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ABSTRACT-

Brain Computer Interface is a system that translates the electrical activity of the brain into commands which can control devices in real time applications, enabling the disabled people to communicate with the outside world.

In this paper we focus on P300 based real time application where the users' difficulty in communicating with the external environment is made easier. The P300 Event Related Potential (ERP) are natural responses of the brain to some specific stimuli. A person who is paralysed or bedridden needs full care and attention. This means that a care team will likely be working together (including family, friends, nurses and other professional help). Because of this, it is important to make sure that every or any one of the care team member should always be there with the patient. If there occurs a situation where the patient is in need and the care taker is not present with them, our work finds a solution for this problem using BCI technology. In this concept we use a CRT or LED monitor placed infront of the user where different images are displayed. These images represent the basic needs of the paralysed person. When the user is in need of some requirements they can gaze at the images displayed on the monitor. Meanwhile the signals generated during this event is processed and the output is given to the desired applications. Thus this paper eases the users difficulty in meeting their basic needs.

Keywords: brain computer interface(BCI),Event Related Potential(ERP) ,P300 component.

I. INTRODUCTION

Brain Computer Interface(BCI) is an emerging technology which aims at building a communication channel by directly bridging the brain and the external systems. This BCI system are capable of acquiring brain activity signals, interpret them and eventually use them for any kind of purpose. Its main goal is to convey people's intensions to the outside world directly from their thoughts.

Mainly two kinds of BCI can be distinguish , Invasive and Non-Invasive. Non invasive techniques uses signal coming from surface Electroencephalographic(EEG) record and invasive techniques uses the signal coming from deeply implanted electrodes on the brain.

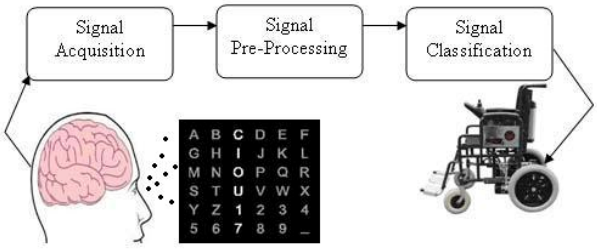

Fig., 1 General BCI Architecture

Invasive methods obtain a signal of better quality and enable complex application like control of artificial organ. However, they required a heavy surgical intervention. The brain functions are monitored using various techniques including Electroencephalography(EEG),

Magnetoencephalography (MEG), Functional Magnetic Resonance Imaging(FMRI) and Positron Emission Tomography(PET).

Among these our paper focuses on Electroencephalography(EEG), the optimal choice for BCI implementation due to its low cost and high time resolution compared with other modalities.

A. Classification Of Bci Systems

BCIs have been investigated from different perspectives. Depending on the Data Acquisition process BCI can be classified into

i) Invasive BCIs
ii) Partially BCIs
iii) Non-Invasive BCIs

i)Invasive BCIs: Invasive BCI are directly implanted into the grey matter of the brain during neurosurgery. They produce the highest quality signals of BCI devices . Invasive BCIs has targeted repairing damaged sight and providing new functionality to paralyzed people. But these BCIs are prone to building up of scar-tissue which causes the signal to become weaker and even lost as body reacts to a foreign object in the brain.

ii)Partially Invasive: Partially invasive BCI devices are implanted inside the skull but rest outside the brain rather than amidst the grey matter. They produce better resolution signals than non-invasive. BCIs where the bone tissue of the cranium deflects and deforms signals and have a lower risk of forming scar-tissue in the brain than fully-invasive BCI**s**.

Electrocorticography(ECoG) uses the same technology as non-invasive electroencephalography, but the electrodes are embedded in a thin plastic pad that is placed above the cortex, beneath the dura mater.

*iii)Non-Invasive BCIs***:** In non-invasive neuro imaging technology, signals recorded have been used to power muscle implants and restore partial movement in an experimental volunteer. Although they are easy to wear, non-invasive implants produce poor signal resolution because the skull dampens signals, dispersing and blurring the electromagnetic waves created by the neurons.

Another research parameter is the type of waves measured. In Magneto-encephalography (MEG) and functional magnetic resonance imaging (fMRI) have both been used successfully as non-invasive **BCI**s. fMRI measurements of haemodynamic responses in real time have also been used to control robot arms with a seven second delay between thought and movement.

