ISSN: 2321-7782 (Online)
e-ISJN: A4372-3114
Impact Factor: 7.327

Volume 5, Issue 12, December 2017

International Journal of Advance Research in Computer Science and Management Studies

Research Article / Survey Paper / Case Study

Available online at: www.ijarcsms.com

A Study on the Role of Electroencephalography (EEG) In Brain Computer Interface (BCI)

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Abstract: ***This paper describes about describes about EEG (Electro Encephalo Graphy) what is it, how is it related to Brain Computer Interface, what are its types along with its working and applications in real world.***

Keywords: Brain Computer Interface (BCI), Wired EEG, Wireless EEG, Invasive and Non-invasive BCI's.

I. INTRODUCTION

The BCI cycle starts with the user engaging in a cognitive task while receiving possible stimuli. Traces of brain activity are picked up by sensors. These signals are preprocessed, relevant features are extracted, and an outcome is predicted that is supposed to reflect the user's intention, either on a continuous scale or as discrete symbols. The outcome acts as an output signal for

Controlling an external device. The cycle is closed by the user perceiving the output, which allows a judgement about the appropriateness of the device's behavior and an adaptation of the mental activity. The output can be presented in multiple forms and modalities, depending on the user's abilities. While iterating through the cycle, both the user and the computer may learn to adapt, thereby increasing the performance of this man–machine system.

