Brain Computer Interface

Shivani Agarwal
Asst. Professor
Department of Computer
Science and Technology
IMS Engineering College
Ghaziabad

Rohan Taneja
B.Tech 2nd year
Department of Computer
Science and Technology
IMS Engineering College
Ghaziabad

Tuariq Beg
B.Tech 2nd year
Department of Computer
Science and Technology
IMS Engineering College
Ghaziabad

ABSTRACT
Today, during the golden period of science, we are seeing and undergoing many technologies that are unbelievable just like soft computing, neural networks, brain computer interface, etc. The technology brain computer interface connects the brain (nervous system) with a computer system. The goal of Brain Computer Interface (*hereinafter, "BCI")* technology is to behave as a communication line for those retarded or disabled people who have neurological or neuromuscular disorder problem.

It is a blessing from God for the disabled people. Here in our review we will state the advantages and the disadvantages, drawbacks and different applications and will acquire knowledge by investing facts about BCI. Current BCI's have maximum information transfer rates of 5-25 b/min. BCI technology is improving decade by decade, day by day. The latest technology of BCI in today generation is Horizon 2020. The BCI technology is developing future and their applications are encouraging discussions and are providing a great field for researchers to be enthusiastic about.

General Terms
Electroencephalography, Magneto encephalography, Functional Magnetic Resonance Imaging, Neuromuscular, HORIZON 2020, Nero-prosthetics

Keywords
BCI, EEG, EMG and Central Nervous System (CNS)

1. INTRODUCTION
A brain computer interface is a technology which provides the platform that is communication channel for disabled users. Those who cannot speak or respond may use BCI to interact with the world.

It can also be used for restoring damaged heavy sight and moments. It measures the signal of the central nervous system and connects the brain with the computer hardware and converts the signal from CNS into artificial output to interact with the external environment.

The BCI could be used to restore mobility in paralyzed limbs by electrically stimulating muscles. Over past five years, the volume and pace of BCI research has grown rapidly. In the early days of this technology it primarily focussed on neuroprosthetics applications.

The first nero-prosthetic device which was self implanted in human in the 90's, was a series of devices that could substitute a motor, sensory or modality that might have been damaged as a result of an injury. Cochlear implants provide an example of such devices.

BCI technology is a stage precedent process consisting following stages: Signal acquasition, Preprocessing or Signal Enhancement, Feature Extraction, Classification and the Control Interface. All the stages mainly depend on the brain signals which are captured. Brain signals are mixed with other signals which are coming from the different activities of the brain. Somehow the signals are not stationary and may also be distorted by artifacts such as EOG and EMC. These are techniques to measure the signals coming from brain and to show as output. Each works as a single unit activity.

2. BACKGROUND
The history of BCI is quite unique. It started with the invention of *Electroencephalography* (EEG) by Hans Berger in 1924 [2]. He also invented the alpha waves also known as "*Berger Waves*". He was the first to describe the pattern of brain waves and the brain diseases such as epilepsy. His first EEG recording of human brain activity is known as *Electroencephalography*. He used to insert silver wires under the scalps of his patients and for the recording he used the *Lippmann's Capillary* device. For his great inventions for the human society he was awarded the *Deutsche Gesellschaft fur Klinische Neurophysiology*. Another big name associated with the invention of BCI is of Jacques Vidal. Initiate the research on BCI at the University of California in 1970's. Jacques Vidal gave a lecture at Graz, Austria supported by Future BNCI Project in 2011 which was on the new technology Horizon 2020. In the mid of 1990's there was a great fortune in the development of BCI and the technology was able to capture the complex brain motor cortex signals by recording from neural ensembles (groups of neurons and using these external devices). There is an Annual BCI RESEARCH AWARD with 3000 USD, is awarded in recognition of best researches in the field of BCI. New research field are opening for researchers at this time.

Researchers And Their Researches
2.1 JACKQUES VIDAL [1]
In 1970, Vidal cast an expression about the brain computer interface . He gave the first successful result for connecting brain with computer hardware. Currently Vidal is working on application of functional modeling in statistics.

2.2 APOSTOLOS GEORGOPOULOS
In 1980,He founded a mathematical relationship between the electrical responses of single motor-cortex neurons in rhesus macaque monkeys and the movements of monkey's arm.

2.3 Kennedy and Yang Dan
Phillip Kennedy founder of Neural Signals built the aboriginal intracortical brain-computer interface by implanting neurotrophic-cone electrodes into monkeys.

Yang Dan at UC BERKELEY captures images of brain signals of a Cat. That was a great victory of humans over nature.

