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A Survey on Technology: Brain Computer Interface

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ABSTRACT: The aim of this paper is to explore about development of Brain Computer Interface technology. This paper contains basic survey on different aspects of BCI. The field of brain–computer interfaces (BCIs) has grown rapidly in the last few decades, allowing the development of ever faster and more reliable assistive technologies for converting brain activity into control signals for external devices for people with severe disabilities. In recent years, however, the scope of BCIs has been extended from assistive technologies to neuro-tools for human cognitive augmentation for everyone. For instance, novel applications of BCIs have been proposed, enabling people to go beyond human limitations in sensory, cognitive, and motor tasks. A brain–computer interface (BCI), which is also called as neural-control interface (NCI), mind-machine interface (MMI), direct neural interface (DNI), or brain machine interface (BMI), is a direct communication between an enhanced or wired brain and an external device. BCI differs from neuro-modulation in that it allows for bidirectional information flow. BCIs are often directed at researching, mapping, assisting, augmenting, or repairing human cognitive or sensory-motor functions. A brain–computer interface (BCI) is a system that measures activity of the central nervous system (CNS) and converts it into artificial output that replaces, restores, enhances or improves natural CNS output, and thereby changes the ongoing interactions between the CNS and its external or internal environment.

KEYWORDS: neural-control interface; brain machine interface; neuro-modulation; central nervous system.

I. INTRODUCTION

Brain–computer interfaces (BCI) are devices which measure brain activity and translate it into messages or commands, thereby opening up many investigation and application possibilities. Brain-computer interface (BCI) is a collaboration between a brain and a device that enables signals from the brain to direct some external activity, such as control of a cursor or a prosthetic limb. The interface enables a direct communications pathway between the brain and the object to be controlled. In the case of cursor control, for example, the signal is transmitted directly from the brain to the mechanism directing the cursor, rather than taking the normal route through the body's neuromuscular system from the brain to the finger on a mouse. By reading signals from an array of neurons and using computer chips and programs to translate the signals into action, BCI can enable a person suffering from paralysis to write a book or control a motorized wheelchair or prosthetic limb through thought alone. Current brain-interface devices require deliberate conscious thought; some future applications, such as prosthetic control, are likely to work effortlessly. One of the biggest challenges in developing BCI technology has been the development of electrode devices and/or surgical methods that are minimally invasive. In the traditional BCI model, the brain accepts an implanted mechanical device and controls the device as a natural part of its representation of the body. Much current research is focused on the potential on non-invasive BCI. Processing in Brain computer Interface is shown in fig.1 below. First step in BCI is signal acquisition There are many different techniques to measure brain signals. We can divide them into Non-Invasive, Semi-invasive and Invasive.

1. **Non-invasive**: the EEG signal is taken placing electrodes on the scalp, so on the most external part.
2. **Semi-invasive**: the ECoG signal is taken from electrodes placed in the dura or in the arachnoid.

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3. **Invasive**: the Intraparenchymal signal is taken directly implanting electrodes in the cortex

