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# An Intelligent Acoustic Communication System for Aphasia Forbearings

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**ABSTRACT*:*** Communication is a process of transferring the information from one entity to another. Speech is one of the most common modes of communication. The person who suffers from severe motor impairment, severe cerebral palsy, head trauma and spinal injuries cannot able to express their thoughts in the form of speech. The development of direct neuro-control over virtual or physical devices would improve quality of life immensely for those who suffer from impaired communication skill. In this methodthe development of an Electroencephalogram (EEG) based Brain Computer Interface (BCI) system is proposed. The thoughts of the individual are extracted from the brain activity of a particular disordered patient and it is stored in the form of data.The word frequencies for basic essential requirements such as food, water and assisting work should be generated and the data is stored in matrix representation. Already obtained EEG signal and the word frequencies should be compared and the matched frequencies are stored separately. Finally, the matched frequencies of corresponding words are displayed using LCD display and then the words are converted into audible signal by using speech synthesizer.

**KEYWORDS*:*** Brain Computer Interface(BCI), Electroencephalogram(EEG), Liquid Crystal Display (LCD), SpeechSynthesizer.

## I.INTRODUCTION

The communication system for person with severe disabilities helps him to express thoughts for translating their actions into activity using BCI.BCI have been developed to address this challenge.BCI are systems that can bypass conventional channels of communication (i.e. Muscles and speech) to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time.

The patients who suffer from severe motor impariments (like late stage of Amyotrophic Lateral Sclerosis(ALS),severe cerebral palsy, head trauma and spinal injuries) cannot express their thoughts as healthy human beings because they are not capable of talking or moving. But still they are conscious and capable of performing mental tasks equivalent to healthy individual using brain signals.

EEG-based BCI techniques acquire, process, and then translate signals from brain activity into machine codesto providea directcommunication pathway between the brain and the external world. The acquisition of brain activity by EEG-based BCIs can be divided into two categories: invasive and noninvasive .Invasive BCIs use sensors inside the human brain to obtain high-quality brain-activity signals or to send external signals into the brain. Invasive systems provide a reliable manner for connecting neurons and devices based on appropriate surgical techniques. Noninvasive EEG-based BCIs, which measure the electrical activity of the brain using electrodes placed along the scalp skin, have been shown to provide a feasible method for communication of the human brain with external devices.

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The electroencephalogram (EEG) is a recording of the electrical activity of the brain from the scalp. EEG is used in the evaluation of brain disorders. Most commonly it is used to show the type and location of the activity in the brain during a seizure. It also used to evaluate people who are having problems associated with brain function. These problems include confusion, coma, and tumors, long-term difficulties with thinking or memory or weakening of specific parts of the body.

## EEG BRAIN SIGNALS AND RELATED TECHNIQUES

The waves recorded are thought to reflect the activity of the surface of the brain, the cortex. The nerve cells in the brain produce signals that are called action potentials. These action potentials move from one cell to another across a gap called the synapse. Special chemicals called neurotransmitters help the signals to move across the gap. There are two types of neurotransmitter: one will help the action potential to move to the next cell, the other will stop it moving to another nerve cell. The brain has to work hard to keep equal amount of each of these neurotransmitters in the brain.

