THE TRENDS AND CHALLENGES IN BRAIN COMPUTER INTERFACE TECHNOLOGY – A COMPREHENSIVE STUDY

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ABSTRACT

A brain-computer interface technology is a direct communication passageway between a human or animal nervous system (brain) and an external world to control electronic devices such as computer using only brain waves without any movement. Based on communication, brain-computer interface can be classified as either one-way BCIs or two-way BCIs. Electronic devices can either transmit signals to brain or receive signals from brain in one-way brain-computer interface. In two-way brain-computer system, there is an exchange of information between the external devices and brain in both directions i.e., acts as transceivers. The scope and latest developments in brain computer interface had discussed in this work.

Index Terms—brain computer interface; braingate; invasive; noninvasive

I. INTRODUCTION

Brain computer interface techniques interpret electrical signals of human brain bustle and convert them into a digital form that digital systems such as computers can easily recognize, process, and translate into measures of some kind, such as control computers, or turning on/off a television and other electronic systems. The brain-computer interface most helpful for physically disabled, who cannot utilize their hands normally, to control wheel chairs, computers, mobile phones or any other electronic devices with their brain activity.

Fig.1.Design of brain computer interface

A brain-computer interface technology is a direct communication pathway between a human or animal nervous system (brain) and an external world to control electronic devices such as computer using only brain waves without any movement. In Brain Gate technology, a sensor is embedded in animal or human brain. The sensor consists of large number of electrodes to sense and receive the information from the neurons of the brain. Then the sensor interprets the information into electrical impulses and sent to an external device. The decoder utilize the brain signals to control the devices such as car, computer cursor, wheel chair or robotic arm. In this way, an animal or human can control any electronic objects using only the mind.

The research in brain computer interface incorporate many fields such as

- Information technology
- Computer science
- Neuroscience
- Biomedical engineering
- Nanotechnology
- Biotechnology
- Cognitive science
- Applied mathematics

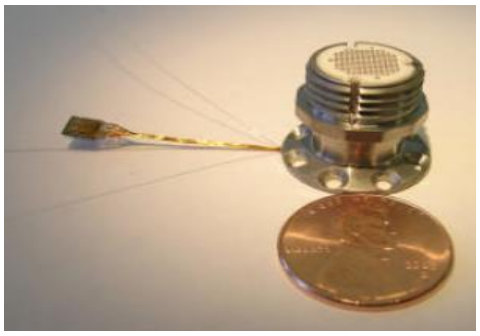

Fig.2. Brain Gate Implant

Brain-computer interface approaches can be classified as either invasive or noninvasive. In invasive method, electrodes are straightforwardly embedded onto a human's brain. In contrast, noninvasive methods in which the brain signals can be read by medical scan-ing devices (sensors) mounted on headbands.

Fig.3.Brain Gate cable assembly

The salient features of noninvasive techniques are

- Less intrusive
- Less efficient interpretation of the information received from brain
- Electrodes are not directly placed on the required location of the brain. Usually implant on the scalp.

- Capability to interpret information from various parts in the brain to study the activities of brain for larger extent

The salient features of invasive techniques are

- Need surgery to implant sensor (electrodes) on or close to the brain.
- There is a chance of damage or infection in brain

Based on communication, brain-computer interface can be classified as either one-way BCIs or two-way BCIs. Electronic devices can either transmit signals to brain or receive signals from brain in one way brain-computer interface. In two way brain-computer system, there is an exchange of information between the external devices and brain in both directions i.e., acts as transceivers. The scope and latest developments in brain computer interface had discussed in this work.

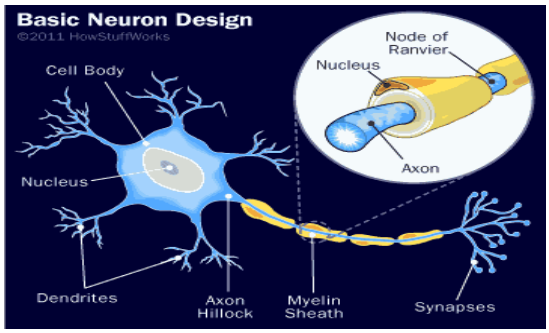

Figure 4. The structure of basic neuron and the transmission of signal through it.

The sketch of the paper is as follows. An overview of software for brain computer is discussed in the section II. The section III explicates the recent trends in BCI technology. The future of brain computer interface had discussed in section IV and as a final point the section V concludes the paper.

II. SOFTWARE FOR BRAIN COMPUTER INTERFACE

Open ViBE is a most widely software which unlock the way to pioneering technology for human beings to communicate with computer system. This software investigates the electrical activity of neurons of brain and decipher it into control signals to control wheel chairs, computers, mobile phones or any other electronic devices with their brain activity.

The following list shows the freely available, open source, non-commercial and most popular BCI software platforms.

