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Review Article

MEDICAL APPLICATIONS BASED EEG CONTROL INTERFACE TECHNIQUES-A REVIEW

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ABSTRACT

The present day computers are developed to have the ability to understand the human brain which is truly stupendous. These make science fiction into reality. Many researchers envisage is transmitting signals specifically to a person's brain that would permit them to see, hear or feel particular tactile data sources. And beyond that even considering the possibility to control PCs or machine with brain control interface. Monitoring the human brain has incredible potential in helping us comprehend the working of our mind and also in forestalling mental disorder and cognitive decline to enhance the individual's quality of life. Modern noninvasive surface Electroencephalogram (EEG) is the prevailing methodology for studying the dynamics and interaction with the outer environment. BCI technology and innovation must be progressed so that it could be utilized as a part of everyday life for monitoring health. To accomplish this, EEG frameworks must be changed from stationary, wired and bulky framework utilized in most part of the clinical work today to a wireless, remote and savvy wearable, to give a high flag quality. Application of BCI in medical field looks forward to the non-invasive, mobile, real time data acquiring, secure and added to that user friendly. This paper reviews about the recent trends, techniques and applications of EEG waves in medical field depending on the classification of BCI system.

INTRODUCTION

Many researchers have attempted to comprehend the most complex part of our body, the human brain, and after that tried to concentrate on the characteristics of brain, brainwaves and its significant signal pattern so as to understand the human behaviour. Brain is made up of billions of cells called neurons and those neurons combine together sending electrical signals called brain waves. So depending upon the frequencies the Brain waves are divided as Alpha, Beta, Gamma and Theta waves [1]. Hans Berger, a German Psychiatrist and researcher who discovered Electroencephalogram (EEG) in 1924 found out that different electrical frequency could be connected to certain activities and actions of the individual, thereby performing different psychological tasks, exercise, relaxment and movement [2].

Brain Control Interface (BCI) is one of the fast flourishing frameworks in medical field for the past few years. The Brain Control Interface technique integrates the acquisition and analysis of Brain waves, signal processing and control units to maintain a communication to the device or machine in the external environment. The term BCI was coined by Dr. J. Vidal in 1970's wherein brought hope to the people who suffered by the severe motor disabilities, spinal cord injuries, lateral sclerosis and injuries related to neuromuscular diseases [3].

Architecture of BCI

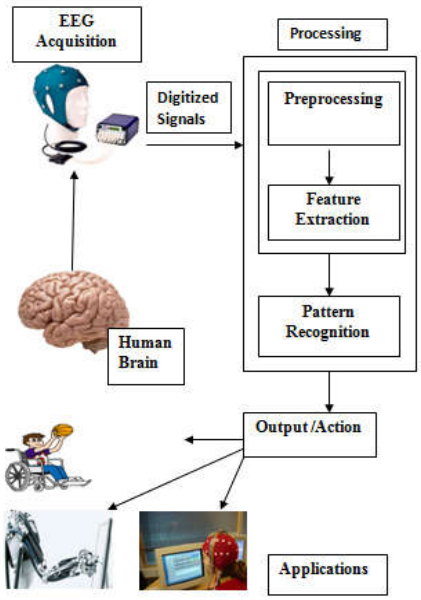

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Fig 1 Architecture of BCI

The BCI system comprises of Signal acquisition, processing and analysis of the EEG waves inorder to maintain a direct transmission to the machine interface like robotic arm or a wheel chair or even for research purpose [4]. The brain waves are recorded with the help of electrodes placed on the scalp or placed inside the skull as implanted electrode which is non-invasive and invasive respectively.

Attributes & Classification of BCI System

The present BCI system could be classified depending on the attributes, the protocols and technology of working and how these attributes are been used by Brian Control Interface in Medical Field [5], [6]. The design attributes are based on Transmission, Sensor placements, Number of channels, Neurological phenomenon.

Users

The end user who is going to get benefit at last with the product designed are the target users. Brain control interface is mainly targeted on the medical field for the disabled people specially. And other disabilities such as spinal cord injury, cerebral palsy, epilepsy, motor dysfunctions, muscular dystrophy, etc.

Transmission

Based on the classification of transmission it is differentiated into wired and wireless transmission systems in BCI.

Wired Transmission

As we know the term wired relays on the cables with physical medium. In attaining the EEG signal from brain, the electrical signals are carried to another end for processing. EEG wired transmission is used day to day in hospitals for acquisition of EEG from patients who are suspected to have brain related diseases or abnormalities.

RMS Maximus 24 EEG machine with 9 electrodes is used for the emotional state assessment by M. Sundar Raj *et al* [7]. EEG acquire software is used to obtain different waveforms. By Arousal – Valance Model the EEG features are mapped into chosen emotions.

