ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

Interface between Brain and Computer for Communication and Motor Control

(Non-invasive Brain Computer Interface of Robotics and Prosthetic Devices)

Suman M Dharaneppagoudar
Department of Electronics and Communication Engineering
Sri Venkateswara College of Engineering
Chennai, India
sumanmd714@gmail.com

A IshrathRehana
Department of Electronics and Communication Engineering
Sri Venkateswara College of Engineering
Chennai, India
aishrathrehana@gmail.com

***Abstract*—Brain Computer Interfacing uses signals recorded from the brain which are obtained by means of both invasive and non-invasive method to communicate and control external devices. As the BCI method does not use any peripheral nerves or muscles, this technology gives hope for a valuable new augmentative communication device for people with severe motor disability. The non-invasive method of recording brain signals from Electroencephalogram can be used to control the prosthetic devices to regain the normal activity of disabled or paralyzed persons.**

***Keywords*—Brain Computer Interface(BCI), Motor control, Electroencephalogram(EEG), Deep Learning, Non-Invasive BCI, Neural Network, feedback,**

1. INTRODUCTION

The idea of having something completed just by thinking about it is a fantasy which resides in some of the deepest crevices of human mind. Despite the immense advancements in the technological domain ,the desire to make lives simpler than the existing scenario will never cease and perhaps it is this quest for improvement which drives the creativity of every single technological domain, the desire to make lives simpler than the existing scenario will never cease and perhaps it is this quest for improvement which drives the creativity of every single technologically insatiable person out there. It wouldn't be an overstatement to state that the world is rapidly getting wrapped in a technological blanket and most of the aspects which had once served as the driving force of a technologically envisioned mind would soon become a reality. One of such mesmerizing technologies which might probably lead to a technological revolution is the concept of 'Brain and Computer Interface'.

Brain Computer Interface (BCI) gives the user ability to control and communicate channels that do not depend on the brain's normal output channels of peripheral nerves and muscles. In recognition of the recent rapid developments and its potential importance for those with motor disability, many technical inventions pave way to control the robotic or prosthetic devices using BCI method. Invasive method of controlling the external devices gives greater accuracy when compared with non- invasive, but they have significant clinical risk and limited stability. The non-invasive method of recording brain signals by using electroencephalogram (EEG) has limited resolution and requires extensive training. The training can be given by taking past inputs and forming a feedback loop to improve the present action. To increase the efficiency of controlling external devices using non-invasive BCI method certain algorithms were used to learn from the data and train the model based on user's thoughts to control the motor devices.

2. NON INVASIVE BRAIN COMPUTER INTERFACE

BCI utilizes neurophysiological signals originating in the brain to activate or deactivate external devices or computers. Non-Invasive BCI researches lie in the field of neurofeedback and operant conditioning of neuroelectric brain activity. Most of the clinical BCI studies in human patients use biofeedback of EEG oscillations. In the biofeedback the subject receives visual or auditory on-line feedback of his or her brain activity and tries to voluntarily modify a particular type of brain wave. The feedback signal contains both the information on the degree of success in controlling the signal and it indicates the reward.

ELECTROENCEPHALOGRAM

The physiological method of choice to record electrical activity of twenty billion neurons and other nonneural cells that make up the human neocortex, it is recorded by placing electrodes i.e EEG sensors. It measures the EEG potential difference between each scalp channel electrode and a reference electrode which represent single EEG signal beneath

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

the active scalp. When working with EEG it is important to note that certain factors decrease the accuracy and efficiency of the EEG signal.

Nonbrain Artifacts: Each recording from the scalp also sums up potential of nonbrain sources (artifacts) and channel noise. Fortunately, the noise is relatively small. However, the strength of contributions from eye movements, scalp muscles may be larger than the contributions of the cortical sources. The separation of this nonbrain artifact from the brain source signal is very important.

Multiscale Recording and Analysis: A major obstacle to understand how our brain supports our behavior and experience is that brain dynamics are inherently multi-scale. Thus, their more complete understanding will likely require the development of extremely high-density, multi resolution electrical imaging methods. Thanks to the deep learning paradigm that helps us to resolve this problem by gathering more and more data to obtain a multi resolution electrical imaging method.

