Usability and Performance Measure of a Consumer-grade Brain Computer Interface System for Environmental Control by Neurological Patients

Farzin Deravi¹, Chee Siang Ang¹, M A Hannan Bin Azhar², Areej Al-Wabil³, Malcolm Philips¹,⁴, Mohamed Sakel¹,⁴,*

¹ School of Engineering and Digital Arts, University of Kent, UK.
² Computing, Digital Forensics and Cybersecurity, Canterbury Christ Church University, UK.
³ College of Computer and Information Sciences, King Saud University, Saudi Arabia.
⁴ Neuro-rehabilitation, East Kent Hospitals University, NHS Foundation Trust, UK.

Received 02 March 2014; received in revised form 07 August 2015; accepted 10 August 2015

Abstract

With the increasing incidence and prevalence of chronic brain injury patients and the current financial constraints in healthcare budgets, there is a need for a more intelligent way to realise the current practice of neuro-rehabilitation service provision. Brain-computer Interface (BCI) systems have the potential to address this issue to a certain extent only if carefully designed research can demonstrate that these systems are accurate, safe, cost-effective, are able to increase patient/carer satisfaction and enhance their quality of life. Therefore, one of the objectives of the proposed study was to examine whether participants (patients with brain injury and a sample of reference population) were able to use a low cost BCI system (Emotiv EPOC) to interact with a computer and to communicate via spelling words. Patients participated in the study did not have prior experience in using BCI headsets so as to measure the user experience in the first-exposure to BCI training. To measure emotional arousal of participants we used an ElectroDermal Activity Sensor (Qsensor by Affectiva). For the signal processing and feature extraction of imagery controls the Cognitive Suite of Emotiv’s Control Panel was used. Our study reports the key findings based on data obtained from a group of patients and a sample reference population and presents the implications for the design and development of a BCI system for communication and control. The study also evaluates the performance of the system when used practically in context of an acute clinical environment.

Keywords: stroke, rehabilitation, brain-computer interface, electroencephalography, emotiv EPOC

References


* Corresponding author. E-mail address: msakel@nhs.net
Tel.: +886-5-6315368; Fax: +886-5-6314486


Copyright © TAETI


APPENDIX A – SUS SURVEY [33]

System Usability Scale


1. I think that I would like to use this system frequently

2. I found the system unnecessarily complex

3. I thought the system was easy to use

4. I think that I would need the support of a technical person to be able to use this system

5. I found the various functions in this system were well integrated

6. I thought there was too much inconsistency in this system

7. I would imagine that most people would learn to use this system very quickly

8. I found the system very cumbersome to use

9. I felt very confident using the system

10. I needed to learn a lot of things before I could get going with this system
APPENDIX B – USABILITY QUESTIONNAIRE

The product evaluation survey completed by the study participants consisted of 12 items with the following choices of responses: 1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree nor disagree, 4 = somewhat agree, 5 = strongly agree.

The items were as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I could easily complete the task with the device</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The device helped me to complete the tasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It was easy to understand how to operate the device</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The device was comfortable to use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using the device was easy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using the device felt safe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aesthetically, I like the overall look of the device</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As a “disability” product, this device would draw unwanted attention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think the idea behind how the device is meant to operate provides a good solution to problems I encounter in everyday life</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It was easier to complete the tasks with the device than it was when using my existing equipment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compared to other products to complete the tasks, the actual functionality of this product is better</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would be happy to use this device if it were made available to me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>