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A Survey on Electroencephalography (EEG)-Based Brain Computer Interface

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Abstract— In this paper the main objective is to develop a system which allows disabled people to communicate with other persons and helps to interact with external environment and also to establish a communication system which will translate the human intentions reflected by brain signals into analog speech signals those are audible via speakers. Brain–computer interface i.e., (BCI) is a new emerging area is mainly for the patients in the treatment bed. TheBrain Computer Interface will receive brain signals, analyze them, and then translate them into commands those are transfer to output devices which will carry out desired actions. Electroencephalography records the brain's electrical activity, obtained by firing of neurons within the brain. If, we find out the difference in those low signal frequencies, those will yields to design a BCI. Based on variation in those frequencies, human thoughts can be recognized as a prototype mechanism.

Keywords: **Brain computer interface(BCI), ElectroEncephalography (EEG)**

I. INTRODUCTION

Modern medicine applies to the variety of imaging techniques of the human body. The Electro biological measurements comprises items as ElectroCardiograph (ECG, heart), Electromyography (EMG, muscular contractions), Electroencephalography (EEG, brain), Magneto encephalography (MEG, brain), electrogastrography(EGG,stomach),electroOptigraphy (EOG, eye dipole field). Imaging techniques based on different physical principles include computer tomography (CT), magnetic resonance imaging (MRI), functional MRI (fMRI), positron emission tomography (PET), and single photon emission computed tomography (SPECT).

II.EEG SIGNAL

The Electroencephalogram is a medical imaging technique that reads scalp electrical activity generated by brain structures whenever these are picked up by metal electrodes and conductive media. While Electrocardiogrammeasures directly from the cortical surface and when using depth probes it is called electro gram. Thus e1ectroencephalographic reading is a completely non-invasive procedure that can be applied repeatedly to patients, normal adults, and children with virtually no risk or limitation.

III.EEG GENERATION

An EEG signal can be generated due to the flow of currents between the brain cells in the cerebral cortex region of the brain. When localcurrent flows are generated, the cells (neurons) in brain are activated.It mostly measures the flow of current during synaptic excitations in the dendrites of many other pyramidal neurons (neurons) in the cerebral cortex. Differences in electricalpotentials were caused by summed postsynaptic graded potentials from pyramidal cells that develop electrical dipoles between the soma (body of neuron) and the apical dendrites(neural branches). Brain electrical current consists mostly of Na+, K+, Ca++, and Cl- ions that are pumped through channels in neuron membranes in the direction governed by membrane potential.During recording the noise in EEG signal can be generated due to the current flow in between the cells of the brain in cerebral cortex region of brain. Duringthe recording the EEG signal noise may beinternal (generated within the brain) or may be external (over the scalp).Larger volumes of activated neurons will generate enough electrical potential to have a perfect recordable signal. Electrical signals that are weak can be found out by the scalp electrodes and can be extremely amplified, and then it is displayed on a white paper or preserved in the computer memory. Because of theability to reflect boththe normal and also abnormal electrical activities of the brain, EEG was found to be a very advanced tool in the region of clinical neurophysiology and neurology.

IV.EEG RECORDING TECHNIQUES

Measurements of encephalography require recording systems which comprises of

- -Electrodes with conductive media
- -Amplifiers with filters
- -A/D converter
- -Recording device.

Electrodes will read the required signal from the overall head surface, amplifiers will bring the available microvolt signals into the range where they can always be digitalized accurately, converter also changes the signals from analog form to digital form, and personal computer will store and display the obtained data.In EEG, the brain-related electrical potentials are recorded from scalp. Pairs of conductive electrodes (see figure 1)also made of silver, arealso used to read this form of electricity. The difference in the voltage between the electrodes are measured, and since the signal is weak (30-100microVolt) it has to be amplified. Current occurs when neurons communicate. The simplest event is called action potential, and is a discharge caused by fast closing and opening of Na+ and K+ ion channels in the neuron membrane. If the available membrane depolarizes to some threshold value, the neuron will then "fire". The brain activity is revealed over time by tracking these discharges.

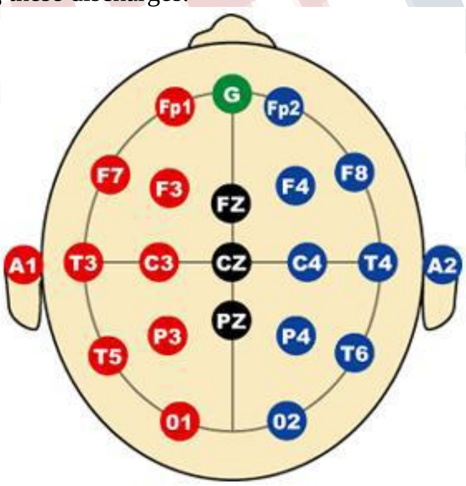

Figure1: The 1020 System Standardized placement of electrodes on scalp for EEG measurements.

