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A Hybrid Haptic Feedback Stimulation Prosthetic Device to Recover the Missing Sensation of Upper Extremity Amputees

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Abstract

Anon-invasive hybrid haptic feedback stimulation system that can sense the contact pressure was designed for a prosthetic hand, in order to recover the missing sensation of the amputation patients. The main objective of this work is to develop and evaluate the first step of a novel approach for a lightweight, 7 Degrees-Of-Freedom (DOF) prosthetic arm to perform an effective object manipulation and grasping. Furthermore, to convey the tactile information about the contact pressure with high identification accuracy. However, a novel wearable hybrid pressure-vibration haptic feedback stimulation device for providing the tactile information about the contact pressure between the prosthetic hand and the grasped objects to the user's brain is designed to achieve the main objective of this study. An evaluation of sensation and response has been conducted with forty healthy subjects to evaluate the ability of the haptic system to stimulate the human nervous system. The results in term of Stimulus Identification Rate (SIR) presented that the whole participants were correctly able to discriminate the sensation of touch, stare of touch, end of touch, and grasping objects. While 94%, and 96% of the entire stimuli were successfully identified by the volunteers during the experiments of slippage, pressure level, respectively.

Keywords: *Contact pressure detection; Feeling recovering; Haptic feedback stimulation system; Prosthetic arm; Tactile sensory system; Upper limb prostheses; Vibration stimulation.*

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1. Introduction

According to the statistics study made by the Federal Statistical Office in Germany, 22,608 patients with upper limb insufficiency are recorded [1]. In the previous three decades, the number of amputees with upper limb