2.4 Miguel Nicolle's

Professor at Duke University basically a neuroscience professor and known for reading monkeys thought. Has implanted electrode arrays in to monkey's brain to obtain neuronal signals to drive a BCI? He was also able to show the brain to brain communication between two rats using Brain computer interface.

2.5 Andrew Schwartz

His research consists of two Relations:

Cortical Control of Neural Prosthetics .Three dimensional tracking in virtual reality and also reproduced BCI control in a robotics arm.

2.6 GERWIN SCHALK

Developer and inventor of BCI 2000 are used for data acquisition, stimulus presentation and brain monitoring applications.

3. FUTURE SCOPE

The upcoming applications and technology related to BCI shows that innovative development is forthcoming in the future when the speed and accuracy of BCI technologies increase enough to make them useful for more peoples with disabilities, the private industries will likely to show their interest in the scope or profit in the BCI industries. The most successful application of BCI is Horizon 2020; it is a gift for the future from their precedence.

1. Stroke recovery, by the BCI technology is called RECOVERIX the most efficient technique to recover stroke.

2. A Technique named is Electromyography (EMG) that is used for checking the electrical activity generate by the muscles of the skeleton so that technique known as electro diagnostic medicine technique ,measured by ELECTROMYOGRAPH instrument. This instrument measures the electrical potential produced by the muscles cell, these cells are activated electrically or neurologically.

3. Functional electrical stimulation is a technique that uses electrical currents to activate nerves innervating extremities affected by paralysis resulting from spinal cord injury (SCI), head injury, stroke and other neurological disorders. FES is primarily used to restore function in people with disabilities.

These technologies give a wider scope for BCI and it is a developing age of BCI. So we can say that a great future is waiting for DOI Peoples
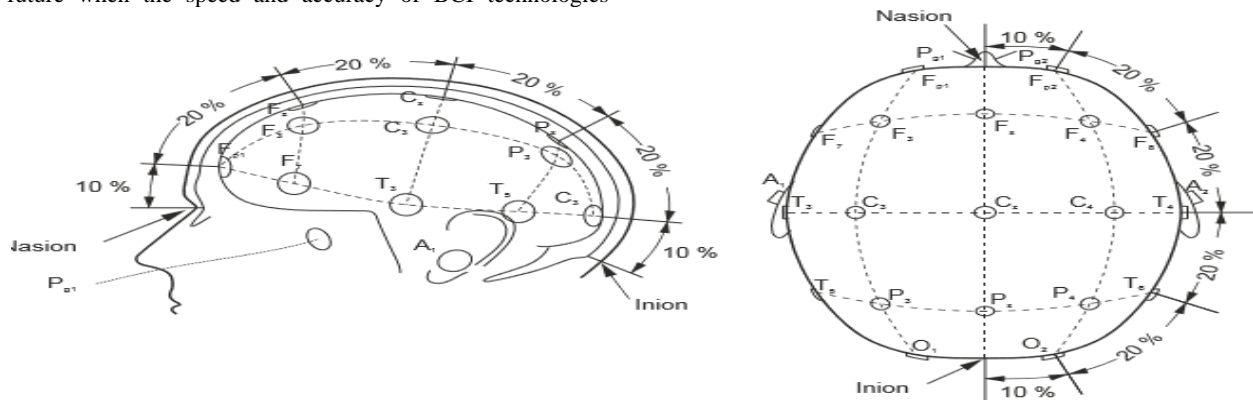

Fig 1: Placement of Electrode over Scalp.[6]

APPLICATION	INVENTOR
BRAIN FINGERPRINTING TECNOLOGY	DR.LAWRENCE FARWELL
PORTABLE BCI TO DIAL A CELL PHONE	TZYY-PING JUNG
EPOC HEADSET DEVICE	EMOTIVE SYSTEM
HORIZON 2020	EUROPEAN UNION's (EU)
ELECTROENCEPHALOGRAPHY	HANS BERGER

Fig2: Inventors and their applications. [10]

4. TYPES OF BCI [3]

There are several types' brain computer interfaces till today but mainly they are divided into two categories.

4.1 Invasive brain computer Interfaces

They are the devices which are directly implanted in the human brain and produce good and strong signals. They are used to repair the vision of DOI people and to provide new functionality for the paralyzed people. They are liable to scar –tissues, causing the signal to become weaker, or even non-existent, as the body reacts to a foreign object in the brain.