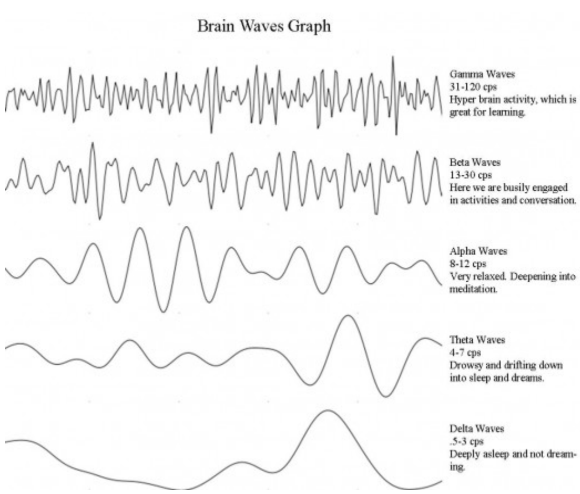


**Figure 1 :EEG activity dependent on the level of consciousness**

The figure 1 shows the frequency band of the beta waves is13-30 Hz; these are detectable over the parietal and frontal lobes. The alpha waves have the frequency spectrum of 8-13Hz and can be measured from the occipital region in an awake person when the eyes are closed. The theta waves have the frequency range of 4-8 Hz and are obtained from children and sleeping adults. The delta waves have the frequency range of 0.5-4 Hz and are detectable in infants and sleeping adults. The EEG signals are basically and closely related to the level of consciousness of a person. When the eyes of the subject are closed then alpha waves begin to have a very strong influence over EEG.

## II.EXISTING METHOD

A brain computer interface is a communication system between human brain and the computer that enables generation of control signals from brain signals such as sensory motor rhythms and evoked potentials therefore, it constitutes a novel communication option for people with severe motor disabilities. The methods are

1. The brain to computer interface (BCI): In this method a person sits in front of computer and his thought is transferred to the PC such that the person can able to communicate with the system without usage of keyboard and mouse.
2. Brain-to-brain interface (BBI): In this method, the interface is designed to allow a human to control an animal/human through his thoughts. Its function is by making the human wear a EEG-based BCI.A mouse on the other hand is made to wear a focused ultrasound (FUS) computer-brain interface (CBI). FUS allows a particular region of neurons in the rat's brain through an ultrasound signal.

## DISADVANTAGES

There is no displaying device for the thoughts of the person what they think in terms of any alphanumerical or symbol representation.

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## III.PROPOSED METHOD

Human communication, nonverbal information such as intention and emotions, plays an important role, especially by using information of emotion people can communicate with each other more smoothly. The emotion recognition systems in speech or facial expressions which have been used include several emotional states such as joy, fear, sadness, disgust,anger, surprise and neutral.The block diagram of Proposed method is shown in the Figure 2.

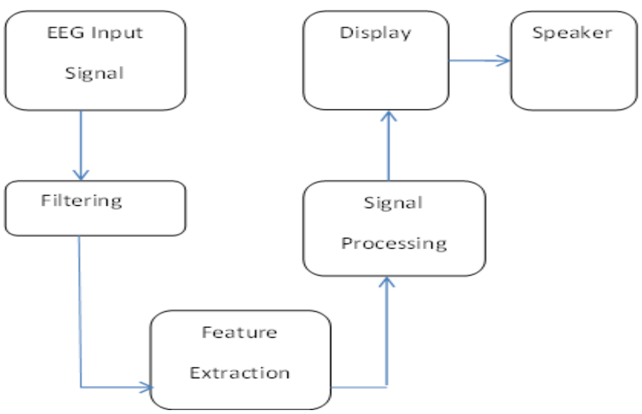


**Figure 2: Block diagram of proposed method**

The basic idea of BCI is to translate user produced patterns of brain activity into corresponding commands. A typical BCI is composed of signal acquisition and signal processing (including preprocessing, feature extraction, and classification).
Although some BCI systems do not include all components and others group two or three components into one algorithm, most systems can
be conceptually divided into signal acquisition, preprocessing, feature extraction, and classification.

***1) Suitable Brain Signals**:* The brain signals that are widely used to develop EEG-based BCIs include P300 potentials, which are a positive potential deflection on the ongoing brain activity
at a latency of roughly 300 ms after the random occurrence of a desired target stimulus from nontarget stimuli (the stimuli can be in visual, auditory, or tactile modality).

***2)Electroencephalogram Signal Acquisition and Processing:*** After the suitable brain signal used to develop the EEG based BCI is determined, EEG signal acquisition and processing need to be performed so as to build the BCI system.

