A Survey on Brain Computer Interface Technology

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Abstract:
BCI is fastest developing technology in advance computing. The main purpose behind BCI is to form the connection between homosapien brain and the technology. This is very effective technology which receives and control logical devices which works on familiar part of the body. This technich mainly design for abnormal peoples. using this technology disable person develops themselves as like normal person. By studying this we introduce human brain with its anatomy.

BCI technology develops a theory of hardware and software. BCI measures the activities of human brain. BCI evaluates the signal which control the brain. It convert signal generated by brain to machine signals.

Concept of BCI gives us knowledge of various technologies like invasive and non-invasive. person gives instruction in signals which are receive by BCI. This techniques has widest scope. It has many neuroscience application.

1. INTRODUCTION:

BCI provide network in between digital devices and homosapien brain. It is the developed version of human computer interface. In BCI it accepts signal form by brain at various places which convert this signals into human activity and instruct to control the work of computer. BCI has many various applications mainly for the persons for disable human being. BCI provides new concepts for gamers. Gamers get new technology for playing games using signal of games using brain. using BCI technology we can captured the intensity of humans feelings. So, it provides the simplest path to communicate people of society.

It provide facility to the people who are not able to do activity like normal people. So BCI help them to interact with different technology. It provide the deep study of the brain function of the nervous system controls by the BCI. Spinal cord and brain are the part of CNS.

Work of CNS is to processing the stimuli which are accept by nervous and after processing this stimuli is return to actuator. Brain performs various tasks production of thoughts, learning new things, understanding of...
speech, feelings, memory etc.

CNS plays vital role in various functions like respiration and blood circulation. BCI works on humans as well as animals. By performing experiment on animals, it concludes that, how animals think. The scientific study of BCI moves further to communicate between disable people not only disable people but also healthy people uses this techniques for hand free gaming and exibilitation. BCI is not fully developed concept it requires expertization which is challenge for BCI. We consider same points while BCI implement in everyday life. Signals invoked by brain is not easy as it has low strength so it becomes challenging. There is requirement of signal processing. Bandwidth of BCI having only 3 character transfer rate. Due to low data transfer it gives correctness in control activities and it gives immediate response. Because of strength of signals is low that's why chances of errors are more and it gives high error rate. As human brain shows variability it gives more errors. Various parts of brain performs various activities and signal generated from that parts are captured by electrodes so it gives inaccurate signal classification. To understand working of brain signals we are studying anatomy of brain. BCI technology provides classification of signals first and then explain its characteristics. This technology is adaptable.

BCI gives various alternatives to restore different functions using motor disability various disorder creates problem in neuromuscular channel by which human brain contact and control with its surrounding. BCI provides interaction between man and machine. This topic is research topic which tell us about neurology and physiology. BCI is the new develop technology in which we can paralise person can use the computer application. Various methods which describes brain activity which considered as BCI. This activity includes EEG (electro encephlography), MEG (Magneto Encephelo Graphy) and also focus on PET (Posifron Emissio Tomography). This includes study of the mental state of the brain. It performs the coordination between EEG signals of the brain. The important and first step to develope effective BCI is to find out proper control signals by using EEG. Different attribute of control signal to describe intension it can convert or modulate detection and tracking continuously. When brain produces signals then BCI measures this signals particular commands are generated by that signal through BCI.

**TYPES OF BCI:**

1) INVASIVE:

In this type of BCI devices are directly placed into brain during neurosurgery. Invasive BCI consists of single unit and multiunit BCI single unit identify signal from single place in brain while multiunit identify signal at various places inside the brain. BCI places electrodes inside the brain has different length, for example, (Utah, Blackrock Microsystems) up to 1.5 mm. Due to higher quality of signal procedure shows problems, i.e. forming of scar tissue is major issue. Foreign object enters inside human body on which it reacts and large amount of scar forms on electrodes, which results in deterioration in signal. Neurosurgery is a risky, expensive process, the aim of invasive BCI is mainly to disable people like blind, paralyzed patients.
2) SEMI-INVASIVE (ECoG):
In semi-invasive Electrocnitography electrodes placed on the upper surface of the human brain to calculate electrical activity from the part of brain i.e. cerebral cortex. It used first time in the 1950s at the Montreal Neurological Institute. Craniotomy is required to place the electrodes on the surface of brain. This is the reason semi-invasive used only when surgery which is essential for medical field reasons (for example epilepsy).

Epidural and Subdural are the parts of brain electrodes placed between them Epidural means outside the dura mater and subdural means under dura mater. Large area is covered by strip of electrodes over cortex upto 4 to 256 electrodes are placed.