V. BRAIN WAVE CLASSIFICATION

For obtaining the basic pattern of individual's brain, the subjects were also instructed to be very close to their eyes and relax. The patterns of Brain formsthe wave shapes that were generally sinusoidal. Usually, these are also measured from the peak to peak and the normal range is from 0.5 to 100 μV in the amplitude, which is almost about 100 times lower than that of the ECG signals. By the means of Fourier transform the power spectrum from the available unprocessed EEG signal is perfectly derived. Inthe power spectrum the comprises of sine waves with various frequencies are alsobrightly visible. Even though the spectrum is always continuous, the ranges are from 0 Hz up to one half of the sampling frequency, the individual's brain state may make various frequencies more and more dominant.

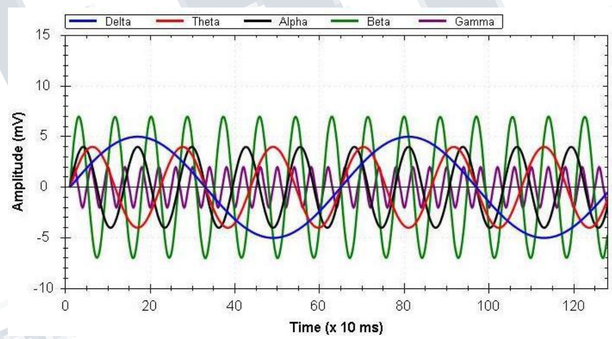

Figure2: The 5 main frequency bands and their relation to each other.

Alpha waves- have the frequency spacing of 8- 13 Hz; they can always be measured from the occipital regionin an awake person when the eyes are closed; alpha activity disappears normally with attention.
Beta waves– have a frequency band of 13 - 30 Hz, these can easily found over the frontal and parietal lobes and is usually represented as dominantrhythm andnormal rhythm in patients.
Delta waves- have the frequency spectrum of 0.5-4 Hz; they are easily detectable in all infants and sleeping adults, and can also be an indicative of damage in the cerebral or may be brain diseases.
Theta waves- has the frequency range of 4-8 Hz; these waves are obtained from children and sleeping adults; the

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theta activity occurs during drowsiness and in certain stages of sleep, being peculiar in wakeup adults but is absolutely normal in children up to 13 years and also when in sleep.

Gamma waves- have the spectrum of upper 30 Hz, and are connected to a variety state of active information processing of cortex.

Brain Computer Interface

Brain-computer interface (BCI) is a powerful software and hardware communication system which definitely enables humans to interact with the surrounding without any involvement of the peripheral nerves andthe muscles with the help of control signals extracted from electroencephalographic activity and also provides a communication path between human brain and the computer system.The EEG-based BCIs are basically divided into two different classes based on the mode of operation: dependent (cue-paced or synchronous) and independent (self-paced or asynchronous). In most of the cases, the basic functionalities of the EEG-based BCIs can be broadly categorized into four subsystems: signal acquisition, signal processing, translation of signal features into commands, and finally the application of the BCI for a specific usage. The schematic diagram of BCI is described as in Fig3

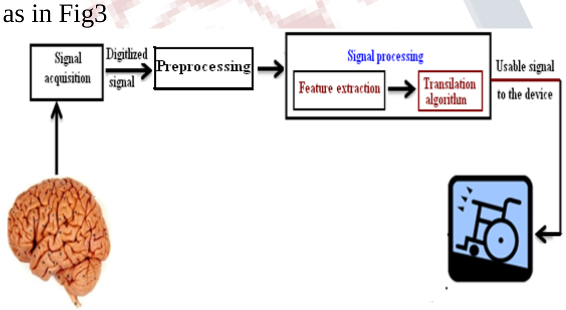

Figure3. Basic BCI system.

Signal acquisition is defined as a process of sampling signals which will measure the real world physical conditions and then converting the obtained resulting samples into digital numeric values which can be manipulated also by a computer. Data acquisition systems, abbreviated as *DAS* or *DAQ*, typically it converts analog waveforms into digital values useful for processing.