3. SIGNAL ALAYSIS

The very essence of the implementation of the concepts of Brain Computer Interface lies in the processing of signals obtained by means of EEG or ECG analysis. The signals are usually obtained by means of EEG. It is the most widely used brain imaging mechanism which is non-invasive in nature. The brain activity is gauged in terms of electric potentials which provide information regarding the neural activity in the brain. A human brain comprises of approximately twenty billion neurons and non-neural cells that make up the human neocortex (the outermost layer of the brain).There are many aspects to be taken into consideration as far as the EEG signal analysis is concerned.

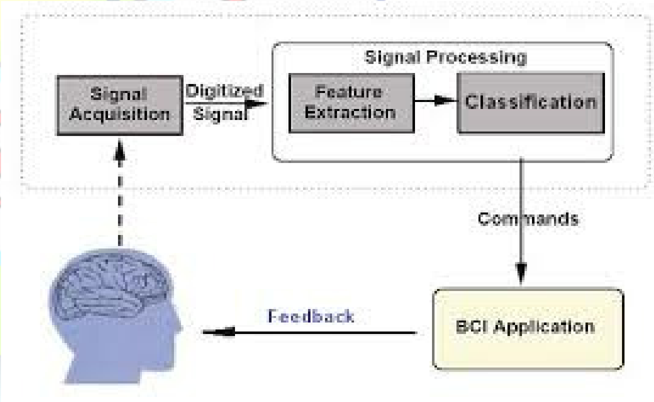
The peripheral aspects of a signal: It is extremely common to have a signal with many undesirable components in the periphery. Electrocardiogram is an electrical device which comprises of a channel for transmission of signal because of which the channel noise can also interfere with the electric potential obtained. The potentials from the nonbrain sources such as the eye movements, scalp movements, muscle movement etc. might also contribute to the potential to a minimum extent.

Deciphering the biological innuendo in brain activity: Unravelling the brain activity is still one of the major challenges to the research scholars, scientists and the psychologists worldwide. One of the major challenges lies in deciphering the complexity of the functioning of the brain. Initiating the development of brain and computer interfaced prosthesis would require the understanding of the relationship between the dynamics of the electrical functions of the neural networks along with the cognitive processes such as complex thought and decision making and the biological interaction with the environment.

Extraction of the input components from the EEG signal: The input components need to be extracted from the EEG signal as the EEG signal might comprise of various other peripheral aspects. These components are needed for the development of translational algorithms.

The signals undergo similar stages of initial stages of processing such as acquisition of the signals from the electrodes, amplification and then digitization. After the analysis of these signals, the inputs that serve to be the base for the development of translational algorithms are developed. The attributes for the encoding of the inputs from the digitized signals are extracted in terms of time or frequency domain and serve as the information for further analysis.

The digitized signals need to be subjected to various feature extraction processes such as spatial filtering, voltage amplitude measurements or spectral analysis. A spatial filter is an optical device which uses the concept of Fourier transform to alter the structure of a beam of light.



TRANSLATONAL ALGORITHM

Specific signal aspects are extracted from the EEG signal. The next important aspect in realizing the concept of brain and computer interface is the development of translational algorithm. Translational algorithms help in the transmutation of these signal aspects which is to be given to the motors as specific commands which act as an interface between the human being and the mechanical device.

In this stage, the dependent variables such as the signal aspects are changed to independent variables such as the commands to