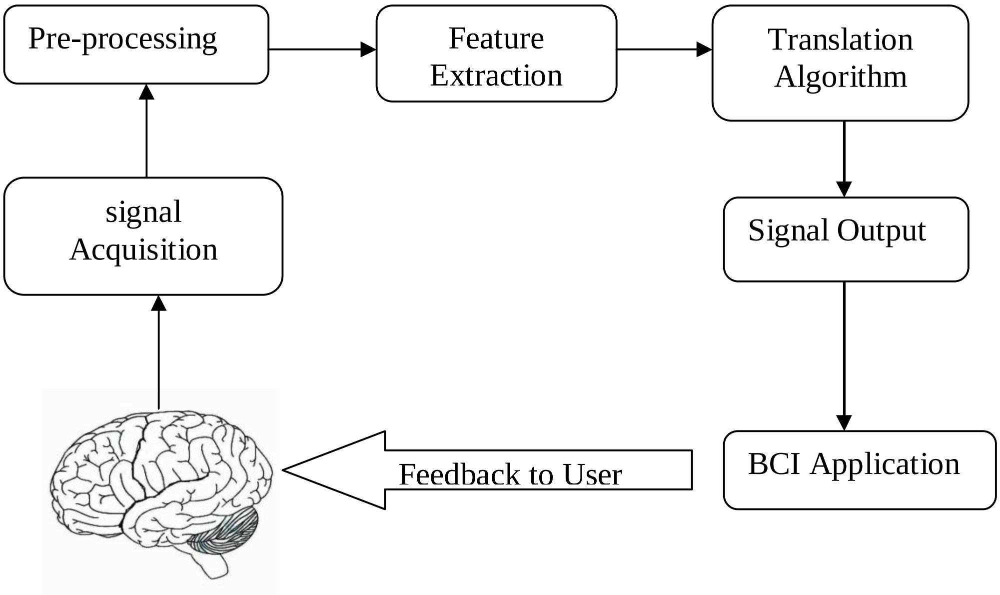

Fig.1: Processing of Brain Computer Interface

As shown in Fig.1,different commands from brain extracted in form of signals and sends forward for pre-processing. Pre-processing method used in EEG are very dependent on the goal of the applications. Having said that, there are some methods that are used very commonly to improve the quality of Signal to Noise ratio, such as Common Average Referencing (CAR) or filtering. It would be interesting to summarize the effective signal pre-processing methods since they usually can be similar in different applications. Feature extraction of EEG signals plays an important role for classifying spontaneous mental activities in EEG-based brain computer interface (BCI). ... After pre-processing, improved MVAAR was applied to extract the feature of EEG signals. Then, Linear Discriminant Analysis (LDA) was used to classify the feature extracted. translation algorithms most frequently used in brain-computer interfaces (BCIs). It is organized into four sections. The first section considers the factors important in selecting a model and provides an overview of the models used in BCI translation algorithms. The second and third sections discuss the two other components of a translation algorithm: selection of the features included in the model, and parameterization of the model. The final section describes methods for evaluating translation algorithms. And then output signal is generated and sends towards devices connected to it and again feedback sends towards user as a response.

II. **HISTORY OF BRAIN COMPUTER INTERFACE**

Brain interface devices used these days require deliberate conscious thought, while prospective future applications are expected to work effortlessly. Present research is focused on non-invasive BCI, unlike the traditional BCI model that requires implanting a mechanical device in the brain, which then tends to control it as a natural part of the body. BCIs are directed at augmenting, assisting, or repairing sensory-motor or human cognitive functions. It combines technologies from the fields of electrical engineering, computer science, biomedical engineering, and neurosurgery. Hans Berger's innovation in the field of human brain research and its electrical activity has a close connection with the discovery of brain computer interfaces. Berger is credited with the development of electroencephalography, which was a major breakthrough for humans and helped researchers record human brain activity – the electroencephalogram (EEG). This was certainly a major discovery in human brain mapping, which made it possible to detect brain diseases. Richard Canton's 1875's discovery of electrical signals in animal brains was an inspiration for Berger. As one of the

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first common use of brain computer interface technology, EEG neuro feedback has been in use for several decades. The year 1998 marked a significant development in the field of brain mapping when researcher Philip Kennedy implanted the first brain computer interface object into a human being. However, the BCI object was of limited function. The only benefit from this development was the use of a wireless di-electrode. John Donoghue and his team of Brown University researchers formed a public traded company, Cyberkinetics, in 2001. The goal was to commercially design a brain computer interface, the so-called BrainGate. The company has come up with NeuroPort its first commercial product. Columbia University Medical Center researchers have successfully monitored and recorded electrical activity in the brain with improved precision. According to researchers, NeuroPort™ Neural Monitoring System enabled them to identify micro-seizure activity prior to epileptic seizures among patients. June 2004 marked a significant development in the field when Matthew Nagle became the first human to be implanted with a BCI, Cyberkinetics's BrainGate. In December 2004, Jonathan Wolpaw and researchers at New York State Department of Health's Wadsworth Center came up with a research report that demonstrated the ability to control a computer using a BCI. In the study, patients were asked to wear a cap that contained electrodes to capture EEG signals from the motor cortex – part of the cerebrum governing movement. A number of developments have been taking place in the field. By 2050, it is has been suggested that BCI could become a magic wand, helping men control objects with their mind. The day isn't far off when man may be able to guide an outside object with their thoughts in order to consistently execute both natural and complex motions of everyday life.

III. DETAILED WORKING OF BRAIN COMPUTER INTERFACE TECHNOLOGY

Various BCIs are commercially available. They are not good enough for use by paralysed people because they don't work well enough. To understand working of brain computer interface let's take example of robotic hand, With an EEG or implant in place, the subject would visualize closing his or her right hand. After many trials, the software can learn the signals associated with the thought of hand-closing. Software connected to a robotic hand is programmed to receive the "close hand" signal and interpret it to mean that the robotic hand should close. At that point, when the subject thinks about closing the hand, the signals are sent and the robotic hand closes. Once the basic mechanism of converting thoughts to computerized or robotic action is perfected, the potential uses for the technology are almost limitless. Instead of a robotic hand, disabled users could have robotic braces attached to their own limbs, allowing them to move and directly interact with the environment. This could even be accomplished without the "robotic" part of the device. Signals could be sent to the appropriate motor control nerves in the hands, bypassing a damaged section of the spinal cord and allowing actual movement of the subject's own hands.

