A study on recent trends in the field of Brain Computer Interface (BCI)

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Abstract - *Since 1969, many scientist has started to know about Brain Computer interface technology as a new platform for those with neuromuscular disorder that confine them from using this common rising methods. It gives a direct communication between the brain and a computer or any external devices. Brain Computer Interface offers a huge scope by strengthening or by decreasing human working capability. It has many applications in various fields such as robotics, gaming, neuroscience etc. A brain–computer interface, also known as a brain–machine interface (BMI).It is a direct communication path between the brain's electrical activity and an external device. It can occur through many stages, firstly the user encodes his or her instructions in the electrophysiological input which is provided to BCI then BCI recognize that command and express it in device control. BCI can do all the task properly when Signal acquisition, translation algorithm and user training are fully updated. This device can help millions of physically disabled people to spend their life as regular person.*

*Key Words***:** Brain computer interface (BCI), EEG, ECog, Electroencephalography, signal acquisition, Feature extraction, Feature translation, invasive, Non-invasive, Electroencephalogram**.**

1. INTRODUCTION

Brain Computer Interface (BCI) is a direct communication process between brain and computer. Over the many years researchers are trying their best to upgrade this device to help physically disorder people or to decrease human working ability. In last 20 years researchers upgrade this device which makes more accurate and also research grown rapidly.21st May 2003 Brain Computer Interface Work was supported by The National Institute of Health. After that lot's of conference was held in different countries with the participation of Engineers, Doctor's, Scientists. It acts without any human effort by monitoring the brain's activity. It has sensors which actually stores the brain's activity. This technology have the potential to control the computer without any human effort ,only Users can think and the whole work is done. Recently through the Brain Image technologies it is a successful technology. Physically Disabled child can control his or her wheel chair without any work. We have also many examples like User's can drink his/her coffee from a cup by using their robotic arm. BCI mainly need a signal acquisition hardware. This signal acquisition hardware be keep safe. Firstly user encodes his/her instructions and then BCI recognize that command by

electrophysiological input after that express it in its device control. The modern Brain Computer Interface device have the maximum information transfer rates which is 25 b/min.BCI research has started in 1970s by Jacques Vidal at University of California Los Angeles which is also Known as UCLA.He had the permission from the National Science Foundation. Brain Computer Interface is the combination of hardware and software. Through this device user can control external devices also computer. BCIs are used at researching, mapping, assisting or repairing any human cognitive functions. The Effective interaction between two controllers are the main thing, the full BCI operation depends on it.In a single word Brain Computer Interface (BCI) operates by recording signals which can come from brain and translating this receiving signal in device command.

In 1970 Brain Computer Interface research was started in California which was experimented in animal and created a new communication link between external devices and brain. In 1973 scientist Jacques Vidal published his first research paper which was on BCI .This paper was named "Towards Direct Brain Computer Communication". Jacques Vidal is known as the inventor of the Brain Computer Interface (BCI) device. He gives lots of articles and research paper on BCI fields. In 1969 Brain Computer experiment was tested on a monkey. The first experiment attempt on a human being was on 90s.In 2000 Jonathon Wolpaw gave his first definition on Brain Computer Interface (BCI).In the beginning Slow cortical potentials (SCP) were using to understand the activity of brain but later it has been replaced. Now Direct Current (DC) EEG shifts are using to understand the brain's Activity .Wolpawand his team first time noticed that a cursor had been controlled by brain activity. After 2000 BCI research was growing and devices are modified.

Mainly three types of BCI are there which are given below;

1.1.Non invasive BCI :

In case of Non invasive electrodes are set on the scalp. These way electrodes can measure electrical potentials or brain signal. The voltage between the neurons can be measured by the electrodes minutes difference and this time signal is amplified and fully filtered. After that it is interrupted by computer program and then the signal is displayed via pens. After all of this automatically it wrote out a pattern on a sheet of paper.

1.2.Invasive BCI:

In case of Invasive BCI,micro electrodes are set on the cortex. This way it can measure a single neuron activity. The damaged sight of the brain is repaired by Invasive BCI. Paralyzed people are also helped by Invasive BCI. Hundreds of pins less than the width of a hair is set against the brain. This way scientist can read firing of neurons in the brain and then neural firing language is sent to the computer which has a special algorithm and decodes neural language to machine language. After that this decoded signal is sent to a another computer then tells the machine what to do.