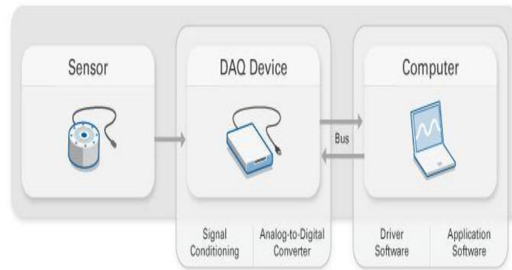

Figure4: Parts of a DAQ System

Parts of BCI

Like any communication systems, a BCI has an input, output (i.e. device commands), in which the components translate input into output, and also a protocol which determines the onset, offset, and timing of operation.

A Brain–Computer Interface (BCI), often called a Mind-Machine Interface (MMI), or sometimes also called as direct neural interface or a Brain–Machine Interface (BMI), is a direct communication channel between the brain and an external device. BCI system can be broadly divided into two important categories in terms of recording methods: an invasive and a non-invasive BCI. The invasive approach gives a much higher spatial resolution and also signal-to-noise ratio (SNR) when compared to the non-invasive. However, the non-invasive BCI type is considered to be very safe and more practical; hence, it is widely used by researchers worldwide to analyze the brain activities. A normal non-invasive BCI needs electrodes to be placed into the scalp of the human to supervise electrical activities of the brain, which can also be defined as electroencephalogram (EEG). Another non-invasive BCIs also include magneto encephalography (MEG) and positron emission tomography (PET). BCI also establishes a real-time interaction in between the user and the outer world. The user in return will receive feedback which will reflect the result of the BCI's operation, and that received feedback can also effect user's subsequent intent and its expression in the brain signals. The first step involved in creating an efficient and effective BCI pattern is to determine a compatible control signals generated from the EEG. An appropriate control signal has the corresponding attributes: (i)it can be precisely characterized for each and every individual;(ii) it can be readily modulated

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EEG Based BCI

Electroencephalography (EEG) is a one of the non-invasive interface, which has a very high electrical potential due to its very fine temporal resolution, ease of use, portability and a very low set-up cost. A general method used for designing a BCI is to use the EEG signals generated during mental tasks. EEG usually refers to the recording of the brain's spontaneous electrical activity over a very short period of time, usually 20 minutes to 40 minutes, as it is recorded from multiple electrodes that are directly placed on the scalp.

EEG Signal Classification

There are five major categories that covers the most widely used algorithms that can be used in these BCI classification systems, and those are: linear classifiers, nonlinear Bayesian classifiers, nearest neighbor classifiers, neural networks, and a combination of the above classifiers.

In all major categories there has been achieved good number of BCI results, except only for the nearest neighbor classifiers, which seems to not handle dimensionality very well. However, neural networks are very much popular in BCI research.

Neural Networks: Multilayer Perceptron:

Multilayer perceptron shows that the neural network comprises of an input layer, possibly and minimum one hidden layer, and one output layer, as shown in fig5

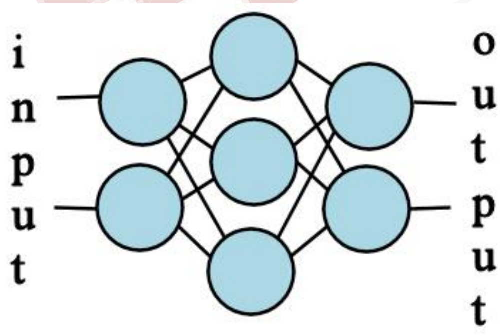

Figure5: Neural network: 2 input neurons, 3 hidden layer neurons and 2 output neurons.

VI. METHODOLOGY:

The Electroencephalographic i.e.,EEG signal processing system is used to recognize the electrical activities of brain to words and they are trying to speak out via speakers.

From a healthy controlled brain, the stimulus will be generated naturally and then the system will check whether the brain is ready for EEG acquisition and then if it is ready it starts the EEG recording if not means it will automatically check all the electrodes and connections and restart the process. After acquiring signal interpretation levels then pattern recognition is initiated and then matching is done by comparing with the trained word sequences and finally the output is sent via speaker. The schematic diagram is shown in fig 6.