***A)Signal Acquisition*:**EEG signals can be collected with electrodes that are placed on the surface of the scalp. The most widely used electrodes are silver/silver chloride (Ag/AgCl) because they have low cost, low contact impedance, and relatively good stability.

Another important issue of EEG acquisition is the locations on the scalp where electrodes are placed. Generally, the electrodes are placed according to the standard of 10–20 international system, which means that electrodes are located on the scalp at 10% and 20% of a measured distance from reference sites including nasion, inion, left, and right preauricular as
Shown in Fig. 4.The EEG signals are recorded at locations of the inferior frontal, central, and parietal

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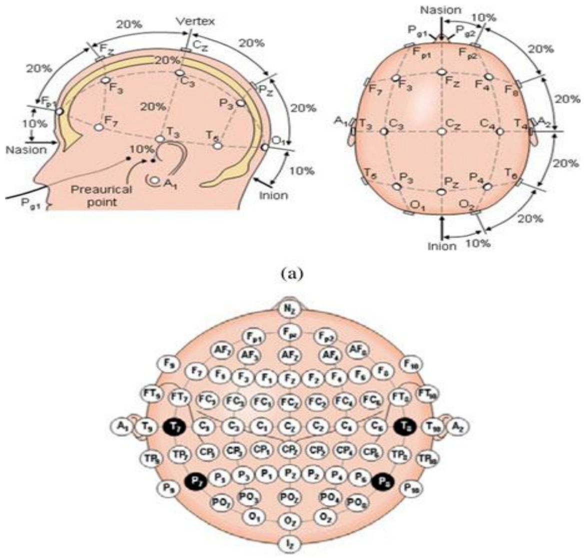


(a)

(b)

**Figure 3 :(a) International 10–20 system seen from left and above the head. (b) Full head view**.

regions (e.g., F3, F4, C3, C4, P3, P4, P7, P8, F7, and F8);for ERD BCIs, some electrode locations at frontal, central, and parietal regions are selected to acquire EEG signals (e.g., F3, F4, C3, Cz, C4, P3, Pz, and P4), whereas, for SSVEP BCIs, electrodes are placed at the occipital region (e.g., O1, O2, and OZ).

***B)Signal Processing*:**The acquired signals are first preprocessed in order to remove artifacts such as power line noise, electromyogram (EMG), electrocardiogram(ECG), electroculogram (EOG), and body movement. Features such as the inputs to the classifier are then extracted from the preprocessed signals. Finally, the classifier translates these extracted features into commands that subjects desire to output.

The simplest and most widely used method to remove artifacts is filtering including low-pass, high-pass, band-pass, and notch filtering, which is appropriate to remove line noise and other frequency-specific noise such as body movement. This is done before feature extraction to increase signal to noise ratio (SNR). This process is decomposing or de-noising the captured signal in order to remove noise andto enhance the EEG signal.Various steps are as follows.

1.Sampling - Signal is sampled at 128 Hz.
The range of beta and mu waves is 8 to 13 Hz and 13 to 30 Hzrespectively, so it is sampled.

2.Filtering-The traditional way to improve SNR is to filter the EEG signals using band pass filter. Here thesampled signal is subjected to low pass filter to blocksignals above 30 Hz.

3.Channelextraction - Processing the whole edf file iscomplex, so signal values from required channel areextracted out separately from the filtered signal.

4.Wave Decomposition - The length of the wave isdecreased by reducing the number of values in signaland retaining the original waveform. Here the signal isreduced to $1/4^{th}$ of the original signal using DiscreteWavelet Transformation (DWT) function.

We use EEGLAB to get the raw signal produced from emotive headset available in MATLAB. pop_biosig() function is used to make raw EEG signal in EDF format available in MATLAB. This function takes the pathname of EDF file and parameters.