1.3.Semi-invasive BCI :

In case of semi-invasive BCI electrodes are set on exposed area of the brain. Semi-invasive BCI requires craniotomy to set the electrodes. When surgery is needed semi-invasive BCI are used.

Electroencephalogram BCI:

In case of EEG electrical activities are recorded with the scalp which produced firing of neurons within the brain. This BCI system is divided into three different partwhich are known as EEG acquisition, EEG signal processing and output generation.
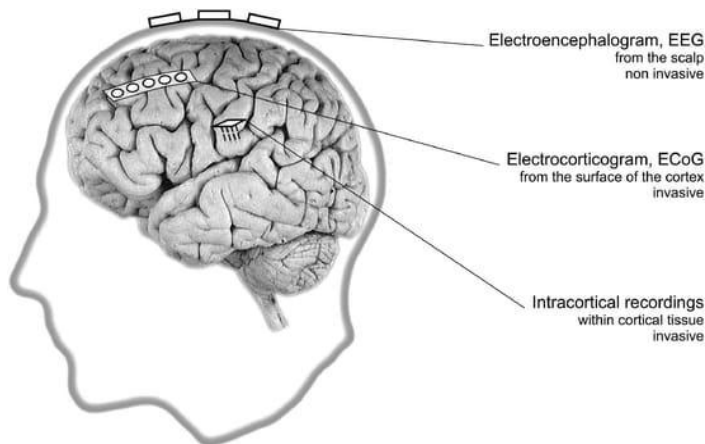

Fig.1: Position of EEG, ECoG, Semi-invasive

We know that our brains are connected with the neurons and every nerve cells connected to another dendrites and axons. If we done any work neurons are working all the time. Firstly device takes brain's activity and understands them, after that it translates them into machine language which is relayed to the output device and after it carried out the desired action. A electroencephalogram (EEG) alone is not a BCI devices. EEG alone is not a BCI devices because it only records brains signal not generate any output. Users and Brain Computer Interface device always work together and after a certain period of time it generates brain signal and encodes that signal and turn into machine language. This way mainly BCI devices are work.
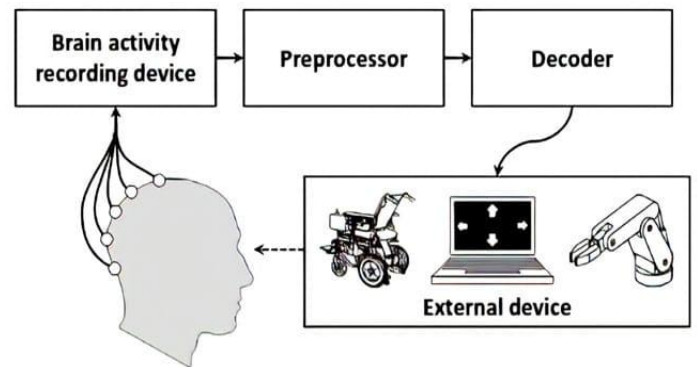

Fig.2: Way of working of BCI

1.1. Features:

BCI devices have 4 components which are given below;

Signal Acquisition:

Brain signals are measured by signal acquisition using proper sensors. These signals are amplified and may filtered to remove distortion like notice and it level up to its suitable electronic processing. After all these this signals are digitalized and transferred to another computer.

Feature extraction:

Feature extraction is the process to understand the characteristics of signal and present it to the required form for translation of command.

Feature Translation:

After the feature extraction the amplified or filtered signals are passed through feature translation algorithm after that it change the signal into appropriate form. The features translation algorithm must be dynamic because it can make up any environment.