The characteristics of ECoG are as follows:
- spatial resolution is higher and also signal fidelity
- noise resistance.
- clinical risk is low, Robustness is for long recording time period.
- Amplitude with higher amount.

3) NON-INVASIVE:
Now we study the main non-invasive techniques in the following extract. Various non-invasive techniques are used in the scientific study of brain, according to hardware and cost EEG is the most common technique.
- MEG it stands for magnetoencephalography
- PET is stands for positron emission tomography
- fMRI is stands for functional magnetic resonance imaging
- fNIRS is stands for near-infrared spectroscopy
- EEG is stands for Electroencephalography
MEG (Magnetoencephalography)
Using sensitive magnetometers, activities of brain are measured by recording magnetic fields through the current which generated in brain.

PET (positron emission tomography)
Observation of different processes like metabolism, blood flow, neurotransmitters done in this technique it is also called as nuclear imaging technique.

fMRI (functional magnetic resonance imaging)
Functional magnetic resonance imaging or functional MRI (fMRI) is called as functional neuroimaging process. It uses MRI technology that mapped activities of brain with the help of detecting variation in blood flow. Neuronal activation is coupled with cerebral flow of blood in this technique. If we use some area of brain blood flow from that region increases continuously.

fMRI developed in the 1990s. It is a safe technique to use. Effect of radiation is not use here. This technique is simple to use. It has effective spatial, better temporal resolution.

fNIRS (near-infrared spectroscopy)
Functional Near-Infrared Spectroscopy (fNIR or fNIRS), is the use of NIRS (near-infrared spectroscopy) for the purpose of functional neuroimaging. Using FNIR, activities of brain mapped by hemodynamic technique responsible for neuron behaviour.

This is optical technique to calculate cortical activities of brain.

EEG (Electroencephalography)
EEG is the non-invasive technique which shows the electrical activity of the brain. In EEG electrodes place...
on the surface of scalp.

**COMPONENTS:**

Parts of the nervous system are the central nervous system and the peripheral nervous system. The brain is the main part of CNS it also have trillion of cells. and the classification of brain is done into cortex, little brain, stem and again sub parts of cortex are 4 lobes that are frontal, parietal, temporal, occipital. Brain forms signal. We know that outer covering of our brain that is skull which is very hard and so it forms difficulty to count the every neuron. When a more neurous perform the same activity simultaneously, so we can observe activities in the brain with electrodes. On the large distance nerve cell respond to stimuli. For deliver of proteins axonal system is used. Structure of axon is cylindrical and axons are use to transmit an electrical impulses. One other part joined to the axon is dendrites. Dendrites performs the function of replying the signal and receive the impulse. Cell bodies are one nucleus also contains many nerve cell metabolism.

Glia cells are type of cells which are Located in between neurons. Nerve in brain is connected to 10000 other nerves through connections of dendrite. An electrical signal transmit to axon after the communication of neurons. Conversion of electrical signal is first done to chemical signal. The neurotransmitters which are release by axon go through synapse and then go to the dendrite. And converted back to electrical signals.

Current generated when positive polarity enter into negative polarity called primary currents.

Difference in the voltage produce in the scalp is picked by electrodes of EEG. Voltage gradient generate the voltage signals. When Dentrites activate in synchronous manners then measurable signal occur. Potential of action of the axon, synaptic cleft produces current, and current generated by dentrites this are the signals which are possible to measure.

Measurement of potential generated by activity of the brain is done by electrodes on the scalp. Wet and dry are two types of electrode which are placed on scalp mental disks which are placed on the scalp are electrodes and there are at most 20 systems internationally invented to measure the potential of electrode. the type of gel is used in wet electrode which is saline solution of gel. and because of distance between electrode is increased hence capacity of conduction is increases. material used for making the wet type of electrode is steel, tin, gold, silver. and the electrode of wet type are coated with silver chloride solution.

There is second type of electrode which is dry electrode and it is very easy for use.

EEG is real time application. EEG is fast machine in which it measures the thousand signal per second. difference in voltage is measured by EEG.

The EEG can record same time from many electrodes, for interpret ERP. When synaptic excitation of the dendrites occurs, currents is formed and received at EEG, but the signal detection is low, the electrodes are at more distance from the neurons to measure the flow of electric signals is then required an amplifier. Electrodes, Amplifiers, A/D converters, Recording Device are needed.