***C)Feature extraction*:** To make classifiers of BCI systems have good performance, features that can significantly distinguish different classes are extracted. Features that are applied to BCI systems of brain-controlled mobile devices can be divided into two main categories: features in time domain which are typically amplitudes of event-evoked potentials and features in frequency domain, which are typically frequency power spectra of EEG signals that can be estimated with Welch's periodogram algorithm or other estimation algorithms.

***D)Classification*:** A variety of classifiers have been used to translate these extracted features from EEG signals into an output command, from simple classifiers such as nearest neighbor, linear discriminant analysis (LDA), to nonlinear neural networks(NN), support vector machines (SVM), and statistical classifiers.Here we assign a class to set of features extracted from the signal. This class corresponds to the kind of the metal state identified.

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The feature extraction and matching part are coded in MATLAB.

***E)Channel extraction*:**EDF file has raw EEG signal recorded with 35 channels. Processing the whole EDF file is complex, so signal values from required channel are extracted out separately from the raw EEG signal. We are interested in O7 and O8 channels among the 35 channel. It is the 9th and 12th row in 35*5632 matrix. The code to extract O1 and O2 channel is

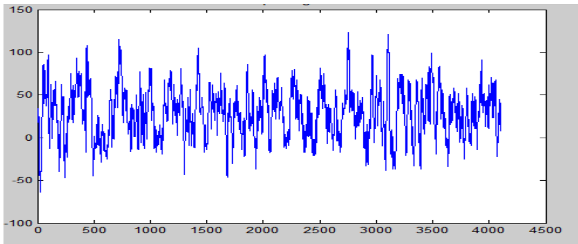


Figure 4:EEG signal taken from healthy person at O1

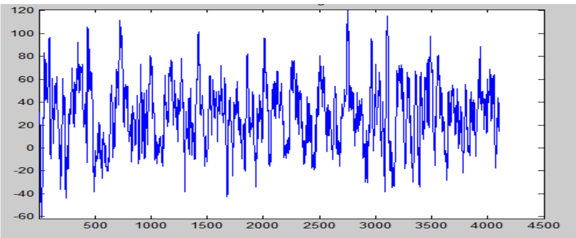


Figure 5:EEG signal taken from healthy person at O2

A number of digital signal analysis techniques have been developed and applied to represent the transient sound signals. Discrete wavelet transform is the most suitable of these techniques because ofits localization in both time and frequency.Wavelet transform is a spectral estimation technique in which any general function can be expressed as an infinite series of wavelets. The basic idea underlying wavelet analysis consists of expressing a signal as a linear combination of a particular set of functions (wavelet transform, WT), obtained by shifting and dilating one single function called a mother wavelet. The decomposition of the signal leads to a set of coefficients called wavelet coefficients.

Therefore the signal can be reconstructed as a linear combination of the wavelet functions weighted by the wavelet coefficients. In order to obtain an exact reconstruction of the signal, adequatenumber of coefficients must be computed. The key feature of wavelets is the time-frequency localization. It means that most of the energy of the wavelet is restricted to afinite time interval. Frequencylocalization means that the Fourier transform is band limited. The advantage oftime-frequency localization is that wavelet analysis varies the time-frequency aspect ratio, producing good frequency localization at low frequencies (long time windows), and good time localization at high frequencies (short time windows). This produces a segmentation, or tiling of the time-frequency plane that is appropriate for most physical signals, especially those of atransient nature.The wavelet technique applied to the EEG signal will reveal features related to the transient nature of the signal, which are not obvious by the Fourier transform. In general, it must be said that no time-frequency regions but rather time-scale regions are defined. All wavelet transforms can be specified in terms of a low-pass filter, which satisfies the standard quadrature mirror filter condition.

