ISSN: 2321-8169
350 - 354

Detection and Plotting Real Time Brain Waves

Prof. M. M. PAL
ME (ESC(CS)
Department Of Computer Engineering
Suresh Deshmukh College Of Engineering , Wardha

***Abstract* -** The human brain, either is in the state of alertness or sleeping, various frequency changes are observed in the graph of measured electric signal of the brain. Regarding the frequency components of these signals that occur as a consequence of this electric activity, different brain waves can be distinguished. The electric impulse alternations that generated during the operation of neurons can be measured by the EEG (electroencephalograph) device. In the past, devices that could measure these brain signal alterations were mainly used in medicine. In this project, the so-called Brain Computer Interface unit will be presented that was developed for further brain wave analysis and ensures the detection of brain waves. An application for visualization signals will also be described. The application can be used for EEG data acquisition, processing and visualization which could be the base of several further researches. Moreover a handy product will created for getting the brain pulse values. Advantages of that is no need to carry the computer.

Keywords*-component; BCI; EEG signal, brain activity*

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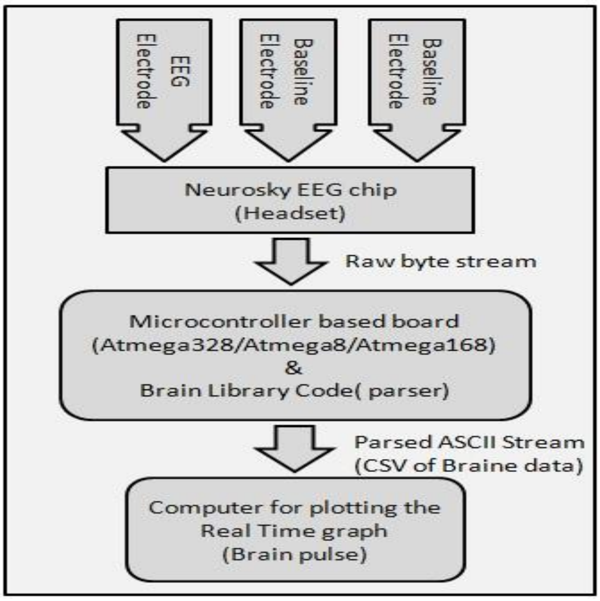
I. Introduction

Brain – computer interface is one of the latest solutions in the area of efforts to control digital machines directly by means of signals sent by the brain. Successful attempts are being made to develop control systems enabling an increasingly widespread use of such a solution. The signal, for which dependencies are determined allowing further control, is recorded by means of electro encephalographic or Magneto encephalographic devices, additionally equipped with auxiliary systems collecting other physiological signals, such as blood pressure or electrical voltage generated by muscles. Knowledge of the construction and function of single neurons facilitates understanding of their role in the conductivity of signals in the nervous system, in particular in the brain. The cerebral cortex is composed of grey matter, and from its surface, the EEG signal, namely the electrical activity of the brain, is captured. The EEG signal is measured mainly by the activity of large pyramidal cells composed of long axons ending in different layers of the cortex or even in different structures of the nervous system localised in the fourth and fifth layer of the cerebral cortex. The majority of pyramidal cells are localised in parallel to the cortex surface, and such a location allows for perceiving the structure as an electrical dipole, whose field is positioned conveniently for placing electrodes on the cranium surface while recording the EEG signal.



Specific Objectives

The project also aims to address a number of specific objectives in the development of a cost-effective, in-home compatible BCI solution. These objectives have been divided into four primary objectives and one secondary objective as follows:

Primary objectives

1. Research background information relating to brain computer interface (BCI) design, electroencephalography (EEG) signal processing, human factors, and ethics.

2. Use selected software tools for real time acquisition, visualization and analysis of brain signal inputs.
3. Conduct comparative analysis of selected brain computer interface systems.
4. Establish a framework from which a reliable and robust functional application can be built for use by selected commercial BCIs.

Secondary objective

5. Explore strategies for improving issues of user fatigue, speed, accuracy, consistency, control, user friendliness and convenience, and signal processing algorithms for desired outputs.