- OpenViBE
- ActiveTwo
- BCILAB and LSL
- BCI2000
- BCI++
- BF++
- TOBI Common Implementation Platform (Python PyTIAClient)

Some of the software is helpful to develop an environment for brain computer interface. They are,

- BioSig
- SNAP
- MatLab
- SCoT
- SigViewer
- MNE
- C/C++

III. RECENT TRENDS IN BRAIN COMPUTER INTERFACE TECHNOLOGY

A wireless transmitter for paralyzed people developed by a Brain Gate team comprised of researchers from Brown University, Blackrock Microsystems and Utah Company to control computers, television or any other electronic devices with their mind thoughts. This transmitter is fixed to the skull and wired to electrodes in the interior the brain. The transmitter has an amplifier to strengthen the electrical impulses produced by neurons, a tiny circuit for the conversion of electrical impulses into digital information, and a radio antenna to transmit the digital information to a receiver as a control signal to control the movement of mouse cursor in computer monitors, on/ off television or any other electronic devices.

A Japanese developed robot suit called 'Hybrid assisted which is intended to assist renovates the mobility to the handicapped and elderly people. This suit can be utilized to and, as well as to provide superhuman strength for services personnel. Further development in this robotic limb is to display the mind thoughts in video display unit.

The brain computer interface technology based headset 'XWave iPhone accessory' is employing for the reading of brain waves. In addition, brain computer interface technology had been applied for many applications such as

- Recover quickly from serious mental traumas
- Delaying and preventing Parkinson's and Alzheimer's disease in elderly
- P300 Chinese speller program is very helpful for paralyzed and handicapped people to write Chinese mandarin characters
- Brain computer interface technology had been utilized for gaming, mobile phones and consumer electronics.

As military applications concerned, this technology had been applied to develop troop response to words and orders.

11. FUTURE BRAIN COMPUTER INTERFACE TECHNOLOGY

Fast growing BCI technology is continuously transforming to adopt the latest developments. In near future, faster and reliable brain computer interface system will be developed to control most electronic devices using mind only for more potential users. Future techno-logy may utilize wireless mode of communication to send the signals from implant to external devices. The development of dry electrodes and wireless electrode connections may stop the use of conductive gel applied on the user's head. It is predicted that the cost of brain computer interface technology will come down as it is extensively utilized for variety of applications. The complexity of the brain computer interface will eventually reduce as the size of the components reduced for reasonable level.

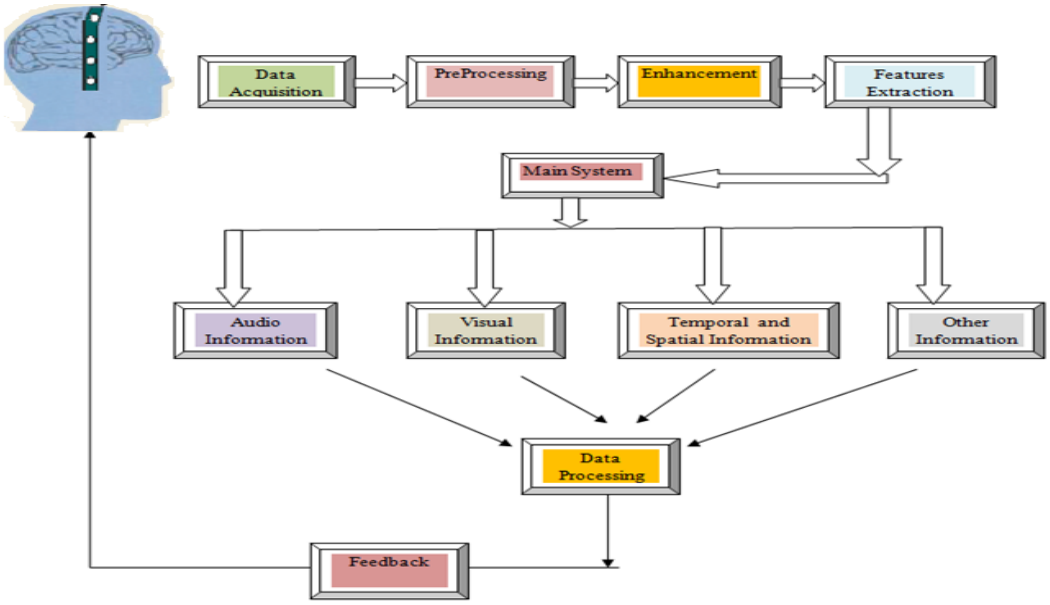

Figure 5: Implementation of brain computer interface system.

The salient features of the future BCI technology is listed as follows

- No need to perform risky operation of brain.
- Wireless technology.
- The data (information) transfer rate should be fast in comparison to conventional techniques.
- Initial cost of installation may be very expensive.
- Working of the system may be complex.

I. CONCLUSION

The new trends and challenges in the brain computer technology has elaborately analyzed in this work. Brain computer interface techniques interpret electrical signals of human brain bustle and convert them into a digital form that digital systems such as computers can easily recognize, process, and translate into measures of some kind, such as control computers, or turning on/off a television and other electronic systems. The brain-computer interface most helpful for physically disabled, who cannot utilize their hands normally, to control wheel chairs, computers, mobile phones or any other electronic devices with their brain activity. Fast growing BCI technology is continuously transforming to adopt the latest developments. In near future, faster and reliable brain computer interface system will be developed to control most electronic devices using mind only for more potential users. Future technology may utilize wireless mode of communication to send the signals from implant to external devices.

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