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

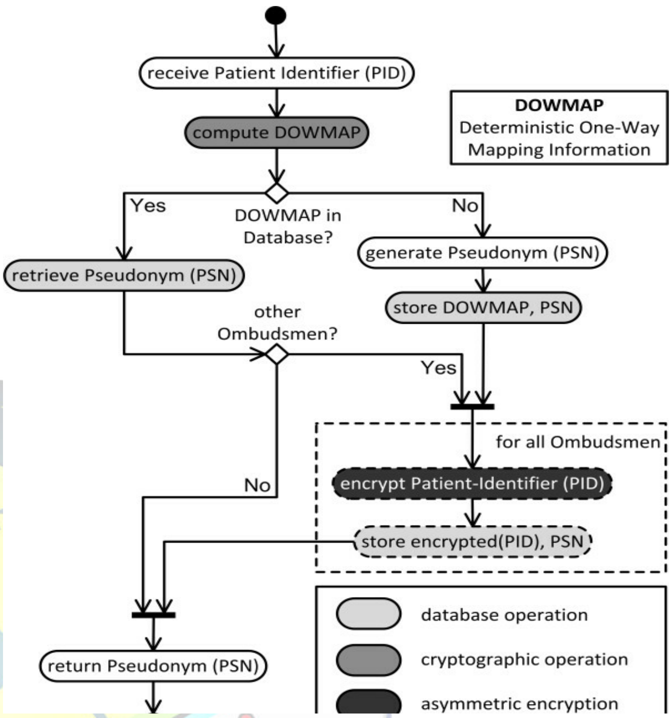
the prosthesis which are given in a cognitive fashion for ease and efficiency in operation. The algorithm can make use of linear algorithms such as classical statistical analysis or non-statistical analysis such as the neural networks. There are three levels of adaptation of effective algorithms tentatively.

The stage of acquaintance: Brain and computer interface technology is an aspect of artificial intelligence with the ability to respond and adapt to the circumstances. When a user uses the prosthetic for the first time, the algorithm is expected to adapt to the user in terms of the signal features and the user's behavioral patterns.

The phase of monitoring: After the tentative adaptation of the device to the user and vice versa, continuous monitoring, analysis and the required adjustments should take place in terms of the maintenance factor so that the spontaneous change in the external factors does not affect the functioning of the device in a major fashion and does not induce discomfort.

Interaction with the brain: The familiarity of the technology to the user and vice versa would then induce accommodation and engagement of adaptive capacities of the brain.

The translational algorithms act as the technical driving force behind the aspect of 'thought-induced movements'. The input source is the brain while the output device is the prosthetic.



CONCLUSION

Implementation of the technology of the brain and computer interface in the development of prosthesis is a very good concept with a lot of opportunities. However, realization of this concept in real time still requires a lot of research and experimentation. Prosthesis based on the brain and computer interface technology could be a revolutionary aspect in medicine. Many challenges arise due to the intricate complexity of human brain which might take a lot of effort and time to unravel. One more challenge is the differentiation between random thought and the command to the mechanical device. Humans think over a lot of things in a day in a random sense. The algorithm needs to recognize the command clearly. Currently, BCI prosthesis are only used in clinical tests and are not available for widespread public use. This technology has a lot of applications. The people with neuromuscular disorders will benefit to a greater degree with this idea of non-invasive BCI prosthesis. It will also serve as an important factor for people with disabilities. They will be able to move their parts only with their thought. They can also be used for communication purposes when the conventional mode of communication does not seem viable. Success in this aspect largely depends on the reliability aspect of the device. Brain and computer interface also seems to promise a lot of advancements and scientific development in terms of many aspects such as improvements in the flying conditions, ease in

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

the way of living, a medical revolution in the treatment of diseases etc.

REFERENCES

[1] Niels Birbaumer Leonardo G. Cohen "Brain–computer interfaces: communication and restoration of movement in paralysis"

[2]Scott Makeig,ChristianKothe,TimMullen,NimaBigdely-Shamlo,Zhilin Zhang and Kenneth Kreutz-Delgado,Senior Member IEEE "Evolving Signal Processing for Brain-Computer Interfaces"

[3]Jonathan R Wolpaw(Guest Editor),Niels Birbaumer,William J Heetderks,Dennis J Mcfarland ,P.HunterPeckhamGerwinSchalk ,EmmaneulDonchin,Louis A Quatrano,Charles J Robinson and Theresa M Vanghan(Guest Editor)"Brain-Computer Interface Technology :A review of the first international Meeting"

[4]Sarah N Abdulkader,AymanAtia ,Mostafa-sami M .Mostafa "Brain Computer Interfacing :Applications and Challenges"

