P300 Somatosensory Validation of Vibrotactile Haptic Feedback for Upper Limb Prosthesis

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***Abstract*— Haptic sensation research based on the event's related potential (ERP) has been carried out extensively in order to help amputees to be able feel and control their prosthetic hand. Clinically, somatosensory evoked potential is suggested in the pain-related evoked potential and able to control a computer using a brain to computer interface system called BCI. Somatosensory response can be evoked by tactile vibrators whether it is directly and indirect contact with skin. Somatosensory evoked potential has been reported to have lower signal to noise ratio compared to the common visual evoked potential. P300 based on somatosensory evoked potential were discovered as a benchmark that a person will generate P300 whenever decision making as simple as lift their finger take place. The aim of this paper is to identify the best location of the upper limb for tactile haptic placement and investigating whether the vibration motor haptic tactile setup reflect on the P300 somatosensory response from encephalography recordings. Results show that most of the subjects correctly guesses during upper arm position of haptic tactile feedback than the lower arm position. The vibration motor haptic tactile feedback setup was validated via experiment with mental task in order to elicit P300 somatosensory event related potential (ERP).**

Keywords—haptic feedback, P300, somatosensory, vibrotactile

I. Introduction

Loss of a limb is a drastic occurrence for people and society, particularly for the upper limb, due to the fine motor task performed by the arm and the hand. Advancement of technology had led to developments in the various fields of science, which includes the field of medical technology. The conceptualization of prosthetics came about in the 900th B.C when the first prosthetic toe was created and the field has since seen significant improvements in terms of upgrading its functionality and aesthetics. Prostheses have been developed to assist restore the lost features to a physical loss [1]. In the context of prosthesis, various kinds of system are developed to be integrated into prosthesis; most of these types are categorized in terms of its design and its source of energy to produce movements. The several types of upper limb prostheses designed according to amputee different activities. The wide range of prostheses for replacement the hand can be classified into passive and active prostheses. In passive prosthesis, the external force applied to adjust the mechanism. While in active prostheses, the force used to control the grasping mechanism of active prostheses is applied internally, such as by an electric actuator or a body-powered cable. [2].

It is desirable to create a smart prosthetic hand that can feel and behave as a true hand to enhance the dexterity of prosthetic grasping and manipulation. This involves delivering physiologically suitable tactile data from prosthetic fingers to the amputees' sensory cortex via a natural afferent pathway [3]. This physiologically tactile data were known as haptic feedback. Research on the haptic interaction based on the event –related potential (ERP) had been done [4]. In clinical area, somatosensory evoked potential is recommended to be used in the pain-related evoked potential in which the stimuli presented [5]. In emulating a similar aspect of the human biological hand, implementation of a haptic tactile feedback to prosthetics would be favorable for the amputee. Haptic tactile feedback provides the amputee with the familiar sense of touch that can help them to feel and move the prosthetic hand up to the intended extend. Therefore, the reason behind the need to implement tactile feedback on 3D prosthesis is because of its greater performance that it can provide.