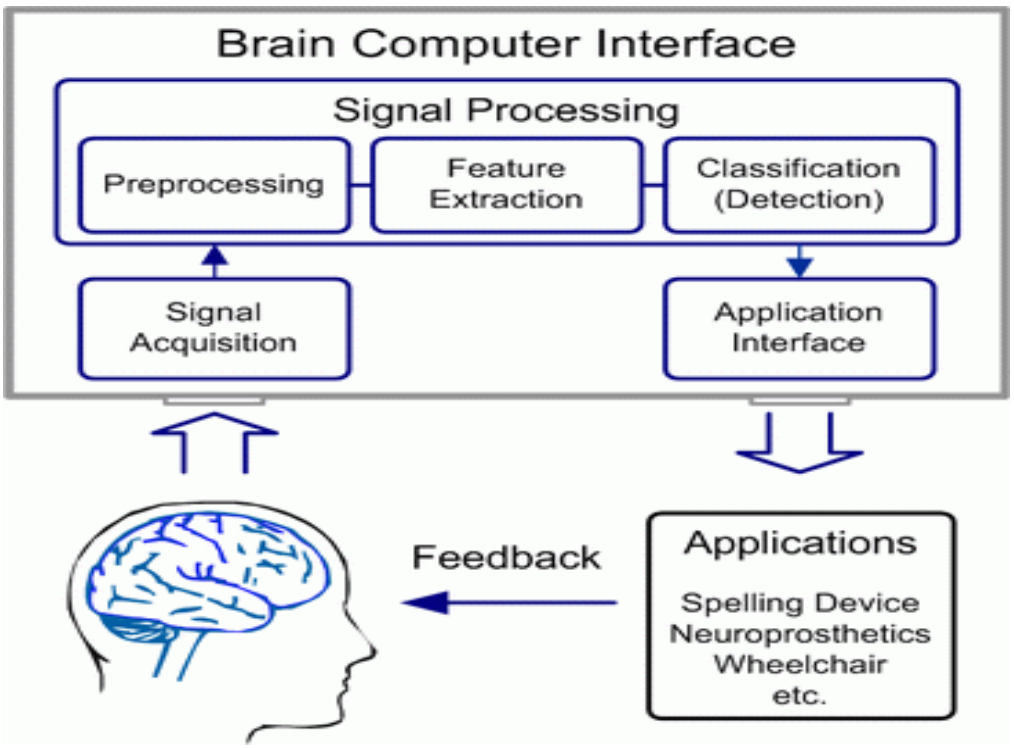

Fig.1: BCI Cycle

II. MOTIVATION

The Electroencephalography (EEG) is the most studied potential non-invasive interface, mainly due to its fine temporal resolution, ease of use, portability and low set-up cost. But as well as the technology's susceptibility to noise, another substantial barrier to using EEG as a brain–computer interface is the extensive training required before users can work the technology. An electroencephalogram is a measure of the brain's voltage fluctuations as detected from scalp electrodes. It is an approximation of the cumulative electrical activity of neurons. EEG measures the electrical activity of the brain with multiple electrodes placed on the scalp. It is portable and relative inexpensive that is why most noninvasive BCIs are presently based on EEG. EEG measurements have become very popular as its temporal resolution is very good and relatively cheap.

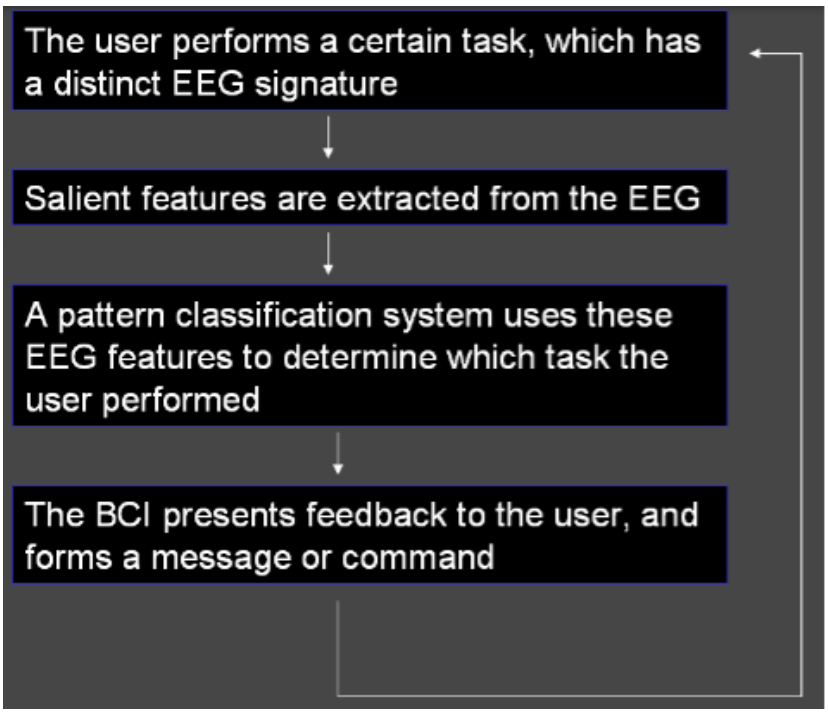

Fig.2: Principles of Operation

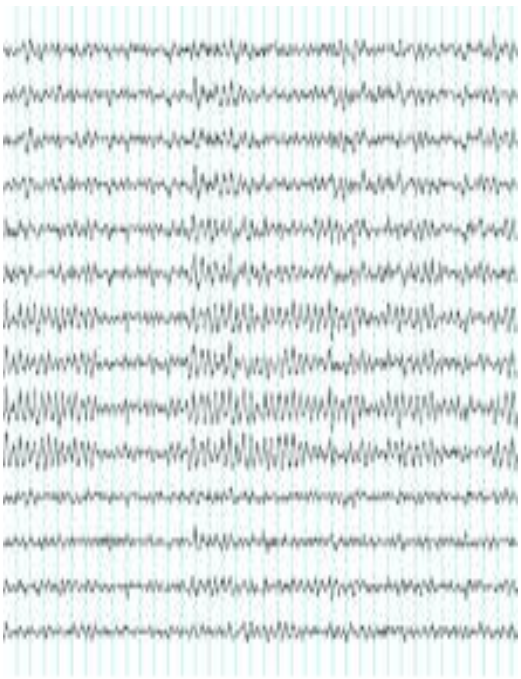

Fig 3: Recordings of brainwaves produced by an electroencephalogram

III. TYPES OF EEG

The Wired EEG Acquisition Mechanism

This type of EEGs require electrodes attached to the scalp with sticky gel and require physical connection to the machine.