Device Output:

The output command which is come from the feature translation will operate the out device or external devices.
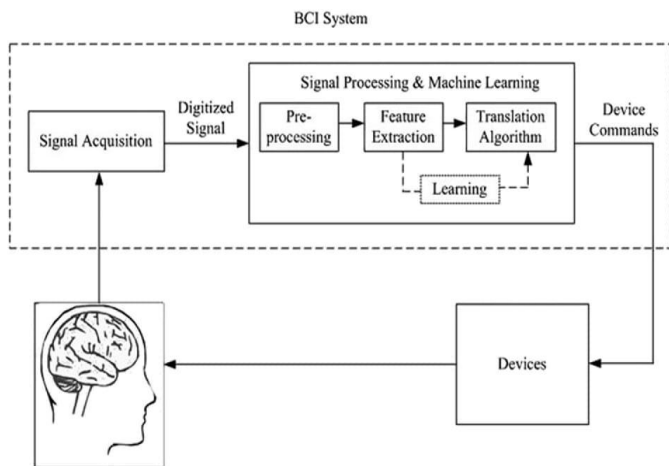
Fig.3: Block Diagram of the Structure of BC

Brain Computer Interface has so many advantages,

1.It helps physically disorder or Paralysed people to control artificial limbs with their mind.

2. BCI devices help gamers' to control games with their mind.

3. It sends data to the mind of a deaf person this way they can hear any external sound.

4. It also sends visual images to the mind of a blind person and they can see.

BCI has drawbacks or disadvantages also;

1. When electrodes are placed inside the skull which creates scar tissue in the brain.

2. Research of the BCI are not enough, right now it is in the starting stages

3. present BCI technologies are unfiltered.

2. Literature Survey

In the paper1: Brain-computer interface technology: a review of the Second International Meeting.

In 01 Jun 2003, this paper was published by Vaughan TM, Heetderks WJ, Trejo LJ, Rymer WZ, Weinrich M, Moore MM, Kübler A, Dobkin BH, Birbaumer N, Donchin E, Wolpaw EW, Wolpaw JR in the Second International Meeting, held in Rensselaerville, NY, in June 2002. Sponsored by the National Institutes of Health and organized by the Wadsworth Center of the New York State Department of Health.They said in their paper They said that electroencephalographic activity which was recorded from scalp or neurons activity recorded from the cortex are used to move cursor movement or select letters or icons. In the BCI translation algorithm the central

element which changed electrophysiological input from the users output can control external device. By the two adaptive controllers the whole BCI operation is depend, the user encodes his/her instructions through the electrophysiological input which is provided by BCI devices and then BCI understand the instructions and then express it in the device control.

In the paper 2: Brain-Computer Interfaces: Beyond Medical Applications. In 4, April 2012,this paper was published by Jan van Erp; Fabien Lotte; Michael Tangermann. They said in their paper was that they said in their paper was that BCI were not stuck in the medical industry. It also helps in gaming, hardware, integrations is systems or many more areas. This was published in the IEEE

In the paper 3: Real-world applications for brain-computer interface technology. In 2, June 2003,this paper was published by M.M. Moore.He found some problems and challenges of BCI output with the human computer interface .They do their research to improve the life of the physically disorder person. He also said in his paper that most of the BCI application is large for training. He said BCI domain are not stuck in a single domain, it also spreads in communication, environment control etc

In the paper4; Brain–Computer Interface Technologies in the Coming Decades. In 13 May 2012, this paper was published in IEEE by Brent J. Lance; Scott E. Kerick; Anthony J. Ries; Kelvin S. Oie; Kaleb McDowell. They said that Up gradation of technology all the device's are upgraded and the world is not static and complex day by day. These technological up gradation are also take part in neuroscience research and discover many designed and developing advanced brain based device that integrate with human capabilities and improve human system interactions.BCI helps paralyzed patient as well as direct control of prostheses and wheelchair.

3. CONCLUSIONS

BCI research gives huge scope for the physically disabled or paralyzed person and then can live their life like the normal people. Not only for the physically disabled persons it helps many other fields also like gamers. It takes a valuable stand in the medicine industry. In future by the up gradation of the BCI devices it will be more accurate. As much as possible the drawbacks of BCI should be less and modified it as the 99% success rate. Then it will be more comfortable for the users. Now in days some times this device can't record proper electrical signal that's why user's can't get proper response from the external devices. I think in the future engineer's and researchers must looking in it.

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