The extracted wavelet coefficients provide a compact representation that shows the energy distribution of the EEG signal in time and frequency. The frequencies corresponding to different levels of decomposition for Daubechiesorder-4 wavelet with a sampling frequency of 128 Hz.Inorder to further decrease the dimensionality of the extracted feature vectors, statistics over the set of the wavelet coefficients was used. The following statistical features wereused torepresent the time frequency distribution of the EEG signals: Maximum of the wavelet coefficients in each Sub-band. Minimum of the wavelet coefficients in each Sub-band. Mean of the wavelet coefficients in each sub-band.Standard deviation of the wavelet coefficients in eachsub-band.

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***F)Speechsynthesis*:**The textual data corresponding to the trained signal is given to the speech synthesizer. Speech synthesizer is the component that produces artificial speech for the given text as input. This allows java applications to incorporate speech technology in to the user interface. It defines a cross platform API to support to command and control dictation system.

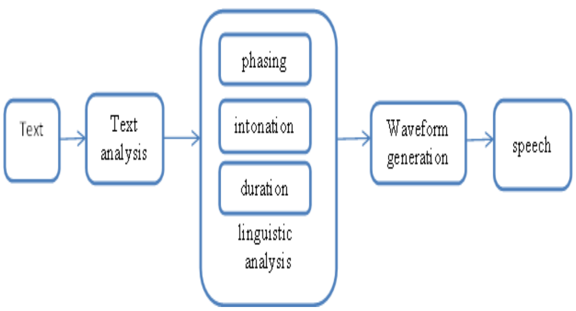


**Figure 6:Speech synthesizer block diagram**

Speech synthesis is the artificial production of human speech. A computer system used for this purpose is called a speech synthesizer and can be implemented in software or hardware.A text-to-speech (TTS) system converts normal language text into speech; other systems render symbolic linguistic representations like phonetic transcriptions into speech.

## IV.CONCLUSION

The human computer interaction in concern with the recognition of emotion in a person with the help of Electroencephalogram (EEG) signals and speech. EEG uses an electrical activity of the neurons inside the brain. EEG machine is used for acquisition of the electrical potential generated by the neurons when they are active. Speech is the most natural form of communication. A much of work is been done in speech recognition in various languages. It is one of the components that closely related to emotions. Very less work has been carried out using combine aspects of speech, emotion and EEG. Speech recognition is the process of converting an acoustic signal captured by a microphone or a telephone to a set of words. The recognized words can be the final results as for applications such as commands & control, data entry and document preparation.Emotion recognition by computers is becoming very popular.This paper attempts to present various techniques that can be used to recognize emotions using speech and EEG brain signals.

The communication system for person with severe disabilities helps him to express thoughts for translating their actions into activity using BCI. This improves the quality of life of dumb people. The advantage of this proposed work is there is no need of any caretakers for assistance of patients and can be controlled by user alone.

## REFERENCES

[1]StaffordMichahial, R.RanjithKumar,Hemath Kumar P,Puneeth Kumar A,Speech synthesizer And Feature Extraction using DWT with classification By Euclidian Distance and neural network of EEG signals, International Journal of Advanced Research in Computer and Communication Engineering Vol. 1, Issue 4, June 2012.

[2]Lun-De Liao,Chin-Teng Lin,Kaleb McDowell,Alma E. Wickenden,Klaus Gramann, Tzyy-Ping Jung,Li-Wei Ko,Jyh-Yeong Chang, Member,IEEE, Biosensor Technologies for Augmented Brain-Computer Interfaces in the Next Decades, Proceedings of the IEEE Vol. 100, May 13th, 2012.

[3]Luzheng Bi, Xin-An Fan, and Yili Liu, Member, IEEE,EEG-Based Brain-Controlled Mobile Robots:A Survey, IEEE transactions on human-machine systems, vol. 43, no. 2, march 2013.

[4] Priyanka Abhang,Shashibala Rao,Bharti W. Gawali,Pramod Rokade, Member,IEEE, Emotion Recognition using Speech and EEG Signal – A Review,International Journal of Computer Applications (0975 – 8887)
Volume 15– No.3, February 2011.