II. Benefits For People With A Disability

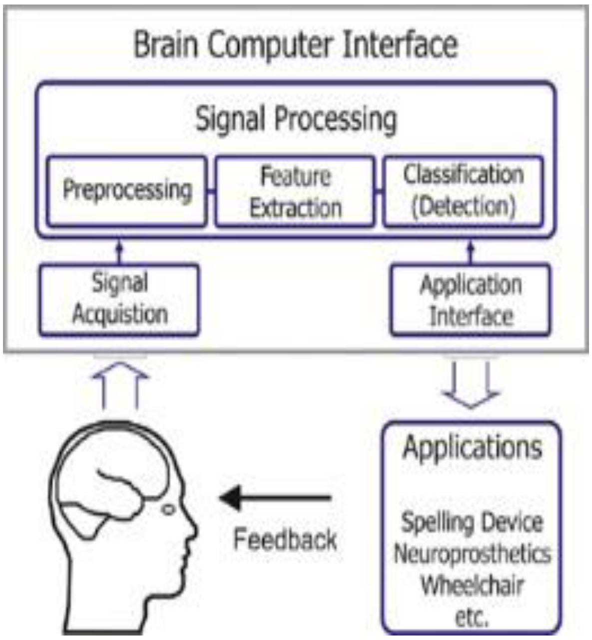
On an international scale, the World Health Organisation (WHO) estimated that 10% of the world‟s population experience some form of impairment or disability (WHO 2006). Two percent of the global population have a musculoskeletal condition (DCP2a 2007) contributing significantly to global chronic disability. Moreover, neurological disorders (DCP2b 2006) and unintentional injuries (DCP2c 2006) pose a significant health burden to the global community. Of particular interest in this project are those people with disabilities that experience moderate to profound motor impairment.

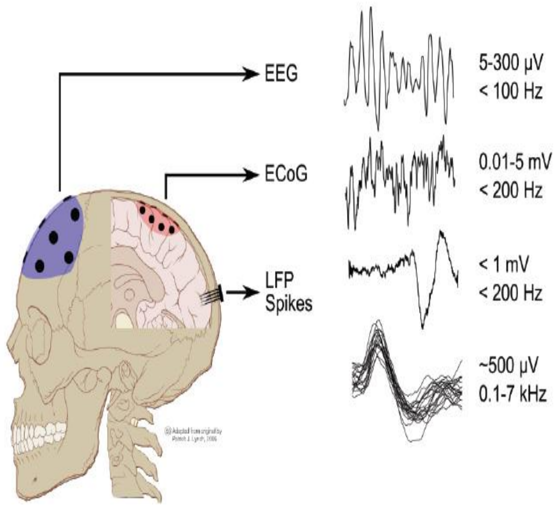
EEG

Electroencephalography, most commonly referred to as EEG, is a technology based on substantial research and evidence (Tatum et al. 2008). EEG measures neural brain activity, which usually corresponds to the brain‟s two lowest functional levels (Dietmar et al. 2010). It is a technology that has been in use, in both clinical and research settings, for decades (Tatum et al. 2008). Moreover, it is a lightweight, inexpensive technology that is easy to apply (Tatum et al. 2008). EEG has high temporal resolution, which is useful for detecting changes within certain time intervals (Tatum et al. 2008). Using a galvanometer, the initial discovery of the brain‟s electrical activity is attributed to Richard Caton (1842-1926). His published works exhibited experiments using dogs, apes and other animals. Caton found, when measuring currents from the external surface of the skull of animals, that "electric currents of the grey matter appear to have a relation to its functions" and that "[when] any part of the grey matter is in a state of functional activity, its electric current usually exhibits negative variation" (Caton 1875). Vladimir Pravdich-Neminsky (1879-1952), a Ukrainian physiologist, undertook further research of mammalian brains and the concept of evoked potential (refer to section 2.6.3.4.1). The pioneering work from these researchers, in particular Caton, provided Hans Berger (1873-1941) with the foundation to expand on EEG knowledge and apply its first usage with human subjects. To detect EEG signals, electrodes are placed on the hairy scalp. These electrodes are of low resistance. Two methods - bipolar and monopolar- could be used to lead voltage. In the former case, the voltage difference is measured between adjacent points, while in the other case, there is a reference point, also referred to as a null point, and the voltage difference is measured to this. This null point electrode should be placed in an area where its potential is not influenced by brain activity, for example on the earlobes. For clinical and diagnostic examinations, the bipolar lead is used generally. The monopolar lead isparticularly applied in different research and tests, as it gives a general information about brain activity. The main advantage of this method is that the null point makes the comparison of signals possible in several electrode pairing. On the contrary, there is not an ideal null point area and that is the main disadvantage of this method. The bipolar version is a better choice for local analysis, as the neighbouring areas can be compared, and that is the reason why it is more likely to be used for diagnosing. In this method, the brain signals measured on the two active halves of the skull are compared. Any activity together with these signals is subtracted and only the difference is registrated.

