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P300 based Brain Computer Interface for Disabled

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***Abstract*— A Brain Computer Interface (BCI) is a communication system that translates brain signals into commands for a computer. BCI is a communication system that recognizes user's command only from his or her brainwaves and reacts according to them. BCI (Brain Computer Interfaces) are systems enabling communication between a person and a computer without muscular intervention that is to say that only cerebral activity is used. In the world several millions of person with heavy neuromuscular handicap could benefit from those systems. The interaction between the computer and a disabled person can be done by a technique which will help a disabled person to communicate easily i.e. the P300 technique. The P300 signals are often used in virtual keyboard applications ("P300 speller") in which users select alphabet successively. Whereas the EEG machine is used to capture the brainwave signal from the scalp. BCI allows user to control their environment by using neural activity of brain. In this paper we proposed P300 based BCI system for disabled people who are suffering from paralyses and comma. We are proposing an application system using P300 which will become a voice of disabled by implementing text to speech technology.**

***Index Term* - Brain Computer Interface, Electroencephalo - graph, P300 Speller.**

I. INTRODUCTION

Human brain contains a huge network of nervous cells (also called neurons). We know that as neurons fire within the brain they produce electrical activity. A neuromuscular disorder person like Amyotrophic Lateral Sclerosis (ALS), brain strike, muscular dystrophy etc. is a nervous system disease that attacks on nervous cells in human brain. These neurons transmit messages from brain to voluntary muscles by which human can control their organs like arms and hands. When the neurons are not capable to communicate between brain and nervous system as a result people suffering from diseases like comma and paralysis. Scientists are trying to develop system that somehow converts neural activity or thoughts of the human brain being in front of the computer into a machine readable format it is called as *Brain Computer Interface* (BCI). Electroencephalograph (EEG) is the measurement and recording of these electrical signal using sensors arrayed across the scalp. The main source of the EEG is the synchronous activity of thousands of cortical neurons. Measuring the EEG is a simple non-invasive way to monitor electrical brain activity, but it does not provide detailed information on the activity of single neurons. The interaction between the computer and a disabled person can be done by a technique which will help a disabled person to communicate easily i.e. the P300 technique. The P300 signals are often used in various applications like the P300 speller which is often used in virtual keyboard application in which users select alphabet letters successively. The letters are displayed on a uniform grid (or matrix) with each letter flashing successively (global technique), or the letters can flash by groups (N-chotomic technique) using a decision tree with successive layers of letters displayed until the final letter is selected. The P300 approach was also used in multimedia and virtual reality applications to select or activate virtual objects by the disabled person. [1]

Our objective for writing this paper to explores some of the problem and challenges for neuromuscular disorder people in front of BCI researchers. We are proposing an application system using P300 which will become a voice of disabled by implementing text to speech technology.

II. BRAIN COMPUTER INTERFACE

A Brain Computer Interface (BCI) provides alternative communication and control channels to convey message and commands from the brain to the external world. Brain Computer Interface system help those patients suffering from several neurological or muscular diseases.[2] BCIs can significantly improve the quality of life of neurologically impaired patients with pathologies such as : amyotrophic lateral sclerosis, brain strike, brain / spinal cord injury, cerebral palsy, muscular dystrophy, etc [3]. At present electroencephalogram (EEG) is the major brainwave signal used by non – invasive BCIs. One strategy of EEG – based BCI involves the use of event related potential (ERP) that exploits the electrophysiological response to a certain event.

A recent study showed that only 12% of published BCI studies use implanted electrodes, 5% use microelectrode arrays and more than 80% use EEG signals. The main reason is that the EEG recording equipment is commercially produced and their cost is lower than other brain signal recording technologies. [4]

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A. TECHNIQUES / METHODS

There are two methods for getting brain signals i.e invasive and non – invasive brain computer interface. In invasive brain computer interface electrode called the neurotrophic electrode is implanted in the brain through a brain surgery. In this method neurons which are in contact with the cone send the brain signals to a tiny receiver near the skull. The signals are amplified and send to the computer. In non – invasive brain computer interface method doesn`t require a brain implant, only user wear a cap studded with electrodes. There are so many researchers support the non – invasive method because there is no risk required a surgery to implanted electrode in brain.

Whereas the non – invasive ones mostly employ electroencephalograms (EEGs) recorded from the people scalp. The non – invasive method can be further subdivided into three groups. The first group explores visually evoked potentials (VEPs) and they can be traced back to the 70`s, when Jacques Vidal constructed the first BCI. The Second group of non – invasive BCIs rely on the detection of imaginary movements of the right or left hand. The third non-invasive group are the BCIs that rely on the 'oddball' evoked potential in the parietal cortex.[3]

An event related potential (ERP) is a stereotyped electrophysiological response to an internal or external stimulus. One of the most known and explored ERPs is the P300.[3]

The non – invasive methods like the P300 speller are enough to give back a communication potential emulating a keyboard or a mouse. [4]

B. BCI APPLICATION

A Brain Computer Interface (BCI) allows people suffering from neuromuscular disorder to use electroencephalographic (EEG) activity to control external device such as robots, virtual environment or spelling devices, video games, wheelchairs, mobile phone control etc.