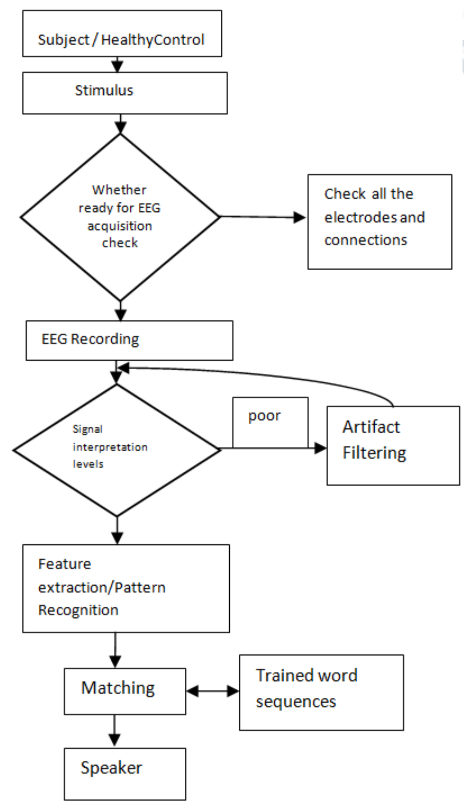

Figure 6: Schematic diagram(Working of this methodology)

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VII. CONCLUSION AND FUTURE WORK

EEGshows the present challenges in signal theory analysis. However in this paper EEG signal processing system is used to recognize electrical activity of brain to words and then those are trying to deliver them via speakers.This shows a new emerging area mainly the patients who suffer from severe motor impairments (like late stage of Amyotrophic Lateral Sclerosis (ALS), cerebral palsy, head trauma and spinal injuries).The fundamental element for such a communication system is known as “Brain Computer Interface”. However, in recent years, the focus has been changed from this main objective to various application areas like biometrics, games, virtual reality and also inmusic i.e.,(brain–computer music interface, or BCMI). An EEG-based BCI system has proved to be the most practical, portable and cost effective.Future work will be considered various more and more exotic classifiers such as fuzzy logic, neural networksor other hybrid pattern classifiers.

REFERENCES

[1] Antara Bhattacharya, Dr.N.G.Bawane,S.M. Nirkhi,“Brain Computer Interface Using EEG Signals”,G.H.R.C.E, Nagpur

[2] Saeid Sanei and J.A.Chambers, “EEG Signal Processing”, First Edition, ch. 1, p1 – p18, John Wiley and Sons Ltd., 2007.

[3] Z. Xizheng, W. Weixiong and Y. Ling “Wavelet time-frequency analysis of electro-encephalogram (EEG) processing,” (IJACSA) International Journal of Advanced Computer Science and Applications,vol. 1, no. 5, 2010.

[4] Eltaf Abdalsalam, Mohamed,Mohd Zuki B. Yusoff,Nidal Kamel Selman, and Aamir Saeed Malik ”Enhancing EEG Signals in Brain Computer Interface Using Wavelet Transform,”(IJIEE) Vol. 4, No. 3, May 2014.

[5]Anupama.H.S,N.K.Cauvery,Lingaraju.G.M”BRAIN COMPUTER INTERFACE AND ITS TYPES - A STUDY”, International Journal of Advances in Engineering & Technology, 2012.

[6] Blankertz, B., Dornhege, G., Krauledat, M., M¨ uller, K.-R., Kunzmann, V., Losch, F., (2006, June). The Berlin Brain-Computer Interface: EEGbased communication without subject training. IEEE transactions on neural systems and rehabilitation engineering

[7]Lotte,F.,Congedo,M., L´ecuyer, a., Lamarche, F., & Arnaldi, B. (2007, June). A review of classification algorithms for EEG-based brain-computer interfaces.Journal of neural engineering.

[8]Prof. Deepa.T.P., Vinay.H.S,” Classification of Motion and Speech Based Brain EEG Signals using Bilayer Bayesian Classifier with Association Rule (BBC-AR)”,International Journal of Computer Science and Mobile Computing, Vol.3 Issue.10, October- 2014, pg. 777-782.

[9] Benjamin Blankertz, Guido Dornhege, Matthias Krauledat, Klaus-Robert Müller, Volker Kunzmann, Florian Losch, Gabriel Curio,” The Berlin Brain-Computer Interface: EEG-based communication without subject training”,(ITNSRE) VOL. XX, NO. Y, 2006.

[10] Jonathan R. Wolpaw, Niels Birbaumer, Dennis J. McFarlanda, Gert Pfurtschellere, Theresa M. Vaughan,” Brain–computer interfaces for communication and control”, Clinical Neurophysiology 113 (2002) 767–791.

[11] Priyanka Abhang, Shashibala Rao, Bharti W. Gawali Pramod Rokade, ,Emotion Recognition Using Speech and EEG Signal –A Review. International Journal of Computer Applications,2011 by IJCA Journal, Number 3 - Article 7,Year of Publication: 2011 (Journal).