Electroencephalography (EEG) is the most studied potential non-invasive interface, mainly due to its fine temporal resolution, ease of use, portability and low setup cost. At present, EEG is the optimal choice for BCIs implementation when compared to other modalities, such as fMRI,MEG, etc.

The remaining paper is organized as follows. Section II explains about the EEG based BCI system and various signal patterns of EEG. Section III describes about the detection of p300 components and its comparision with other modularities.

II.EEG BASED BCI

Electroencephalography (EEG) is a method used in measuring the electrical activity of the brain. The brain generates rhythmical potentials which originate in the individual neurons of the brain. These potentials get summated as millions of cell discharge synchronously and appear as a surface waveform, the recording of which is known as the electroencephalogram(EEG).The EEG signal can be picked up with electrodes either from scalp or directly from the cerebral cortex. As the neurons in our brain communicate with each other by firing electrical impulses, this creates an electric field which travel though the cortex, the dura, the skull and the scalp. The EEG is measured from the surface of the scalp by measuring potential difference between the actual measuring electrode and a reference electrode.The peak-to-peak amplitude of the waves that can be picked up from the scalp is normally 100 microV or less

while that on the exposed brain, is about 1mV. The frequency varies greatly with different behavioural states. The normal EEG frequency content ranges from 0.5 to 50 Hz.

Besides, EEG signal patterns can be used for BCI, for example,

Slow cortical potentials (SCP)

Event related potential(ERP)

Visual Evoked Potential(VEP)

Our target is to build a bci based on ERP specifically P300 component. ERPs are event related potentials generated in the brain during the presentation of stimulus. The stimulus could be generated by a sensor or a psychological event. The P300 component indicates the significant change in the EEG waveform that occurs 300ms when expose to an external stimulus. A most promising application of the P300 components to BCIs is a P300 based speller in which a BCI presents a set of letters and detects the target letter with which the P300 component is suppose to be generated The P300 based speller has advantages of requiring the minimum training time as well as a relatively small variability across subjects.

III. BCI BASED ON P300

The first type of noninvasive BCI we concentrated on is based on the detection of the P300 component of Event-Related Potential. This brain potential is elicited in the context of an oddball paradigm: when a subject perceives two types of events, one of which occurs only rarely, the rare event will elicit in the EEG an ERP with an enhanced positive- going component at a latency of about 300 ms (the P300). The P300 BCI system described by Donchin's group flashes letters or other symbols in rapid succession. The letter or symbol that the user wants to select produces a P300 potential. By detecting this P300 potential, the BCI system can determine the user's choice. This BCI method appears able to support operation of a simple word processing program that enables users to write words at a rate of one or a few letters per minute. Improvements in signal analysis may substantially increase its capacities. At the same time, the effects of long-term usage of a P300-based BCI on its communication performance remain to be determined: P300 size and reliability may improve with continued use so that performance improves and accuracy also high.

A)P300 Detection

P300 is a term for a significant positive curve on the EEG which appears 300ms after a relevant and seldom stimulation that does not necessarily have to be visual. The strongest signal can be obtained at the central parietal region which is located at the upper back of the head. This signal occurs involuntarily so no special training is required. Research has shown that stimuli with an erotic content lead to stronger P300 brain waves. Another study found out that P300 signals were weaker in tobacco-smokers, alcoholics and drug-dependent people. Nevertheless, a P300 characterizes a stimulus which is perceived by the subject as eminent.

Fig, 2 36-position array of letters

Detecting the P300 response reliably requires averaging the EEG response over many presentations of the stimuli. The purpose of the current experiment was to discover the minimum number of presentations at two different inter-stimulus intervals (ISI) required to detect the P300 response. The experiment presented a 36-position array of letters, plus common typing characters and controls (e.g. space, backspace), made to flash in a random sequence first by rows and then columns. Each trial consisted of a complete

set of six column or row flashes. Trials contaminated with muscular or EOG response were rejected and additional trials presented until data were collected from a block of 30 good trials, during which subjects were to fixate on a particular position, and count the number of times it flashed while a control message was elsewhere on the screen.

After each block the fixated letter(one of B-R-A-I-N) was added to the screen so that subjects were conscious of slowly spelling out the word “BRAIN” through a succession of five blocks. A set of five blocks was run at each ISI – 125 ms and 500ms. The two presentation rates were chosen to bracket a range of communication rates from a low of 30 averaged trials at 500ms ISI(93.6 seconds of presentation per character) to a high of one trial at 125ms (1.245 seconds of presentation per character), an effective communication rate range of .01 to .8 characters-per-second, respectively.