“The electrodes receive the signal from the scalp, the amplifiers perform operation and process the signal to form the large amplitude of signals for that purpose the A/D converter can process the signal correctly. Finally, the device which record is can computer

Electrodes:

, many forms of electrodes are there to use in EEG, eg. dry as well as wet, gold, silver, stainless steel as well as tin electrodes caps. head is divided in proportional distance in the 1958 a standard system of electrodes.
active, reference and ground electrode. This is minimal configuration of electrode. The measurement of difference in EEG OVER THE TIME in between signal and active electrode … when there is lack of activity in the brain so that time it became difficult to get reference, the commonylocation of this is mastoid, ear lobes as well as tip of the nose. The function of ground electrode is the measurement of voltage difference between active points and reference

Amplifier:
electrodes picked up the signals. Is at long distance. Because of this we need an amplifier to bring the microvolts to a range so they can be digitized. With the help of a cable which can measure up to 1 to 2 meters. The signal is sent to an amplifier, but sometimes cable are perform function like antenna and try to get signals…. so because of this reason it forms noise, but for minimizing this problem some pre electrode are used in active electrode, but because of expensiveness and largeness they are not accurate fit in some situation.

A/D converters:
signal from analog to digital form this amplification of signals is done by A/D converter. A/D converter having 100/200 bandwidth which are limited but enough for sampling EEG signals.

Recording device:
The computer is used as recording device and also similar device like computer is can be used as recording device.

1) Preprocessing:
As the data in EEG is affected by noise the information in EEG which is raw is not clean.

EEG equipment, Electrical interference external to the subject and recording system. The leads and electrodes, electrical activity from the heart, eye blinking, eyeball movements, muscles movements in general. This are the sources of noise in frontal and occipital recordings eye blinking is very clear, while ECGs on the occipital electrodes.

The cleaning the data from the noise is done by preprocessor. Different methods are defined in preprocessing this are the steps in preprocessing. Example, the data is filtered, high-pass filters are applied on data. To remove the DC components here frequency cut-off of 1Hz is enough. Also remove the high frequencies of the signal, low pass filters can be applied. Because in EEG the frequencies over 90Hz are not allowed. The eyeball movements or eye blinking are some others. Other methods are used to remove

2) Feature Extraction:

the analysis of the signal and extraction of information is the next step. It is impossible to find meaningful information because the EEG signal is very complicated processing algorithms which allows to find content it is needed. Which would be hidden at a naked eye.

methods for feature extraction are:

1. Band powers Cross-correlation between EEG band powers
2. Frequency representation
3. Time-frequency representation Hjorth parameters,

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4. parametric modelling inverse model

3) **Translation:**

result is passed to the feature translation algorithm After classification of signals, At this moment the features should translated in the action required. “For example, the translation of P3 into the selection of the letter that evoked it” to select the letter, the algorithm will send a command to the feedback device,

4) **Feedback device**

the translation step sends the command to feedback device For example the signal will be used to move a cursor in the computer.

**ADVANTAGES:**

1) BCIs reduce the time needed between the movement of the mouse and actual movement of the cursor. The time needed is very small but it makes big difference to some time-sensitive applications. Before you are doing something, BCI can know what you are thinking. Before the Electrical neural pattern has fully manifested into a conscious feeling, BCI can identify them as thought.

2) People who are paralyzed, unable to use their hands, BCI hold great potential for them

3) They are generally awesome.

**DISADVANTAGES:**

1) Considering the complexity of the problem, research in to BCI is at basic level. 
2) Fairly inaccurate in terms of classifying neural activity. 
3) Limited ability to read the signals of the brain. 
4) It requires pretty drastic surgery to place the BCI under the skull. 
5) Its comes to massive amount of ethical issues, while reading inner thoughts of people.

**APPLICATION:**

- Communication gadget for disabilities like tetraplegia or locked-in syndrome

- The process of Neurorehabilitation after the neurological diseases or neurological injuries

- For Entertainment also for gaming

- detection lier, Brain Fingerprinting process, Trust assessment process

- Health like sleepy-stage of human or mood determine
• Cognitive-state, like stress, tension, fatigue, alertness, control in pilots, controllers for air traffic, plant managers

• Prosthetic control for various disabilities such as tetraplegia, locked-in syndrome

CONCLUSION:

By studying BCI we get that human brain generates waves which are read by BCI, after receiving these signals it converts into actions, and instruct that actions that can control and manages the computer(s).

On the basis of electrical neuro cells produced by brain BCI classified into three groups. The brain creates various neural activity. There are a group of signals, which are used by BCI. These signals are divide into two Classes which are spikes and field potentials, Components of particular interest to BCI can be 48 R.A. Ramadan et al. divided into four categories which are slow cortical potentials (SCP), oscillatory EEG activity, neuronal potentials and event-related potentials (ERP). Several techniques are used to control brain activities; each technique shows own characteristics also pros and cons. It is very interesting to research in BCI because it can give solution to many problems which are like impossible, Many applications includes entertainment with playing games mainly with 3D monitors. Future development can seen in research field of BCI. Since the current systems are focused on use of motor system in BCI to improve and develop performance.

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