Literature Review

A review of Human Computer Interaction and its uses in Medicine

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Table of Contents

Introduction

Human Computer Interaction (HCI) focusses on system design, implementation and evaluation, in order to provide an interface between a computer and a human (Badhiti, 2015). Research into this field has recently led to developments such as motion control, though there is wider scope for future developments. This could be found if there was collaboration between HCI researchers and researchers in Biocomputing and game design. The following possibilities from this are what I will be focussing on, although I will not be focussing deeply on game design. Although collaboration between these fields could lead to implementations to a wide range of sectors, the medical sector is what this review will focus on.

Research

Since the term originated in a paper published in 1975 (Carlisle, 1975), most commercial hardware developments have required physical human interaction to function, which is apparent due to the lack of an otherwise alternative on the market. Consequently, this means that people who have no control over their muscles cannot control a computer. This is stressed by a published report stating that recent developments in HCI focus on, amongst other activities, physical actions (Karray … Arab, 2008). However, this paper was published in 2008, so its validity in current times must be questioned.

More recently, however, research has taken place within BCI (Brain Computer Interface), whereby a computer can be controlled through mind control (Wu … Wang, 2014). Therefore, there is an argument that this area could provide a possibility for people who cannot control a computer in the traditional way to do so. Sarah Abdulkader contradicted this by saying that in some cases, a person may need training before they can interact with a computer in this way, and the brain activity reading could be inaccurate, meaning that this method of HCI may not be appropriate for everyone (Abdulkader … Mostafa, 2015).

The issues regarding accuracy are only true for non-invasive forms of BCI. If the technology is implanted into the brain, it allows for high accuracy transmission due to little distance between the device and the brain (Naumann, 2012). However, as the brain notices a foreign object, the body will begin to attack it and therefore its effect will be weakened (Polikov … Reichert, 2005), dampening Naumann's comments. Whilst invasive BCI is more accurate, this involves brain surgery, and may still be unsuccessful. Therefore, it is best to err on the side of caution before carrying out any advanced research in this area.

Linking to BCI is Biocomputing, defined as "the design and construction of computers using biochemical components"('"biocomputing"', n.d.). Research has taken place as to how we can use cells to process data (Bell & Holcombe, n.d.), and remarks that

modelling of this has been successful. To link this to BCI, Thomas DeMarse successfully controlled a plane simulator using a selection of 25,000 neurons taken from a rat brain (DeMarse & Dockendorf, n.d.). This research has shown us how cells can process information if they are laid out in the correct fashion. This is the biggest issue with the research, as the cells need to be laid out specifically. If research is continued as Bell and Holcombe suggest, solutions could be found. Research has also taken place into how we can artificially replicate the hippocampus, a brain component, of an animal successfully and implant it (Berger … Tanguay Jr, 2001). However, the body will still attack the implant. To me, this presents a possible gap in research, being how brain-dead patients can process data even if they are not conscious of this.

There is a possible great use for BCI in medicine. Medical research has proven that patients in comas have brain activity. In some cases, they can process information (Laureys … Schiff, 2004). Following on from this, it could be argued that these patients can interact with their surroundings. This leads to a possible new research area which is how coma patients can communicate. This could be used to communicate life support questions and to record responses. This idea needs more research before implementation, for numerous reasons including accuracy and brain issues from surgery. However, if this research were to take place, a good starting point would be to see if people who cannot speak due to conditions such as ALS can communicate this way effectively.

A speculative use for BCI within medicine could be for the processing of large amounts of data. As mentioned by Bell & Holcombe, cells can process data. If this were to be linked to the field of Biocomputing, whereby it is possible for cells to process information if they are laid out correctly (DeMarse & Dockendorf, n.d.), it could be said that if brains were to be donated after death and could be stimulated, they could process vast amounts of information. This could lead to the solving of some mathematical or scientific problems, however this possibility is speculative, and more research needs to take place before this is tangible.

As it is possible to create an Android game controllable by the brain (Wu … Wang, 2014), if this were to be linked to the comments written regarding coma brain activity (Laureys … Schiff, 2004), and cell information processing (DeMarse & Dockendorf, n.d.), it would be interesting to know if a coma patient could interact with a game. As cells can process information, it may be possible to use the patient's brain cells to process the information, and to store the application on an artificially created hippocampus (Berger … Tanguay Jr, 2001). If this were to be implanted in the patient's brain, they could have direct access to the game. This could lead to brain stimulation, thereby increasing the speed of recovery. If the game's instructions were to move muscles, this would avoid muscle wastage from prolonged periods of laying.

However, to ensure that this is accurate, invasive BCI would be needed, which can lead to rejection as seen before.

Conclusion

My review has led me to believe that in the future, there is a possibility that coma patients could benefit from new methods of HCI when combined with Biocomputing. If research were to take place which combines HCI and Biocomputing, there could be new opportunities for unconscious patients to interact and to stimulate the brain to increase the speed of recovery using games. We could also possibly learn how to harness the brain activity of unconscious patients. Whilst these ideas are speculative, particularly with the associated risks, if research took place as to how invasive BCI could be used with minimal health and rejection risks, I believe that both coma patient's prospects and data processing could improve.

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