International Journal of Swarm Intelligence and Evolutionary Computation

Gulrez, Int J Swarm Intel Evol Comput 2015, 4:1
DOI: 10.4172/2090-4908.1000e110

Editorial Open Access

Do We Need an 'Interaction Measure' Between Human Body and Robotic Interfaces

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During the last one decade a lot of research effort has been made towards the understanding that how brains control machines. An emergence of neural engineering on the canvas of science is due to this decade long effort. Neural engineering has introduced brain-machine interfaces which can solve the problem of paralysis based on the knowledge emerging from the neural activity of the brain. The challenge is to read the neural activity from the brain and estimate the correct corresponding movement of the human body. This information is useful for bypassing the damaged neural circuitry and directly controls a robotic/prosthetic device.

The science that was influenced by the brain activity models is information theory. The neural models were created and were used as artificial intelligence techniques as described by Hodgkin [1]. In recent time the interaction between the brain and engineering has evolved from neural models towards the interfaces which directly take control commands from the brain. In the past the concept of decision-making heavily relied the information theory and the work done by Paul Fitts as a Fitts' Law [2,3], described the way information is processed by the brain to control the limbic-movement. The Fitts' Law has laid the basis for the design of human-computer interaction (HCI) and brain-machine interfaces (BMI).

A lot of research has been made towards designing of 'effective' HCI devices such as wearable computers, touch systems, keyboards, mice, etc. In order to effectively use HCI devices, a measure of interaction has to be determined. The interaction measure between a digital device and human is usually determined through the subjective assessment approaches. In an ideal case, interaction measure may allow human users to select a computer or robotic device which fits well to their specific needs. For example, the interaction measure of a robotic rehabilitation device will tell users the degree of effectiveness or appropriateness of the device features within a scope of injury. Likewise, the interaction measure of a robotic interface could be enhanced by substituting the interface with self-learning capabilities [4-6]. Such an interface will modify its control outputs according to the changing needs of the user within the desired scope.

The main element of a BMI or a HCI system is a human body, a digital device and 'interface' acting like a medium of communication between the two. For example, an electric powered wheelchair (EPW) controlled by a human using a joystick interface or other non-conventional interfaces such as a sensorized shirt [7]. The interface placed between the human body and the digital device is of foremost importance in this scenario. Presently, these interfaces only perform one way communication, i.e., listening to human body signals and producing an output control signal. These interfaces can be developed more advanced by enabling them to communicate in the reverse direction also, by informing the state of the machine to the human neural system. In this way, humans learn the machines and machines learn the humans in an adaptive way. Presently, there is a disconnect of adaptive learning between the users and the machines at different time instances and references. BMIs have received much attention during the past years, in which the decoded brain activity control a videogame, prosthetic arm, hand, etc. directly through the brain signals [8-9], i.e., bypassing the hand and finger movements. In severe disability cases e.g. in the survivors of stroke, spinal-cord injury, etc. the paralyzed body still has capacity to send signals to interfaces through their left over mobility. Although, this technique to operate a robotic device with residual mobility is gaining interest and has been used in the operations of EPWs [7]. The important question arises while using BMI systems is how to measure interaction? If the user knows the interaction measure as a predefined entity, this will enable a smooth transition for the human body to send and receive signals to operate the digital device.

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Received May 11, 2015; **Accepted** May 16, 2015; **Published** May 19, 2015

Citation: Gulrez T (2015) Do We Need an 'Interaction Measure' Between Human Body and Robotic Interfaces. Int J Swarm Intel Evol Comput 4: e110. doi: 10.4172/2090-4908.1000e110