The authors used four techniques to analyze the data reliable p300 response detection- stepwise descriminant analysis(SWDA), peak picking,area and covariance and indentified SWDA as leading to the greatest accuracy at the fastest presentation rate. Results indicated that a character chosen from among 36 items can be detected with 95% accuracy within 26 seconds.

IV. MODULES IN THE BCI TECHNOLOGY

In the following phase, we will see briefly discuss the necessary steps and flow diagram for detection and process of p300 component.

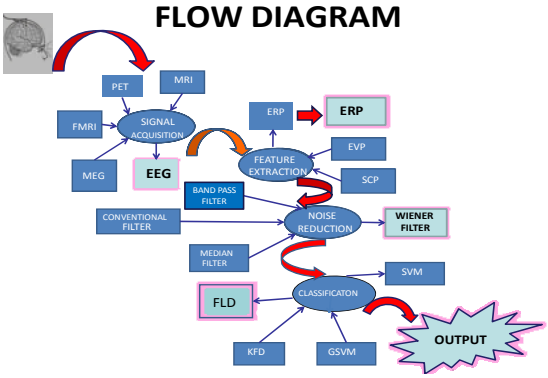

Fig., 3 flow diagram activities of processing of signals

i)Signal Acquisition: Signal Acquisition is the process in which signals are obtained from the brain through invasive or non-invasive methods (for example, electrodes). We concentrate on non-invasive method **electroencephalogram by placing the electrodes on the scalp.** After acquisition, the signals are amplified and sampled

ii) Signal pre-processing: This includes amplification, initial filtering of EEG signal and possible artifact removal. Also A/D conversion is made, i.e. the analog EEG signal is digitized. In the signal pre-processing the noise and the artifacts are removed.

iii) Feature extraction: In this stage, certain features are extracted from the preprocessed and digitized EEG signal. In the simplest form a certain frequency range is selected and the amplitude is measured. Typically the features are certain frequency bands of a power spectrum. If the feature sets representing mental tasks overlap each other too much, it is very difficult to classify mental tasks, no matter how good a classifier is used.

*iv) Classification:*The features extracted in the previous stage are the input for the classifier. Different BCIs can classify different number of classes, typically 2 to 5 classes. The classifier can be anything from a simple linear model to a complex nonlinear neural network that can be trained to recognize different mental tasks. The classifier can calculate the probabilities for the input belonging to each class. Usually the class with the highest probability is chosen. However, in some BCI protocols none of the classes may be chosen, if the classification probability does not exceed some predefined level. This kind of classification result can be called “nothing” or “reject”.

v) Device control: The classifier’s output is the input for the device control. The device control simply transforms the classification to speaker. In the speaker the voices are pre-

recorded according to the images present in the P300 Speller. If the user gaze at the particular image, voice recorded for that image is produced as an output.

V. OUR PROPOSED METHOD

We use a CRT/LED monitor consisting of icons representing the basic requirements for the paralysed personinstead of the letters and symbols. When the users gaze on the P300 speller which is placed in front of them, the signals are generated and it is processed. The signal generated is in the form of Raw EEG which is done in feature extraction process. Then the signals are classified and the P300 signals are sent to classifiers. The user can convey his needs to the outside world as pre-recorded voice from the loupspeaker. The signals generated while gazing are processed and the ouput is interfaced with the loudspeaker.

VI. CONCLUSION

BCI systems could eventually provide an Important new communication and control option for those with motor disabilities and might also give those without disabilities a supplementary control channel or a control channel useful in special circumstances.

The neural activity used in BCI can be recorded using invasive or noninvasive techniques. P300-based BCI can be very helpful to the people with neuromuscular disorder and it has been shown the best method among the existing methods using the above comparative studies.

We can say as detection techniques and experimental designs improve, the BCI will improve as well and would provide wealth alternatives for individuals to interact with their environment.

V. FUTURE WORKS

The output of the processed signal is interfaced with the loudspeaker as pre-recorded voice in the existing system. In the future work, instead of pre-recorded voice the output can be interface with the wireless network such as sending a short message service(sms) to the caretaker or the people associated with the user.

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