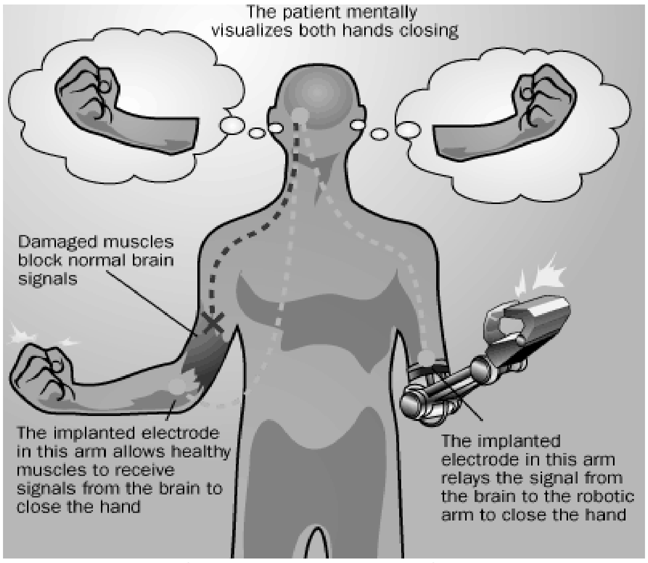

Fig. 2:Working Of Brain Computer Interface In Robotic Hand

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A Robotic Arm is a very versatile robot which can be used for a variety of applications. A robotic arm is probably the most mathematically complex robot that could be built. The design of a robotic arm depends on a number of parameters among which Degree of Freedom (DOF) being the most basic one.

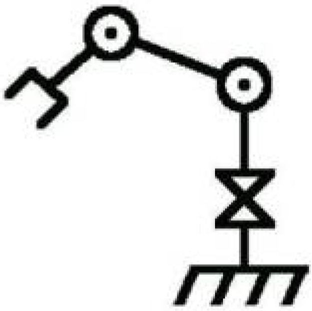

Fig.3: Simple Block Diagram Of Robotic Hand

Each degree of freedom is a joint on the arm, a point upon which it can bend or rotate or translate. The number of DOF will be equal to the number of actuators on the robot arm. The Denvit-Hartenberg (DH) convention is the accepted method of drawing robot arms in Free Body Diagram (FBD's). Rotation and translation are the two motion that a joint can perform. The connection between two actuators is named as a link. Hence, considering all the 3 axes, the maximum number of DOF that a joint can exhibit is six. The action of end effectors is not considered as a DOF. A robotic arm with 3 DOF can be represented as a FBD as in Fig. 3

IV. SURVEY ON FUTURE PROJECTS OF BRAIN COMPUTER INTERFACE

According to recent study at Stanford University, BCI technology has been used to help ALS patients suffering from varying degrees of “locked-in syndrome” and has provided the means for them to communicate using humanoid robots. Humanoid robots are robots that are designed to have the shape of a human body. Post-hoc analysis of the preliminary data indicates that such patients can communicate using humanoid robots to accomplish routine tasks, such as retrieve mail or pick up a plate to eat dinner from. This technology could potentially be life changing. Before this type of research, patients solely depended on a caregiver, such as family members or friends to accomplish simple tasks.

A project called “Brainternet” is generating additional excitement for the field of BCI technology by converting the brain of a user into a node for the internet of things (IoT), which allows a “plugged-in” brain to connect to the internet. A headset of electrodes is attached and action potentials are detected and then transmitted to a receiver like Raspberry Pi. This device acts to convert brain activity into signals uploaded to public domains on the internet. Once connected, a user can communicate with other users online by using brainwaves detected via an EEG device.

The emergence of non-invasive BCI devices — based off an EEG — is emblematic of future mainstream accessibility of BCI technology. For example, BCI technology can allow users to create music with their thoughts. The specific device for this is called an en encephalophone. This device works by receiving input from cortical signals such as the posterior dominant rhythm (PDR) from the visual cortex or the signal from the motor cortex. This technology can be used by people who suffer from neurodegenerative conditions, but there are chances of BCI to become a mainstream product.

V. CONCLUSION

Brain Computer Interface is an advancing technology shows major shift in areas like Human reality, Machine control, and medical areas. BCIs are becoming a viable and effective alternative for assistive technology. But BCIs are still comparatively slow and error-prone compared to traditional input technologies. More research is essential in order to develop techniques to reduce both neural and environmental artefacts, to reduce error rates, and to increase accuracy.

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Brain signals allow for an early prediction of an action, they do not necessarily reflect the final decision. In the presence of motor predictive brain signals, the participant may still change their mind and cancel the movement or act differently. Brain Computer Interface will improve as well and would provide up-gradation in many existing scenarios.

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BIOGRAPHY

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