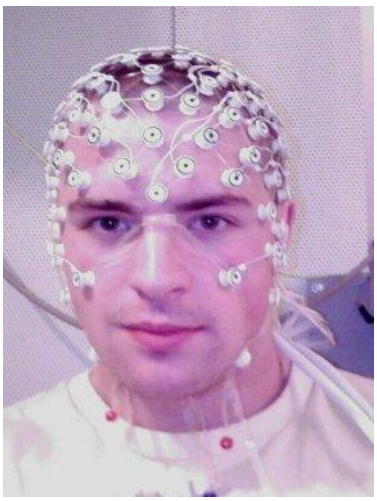

Fig.4: Example of Wired EEG

Wireless EEG Acquisition Mechanism

This type of EEGs require only wearing headband and requires no physical connection to the machine.

Fig.5: Example of Wireless EEG

IV. WORKING OF EEG

In EEG, the recording is obtained by placing electrodes on the scalp with a conductive gel or paste, usually after preparing the scalp area by light abrasion to reduce impedance due to dead skin cells. Many systems typically use electrodes, each of which is attached to an individual wire. Some systems use caps or nets into which electrodes are embedded; this is particularly common when high-density arrays of electrodes are needed.

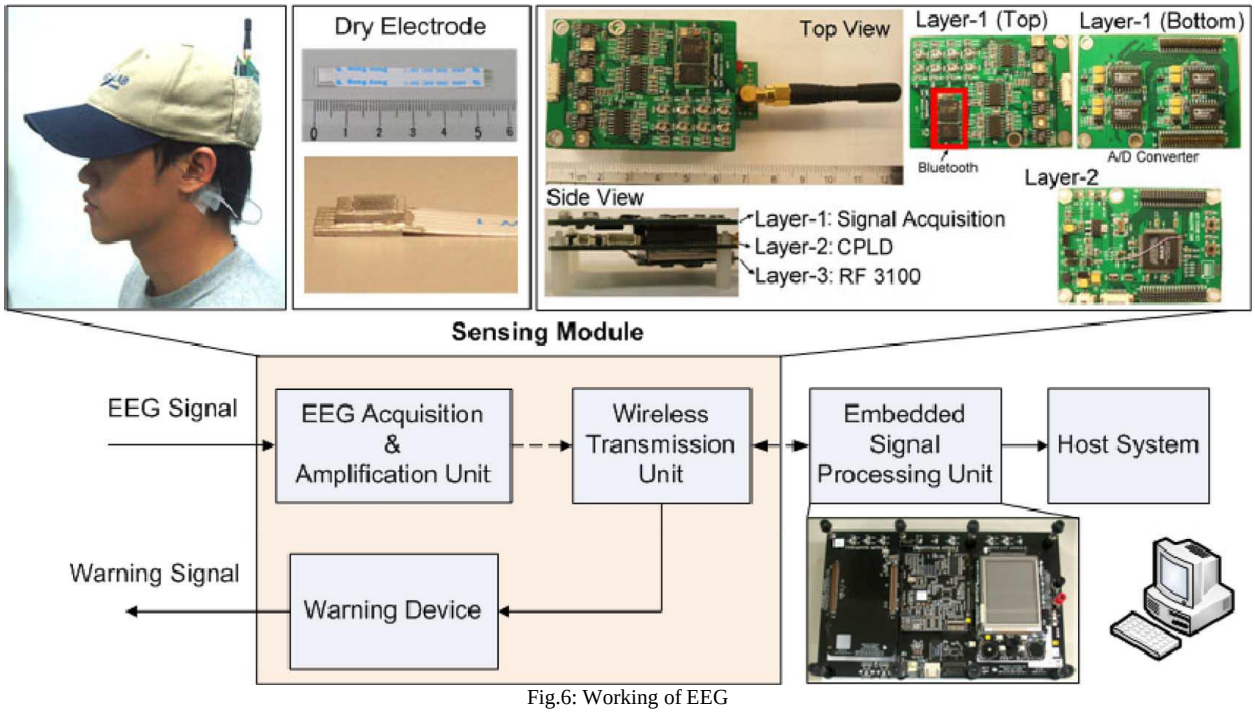

Fig.6: Working of EEG

V. APPLICATIONS OF EEG

EEG mostly has its clinical use.

