology (ASNCN) [1].

After a stroke, people generally suffer permanent movement impairments that limit their ability to engage in meaningful occupations such as self-care, writing, work, or even driving. Among the most common effects of stroke is impaired hand function [2]. Virtual reality (VR) and Interactive Video Games (IVG) have recently been introduced as new therapeutic approaches to help and motivate post-stroke patients for assessment and training of upper limb [3, 4].

Recently, researchers have discovered that serious games are a tool that can provide patients with the pleasure, challenge and motivation to perform the rehabilitation

exercises. Among the most important works that have been used VR in the field of rehabilitation, we find; the MIRA platform-based Kinect and Leap Motion Sensors [7], has been tested on elderly people. In another study, researchers compared conventional rehabilitation with rehabilitation using a virtual reality system; this study was performed on children with cerebral palsy. The results show the levels of interest and pleasure expressed by the children [8].

There are many characteristics of serious game can contribute to post-stroke patients engagement and motivation, such as, salient audiovisual graphics, socialization, interactivity, optimal challenge. Many researchers have proved this [9, 10, 11, and 12]. Among these researches, we cite our previous works, where we have developed a rehabilitation platform based on virtual reality, to assist post-stroke patients to rehabilitate their upper limb disability, while retaining the medical benefits of the conventional rehabilitation methods [5, 6]. Although our platform has proven effective in motivating patients to repeat rehabilitation exercises without them realizing. However, it is only limited to global rehabilitation exercises (shoulder, elbow and wrist).

Global motor skills are the set of motor gestures that ensure the overall ease of the body, without seeking the performance or the refinement of a specific gesture. The goal is not to see if the patient does the gesture well, but how she organizes herself to make this gesture. For this, we find other rehabilitation platform for recovery Fine motor skills [15, 16]. However, many of these platforms lack the immersive of the touch sensation. Haptic senses are essential to almost everyone in daily life to feel the environments and objects around them.

In recent years, researchers have proposed to introduce haptic feedback for improving rehabilitation effectiveness and patient quality of life [13, 14]. In [17, 18] the researchers propose a haptic glove system based on virtual reality for patients for practicing grasp-and-release