4.2 Partially Invasive BCI

Partially Invasive BCI are implanted inside the skull but rest outside the brain rather than within the grey matter ,they have the lower risk of forming scar tissues in the brain than fully invasive BCI's .They produce weaker signals than fully invasive BCI's. They require less training for handling. Light Reactive Imaging BCI devices are still in the realm of theory. The application based on partially invasive BCI is categorized below…
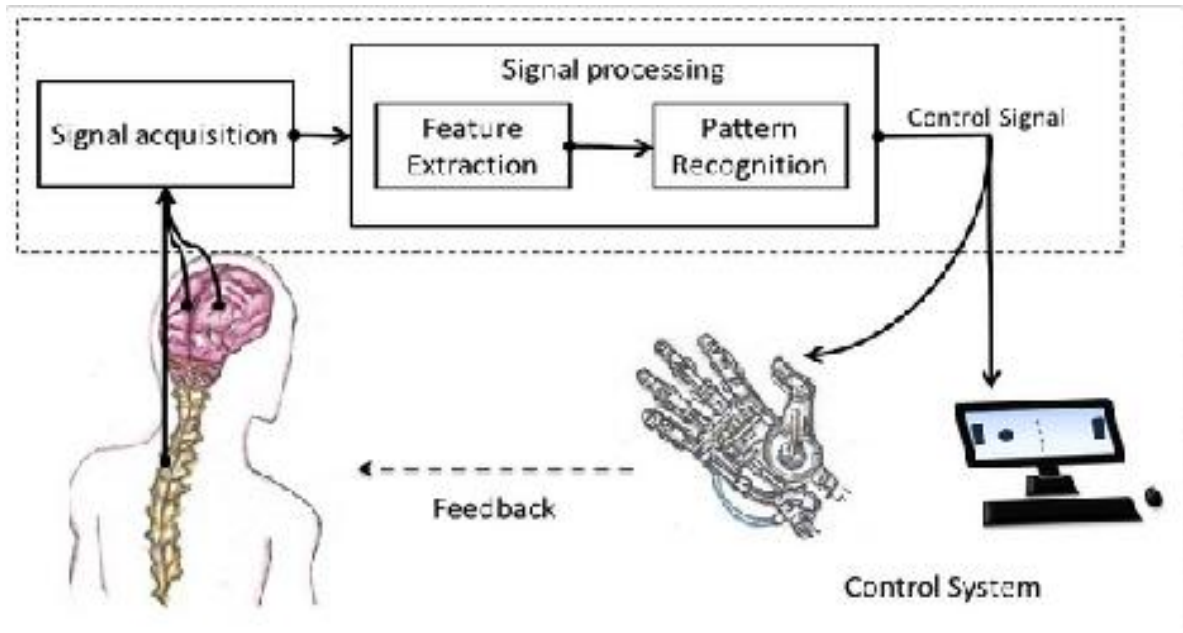

Fig.3 BCI System Configuration [7]

4.2.1 Electrocorticography (ECOG)[4]

Electrocorticography (ECOG) uses the same technology as non-invasive electroencephalography, but the electrodes are embedded in a thin plastic pad that is placed above the cortex, beneath the dura mater. It measures the electrical activity of the brain and first trialed in humans in 2004 by Eric LEUTHARDHT and DANIEL MORAN.

4.3 NON INVAISE BCI's

They are easier to wear .Signals recorded by non invasive have been used to power muscle implants and restore partial movements. They have the least signal clarity when it connects with brain but it is safest of all the types. Barrier as a BCI is the extensive training required before users can work the technology. The main examples of non invasive BCI are listed below.

4.3.1 Electroencephalography (EEG)[4]

Has high potential due to high temporal resolution. It can be use easily.it refers to the recording of brain's activity under a short influence of time. The most common wave that is captured during process is P300 wave. Patterns of P300 waves are generated involuntarily, when people see something they recognize and may allow BCIs to decode categories of thoughts without training patients first.

4.3.2 MEG AND MRI[5]

Magneto encephalography (MEG) and functional magnetic resonance imaging (FMRI) have both been used successfully as non-invasive BCIs. FMRI allowed two users being scanned to play Pong in real-time by altering their hemodynamic. FMRI measurements of hemodynamic responses have also been used to control robot arms with a seven second delay between thought and movement.

Fig 4: Types of BCI Headset [9]

Current Members of BCI SOCIETY [8]

1. Brendan Z. Aallison (Usa)
2. Shangkai Gao (China)
3. Christoph Guger (Eu)
4. Leighhochberg (Usa)
5. Jane Huggins (Usa)
6. Andrea Kubler (Eu)
7. Nick Ramsey (Eu)
8. Eric W. Sellers (Usa)

9. Jonathan R. Wolpaw (Usa)

5. ACKNOWLEDGMENTS

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