Wireless Transmission

This is the most trending system which is prevailing in medical field because of its wearable and portable usage of electrical signals from brain through wireless transmission protocol. Wireless network installation is more easy with less complexity. Moreover it operates to entire wireless area coverage which is the main reason why EEG wireless transmission is been preferred in many research fields in medical field. Kamlesh H. Solanki *et al*, describes EEG and eye blinking signals through BCI control. Through Neurosky Mindwave device, EEG data is been transmitted through Bluetooth to control an electrical wheel chair [8].

Sensor Placement

Based on the placement of sensor it is divided into non-invasive (Electroencephalogram) and invasive BCI (Electrocorticogram) system.

Invasive Electroenchphalogram

Otherwise known as intracranial electroencephalogram which is placed on the brain directly under the skull. Invasive EEG electrode is been used widely in medical field during the brain surgery where the electrodes are been placed directly on the brain inorder to check the brain activity, action potentials, cortical potentials, etc. electrocorticogram plays a vital role in epilepsy surgery in medical field. An invasive electroencephalography monitoring for seizure [9] explains about the indications and surgical planning. Subdural grid electrodes composes of Teflon coated metal discs which is placed on the lesions of the brain. It helps in delineating the epileptogenic zone precisely.

Non-Invasive Electroencephalogram

It is preferred over the invasive type because it is used for normal healthy humans in daily applications because of its non-invasiveness. In areas like Brain controlled robot via Bluetooth the EEG collected from the Brain through Neurosky headset which is a non-invasive kind [10].

Fig 2 Brainwave Neurosky Headband

Number of Channels

The electrocortical activity of the brain which is recorded non-invasively is reported safe compared to invasive electrode channels. The number of channels used may vary from single, two, three to multiple channels like 256 to the maximum.

Single, 2, 3 Channels

To support for severely disabled people Devashish Salvekar *et al*, has made a Mind controlled robotic arm to help in their day to day activities [11]. They have implemented a brain controlled interface with single electrode microcontroller based robo arm. Neurosky Mindwave headset by Neurosky provides a single non-invasive electrode with a ear clip for ground and a AAA battery. It also has an inbuilt module to transmit the signals in digital form to the required station.

Multiple Channels (>3)

The electrode placement on the skull has the formal standard 10/20 system containing as many channels as even 256. Mostly multiple channels are wired because acquiring signals from many single channels and sending via wireless mode is complex. For the people who suffer from severe motor dysfunction Apurva Nepal *et al*, has made statistical analysis of the efficiency of BCI system [12]. With the help of RMS 32 Channel EEG, Maximus 32 EEG data acquisition is done. The number of trails of EEG for many persons and the BCI system

controlling the on / off of light bulb and fan marked to its efficiency is been calculated.

Fig 3 RMS Maximus 32 EEG machine

Neurological Phenomenon

The physiological Characteristics of EEG has wide range of attributes from P300, the alpha, beta, gamma rhythm, Event related potentials, response to visual stimulus etc. [13] [14]. So depending on the requirement of the BCI control systems the attributes are been extracted and used.

DISCUSSIONS

In sensor placement attributes the results obtained from invasive placement of electrodes is more accurate and the neurological conditions of the disabled patients are obtained precisely. Miniature millimeter size implantable electrodes which acts as antenna which is capable of communicating outside human body [15]. Invasive placement of electrodes are risk and could be handled by very well versed surgeons in this field. The implantable device should not affect the human body in any way. But mostly only non-invasive method is been used because it is not complicated even though the result of accuracy compared to the invasive type is less, it is sufficiently enough for the medical proceedings. Many electrodes are used in obtaining Brain waves ranging from 126 electrodes to 64 electrodes to even single electrode. Using lot of electrodes may be uncomfortable to the patients with lot of wet gel on head and the results may g*et al*tered when the electrode do not sick properly or is damaged. Reducing the number of electrodes in BCI is critical situation for successful development of BCI results. Yijun Wang *et al*, [16] has attained Brain computer interfaces based on visual evoked potentials using single electrode. When comparing the wired and wireless transmission of brain waves to BCI control systems the wired is chosen for long distance analysis. But compared to wireless, wired will give more accurate results because the transmission is null. But in wireless the data accuracy and the quality is little bit less because of transmission data is lost.

CONCLUSION

Brain control interface is been used in various fields but it is blooming in medical field because of its fascinating advantages for human race. The main aim of this research is to provide the advantages and disadvantages in the attributes of the BCI. This work provide the recent BCI systems focusing especially on realtime wireless and less usage of electrodes for the betterment of the patients and at the end provide the highest accuracy with minimal usage of instruments with ease.

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