P300 base BCI showed that patients suffering from amyotrophic lateral sclerosis (ALS) can use a BCI to control a spelling device and communication with their environment. (Birbaumer et al. in 1992) [6]

Piccione et al. (2006) tested a 2D Cursor Control System. Some people spell words with their thoughts control home by thinking, navigate a robot with their mind. [Video BCI]

III. P300

The P300 speller first described by Farwell and Donchin (1988), user P300 response to choose letters from a matrix presented on a computer screen. It allows the participant to write words and sentences. The operating principle behind the P300 speller is to oddball paradigm in which target and non target stimuli are presented in a random series. The participant is then instructed to attend to the target stimulus, which is presented infrequently and to ignore the non target stimuli which are presented frequently. The target stimulus elicits a P300 response that can be reliably detected in the EEG. [5]

Fig1: The figure shows the P 300 speller matrix displayed on a screen

The participant is presented with 6X6 matrix that includes 36 characters. The individual rows and columns flash in rapid succession. The participant`s task is to communicate a specific character by attending to that character and counting the number of times it flashes. The flash of the row and column that contains the desired character elicits a P300 response. By determining which row and which column elicit P300 the BCI can identify the character the participant wants to select counting the number of flashes helps to keep the participant`s attention focused on the task.[5] The figure 1 shows the disabled person using the P300 speller matrix on the screen.

A. APPLICATION OF P300

P300 base Brain Computer Interface system helps the neuromuscular disorder people to have the ability to show text on his mind to the computer screen using P300 speller, EEG as a substitute typing finger.

People developed BCI system to performed Twitter action like login, inbox, post, status line, logout using P300 speller [Video Guger Technologies].

Behided Rezazadeh, Jonatus Manzolli g.tech develop BCI system for multimodal Brain Orchestra. [P300 technologies].

Control the smart Home by your thoughts using P300 speller. [Guger technologies Graz Austria] [Video]

IV. PROPOSED SYSTEM

We know that human being has ability of communicate with other people around us. A healthy person can express his or her ideas, feelings and desires by speech, gesturing or writing. These things make his or her daily life more easy and enjoyable. But 'locked- in' people totally lost their control

over voluntary muscles due to a neurological disease such as ALS. Basically many of the disabled patients are mentally fit, they can hear, see and understand everything but are not capable of expressing themselves anymore they lose the ability to communicate with their environment for this purpose the P300 speller is useful.

Our aim is develop system for disabled patients who can select symbol from the screen or character from the screen with the help of P300 speller. The selected character string can be spoken by the computer or speakers. Techniques like text to speech etc. can perform action on that character string which is generated by 'locked – in' people from P300 speller by which the patients can use them as commands to control his environment equipments. The figure2 describes the proposed system we can see that the signals are acquired from the simulator; these signals are processed through various steps by which the application is implemented. In the below figure the application i.e. Text to speech is described in which, A Text-To-Speech (TTS) synthesizer is a computer-based system that should be able to read any text aloud, whether it was directly introduced in the computer by an operator or scanned and submitted to system. The selected stream of words can be converted in speech using text to speech technique.

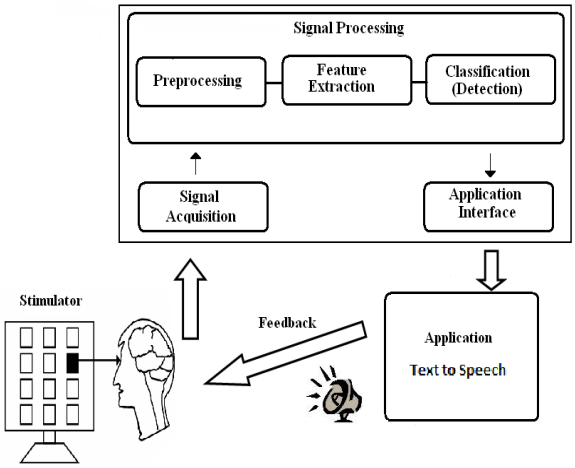

Fig2: Proposed System

V. CONCLUSION

Brain Computer Interface (BCI) was originally developed as communication device for neuromuscular disorder (paralysis, comma) patients. The technique of text to speech will help a disabled person to communicate with the other environment in day to day life without any barrier. It can make a life of a disabled person more independent.

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