CLINICAL USE

EEG is typically used in the following clinical circumstances:

- To distinguish epileptic seizures from other types of spells, such as psychogenic non- epileptic seizures, syncope (fainting), sub-cortical movement disorders and migraine variants.

- To differentiate "organic" encephalopathy or delirium from primary psychiatric syndromes such ascatatonia
- To serve as an adjunct test of brain death
- To prognosticate, in certain instances, in patients with coma
- To determine whether to wean anti-epileptic medications

RESEARCH USE

EEG, and the related study of ERPs are used extensively in neuroscience, cognitive science, cognitive psychology, and psychophysiological research. Many EEG techniques used in research are not standardized sufficiently for clinical use.

VARIOUS OTHER USES

- The EEG has been used for many purposes besides the conventional uses of clinical diagnosis and conventional cognitive neuroscience.
- Long-term EEG recordings in epilepsy patients are used forseizure prediction
- Neurofeedback remains an important extension, and in its most advanced form is also attempted as the basis of brain computer interfaces.
- The EEG is also used quite extensively in the field of neuromarketing.
- There are many commercial products substantially based on the EEG
- Honda is attempting to develop a system to enable an operator to control its Asimo robot using EEG, a technology it eventually hopes to incorporate into its automobiles
- EEGs have been used as evidence in trials in the Indian state of Maharashtra

VI. CONCLUSION

The reason a BCI works at all is because of the way our brains function. Our brains are filled with neurons, individual nerve cells connected to one another by dendrites and axons. Every time we think, move, feel or remember something, our neurons are at work. That work is carried out by small electric signals that zip from neuron to neuron as fast as 250 mph .The signals are generated by differences in electric potential carried by ions on the membrane of each neuron. Although the paths the signals take are insulated by something called myelin, some of the electric signal escapes. Scientists can detect those signals, interpret what they mean and use them to direct a device of some kind. It can also work the other way around. For example, researchers could figure out what signals are sent to the brain by the optic nerve when someone sees the color red. They could rig a camera that would send those exact signals into someone's brain whenever the camera saw red, allowing a blind person to "see" without eyes.

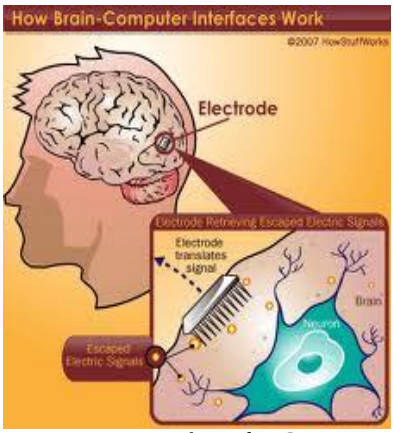

Fig.7: Working of EEG

Cortical Plasticity

Beginning in the 1990s, research showed that the brain actually remains flexible even into old age. This concept, known as cortical plasticity, means that the brain is able to adapt in amazing ways to new circumstances. Learning something new or partaking in novel activities forms new connections between neurons and reduces the onset of age-related neurological problems. If an adult suffers a brain injury, other parts of the brain are able to take over the functions of the damaged portion. Why is this important for BCIs? It means that an adult can learn to operate with a BCI, their brain forming new connections and adapting to this new use of neurons. In situations where implants are used, it means that the brain can accommodate this seemingly foreign intrusion and develop new connections that will treat the implant as a part of the natural brain.

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