III. Methods Of Communication Of The Brain With a Digital Device

Systems which collect and then process information to the level understood by an electrical device, in this case a computer, are called BCI – Brain-Computer Interfaces. BCI plays a role of a communication as well as control system between a digital machine and the examined subject. The signal is generated by the record of electrical brain activity, and then it is appropriately converted, simultaneously resulting in a synchronised visual effect. Such an effect is very important, as it allows biofeedback, owing to which the examined subject receives information on a successful communication process. The overall structure of the process is presented in figure 1.





The brain computer interface (BCI) offers users the potential to gain increased access to environment, particularly those with physical disability or impairment. This technology has attracted focus from many disciplines due to its promising applications such as environmental control, robotic or neuroprosthetic control, gaming, physical rehabilitation and vocational enhancement, not to mention the range of medical benefits offered by this technology.

Despite optimistic expectations for the BCI, this technology has largely been confined to the laboratory. Recent developments over the past few years have seen the production of commercial BCIs intended for general user use. Nevertheless, the presence of such devices raises questions of reliability, cost-effectiveness, user-friendliness, and compactness for the in-home user.

This research found that commercial BCIs do enable usable signal acquisition of raw brain waves. Nevertheless, these systems are limited in terms of spatial resolution, and feature extraction and translation. Results show that two commercially available BCIs in particular offer promising results for the user with moderate to severe physical disability. A suitable imagined music application can be derived using a mix of in-built SDK algorithms, independent signal processing, open sound control and Pure Data for real time processing of brain signals.

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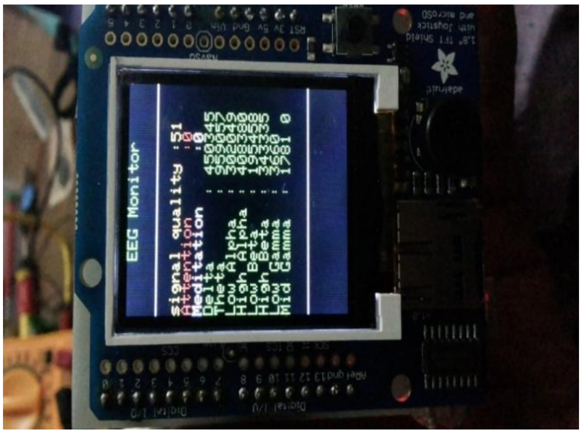
EEG



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A. BCI based on detection of event related potentials

A group of interface systems based on detection of event related potentials may be found in literature as the name of the main component of the P300 device. Originally, the system was created for persons devoid of the possibility to communicate with the external world, for whom the only means of communication was mental contact. The examined person is presented with a rectangular table with symbols. The subsequent columns are highlighted in a set time interval so that at a given moment, only one column is highlighted. If the column including a given symbol is highlighted, the examined person’s brain generates a potential, which is then indicated by detection and measurement device if detection of the signal has been successful. The procedure is repeated for subsequent lines
of the table, as a result of which the BCI device receives information on the currently observed symbol. This method of control provides a unanimous answer, but its efficiency decreases in line with the increase of data presented on the table of the device

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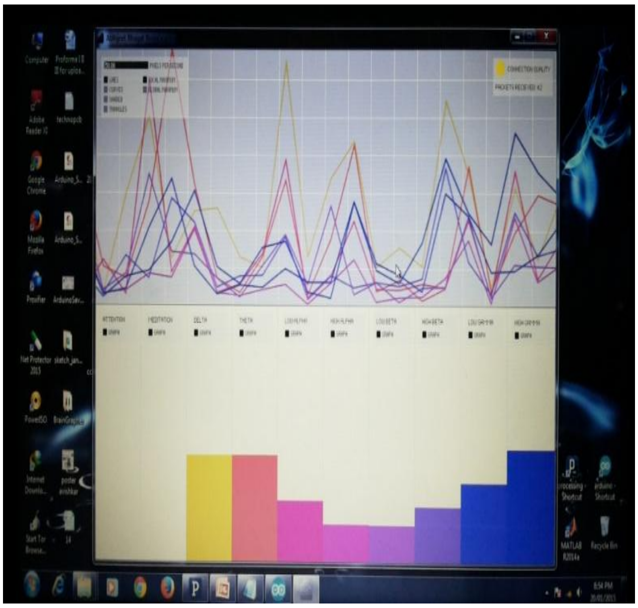

IV. Vi. Conclusion

In this paper, it has been shown that a BCI system could be designed where the subject has to think of a single mental task Only.EEG data acquisition, processing and visualization. Although comparing to the approach of classification, the accuracy of detection remains to be further improved. With the experiment analysis, the approach here can detect any change that occurs in an appropriate set of brain signal features, and it is valuable as no requirement of perplexing analysis process. Furthermore, in this paper we proved the feasibility of signal detection. Advantages of that is no need to carry the computer.

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Prof. Madhuri M. Pal