International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 8, Issue 2 (August 2013), PP. 62-67

Electroencephalographic Signals for Recognizing Speaking Effort –Brain Computer Interface

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Abstract:- This research paper will explore the possibility of using Electroencephalographic (EEG) signals for recognizing unspoken speech (trying to speak but not converted into speech). Significant brain activations may be observed in Functional Magnetic Response Imaging (fMRI Images) & EEG signals related to speaking effort. .Brain activity patterns generated from speaking effort may be interpreted into words. .When a person tries to speak we can identify the intensities of blood flow and oxidization in brain and in those regions electrodes of EEG may be placed. From those electrical signals speaker effort will be captured and matched with library patterns. This process leads to interpretation of brain signals to words. But however we come across a basic problem that temporally correlated artifacts may interfere the signals to be recognized.

Index Terms:- EEG,fMRI, wavlet sub band coding , pattern recognition

I HISTORY *(LITERATURE SURVEY)*

This paper will deal with the possibilities to make use of EEG based recognition system for people with speaking disabilities. Human brain requires adequate oxygen for its proper functionality. Due to various reasons like hypoxic injuries - inadequate oxygen in brain lead to speaking disability. Acquired brain impairment can occur as a result of trauma, hypoxia, infection, tumor, accidents, violence, substance abuse, degenerative neurological diseases or stroke or because of age. This leads to partial or permanent disabilities. If oxygen is not available for more than four minutes then serious injuries take place. Because of this permanent disability may take place, a person may acquire mild, moderate and even severe speaking loss, this may be since infancy or after learning to speak. Acquired brain impairment is injury to the brain that results in deterioration in cognitive, physical, emotional or independent functioning.

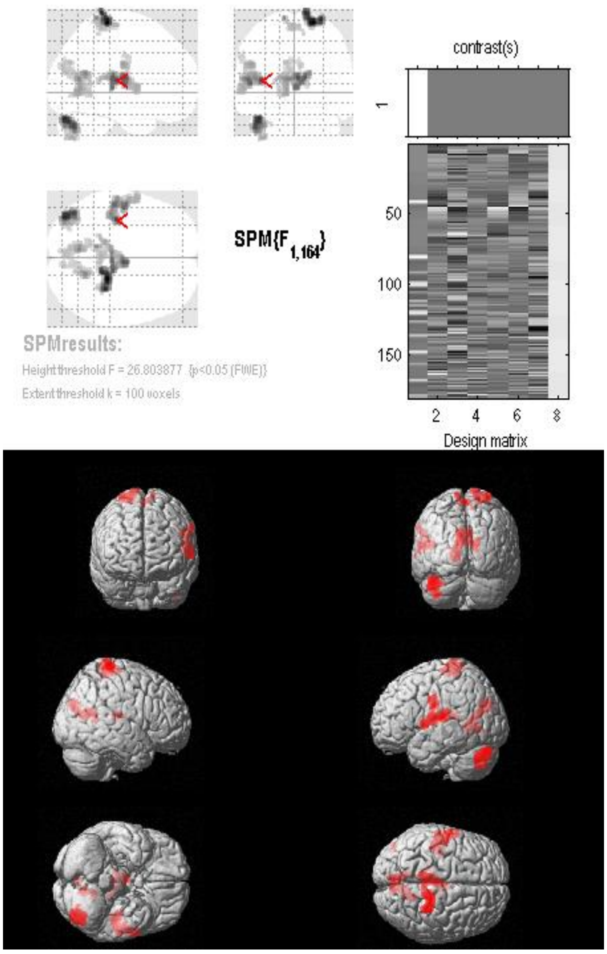
When I was working for a Research institute of neuro science I observed many subjects lost speaking ability after they learned to speak. I started planning for a new effective EEG based brain computer interface. Initially using fMRI scans with speaking paradigms on healthy subjects I collected statistical average of brain activations and mapped to a medium size head. Then I initially identified 10 electrodes for subjects and then optimized them to 8 after many experiments. I also started a parallel work to understand these EEG signals using discrete wavelet transform. The generation of baby wavelets led to separation of electrical signal into bands and sub bands. Then I started experimenting on brain signals by capturing and mapping to a list of pre defined set of words. These experiments were carried on healthy subject this gave me liberty to explain the subjects about the experiment and also to get the evaluation of EEG-DWT test and it also led to substantial improvements in my algorithm.

Most scientists are unaware that thought reading by electroencephalogram (EEG) was reported as feasible in work begun over 30 years ago, I which more recently a number of groups confirm by Electroencephalography (EEG), Magnetoencephalograpy (MEG), and functional Magnetic Resonance Imaging (fMRI) technologies. This review focuses on literature relating to technologic thought reading, though also treated are the discrimination of more general cognitive states, brainwave capture methods, and reports of thought reading development, apparently covert to open literature. In addition to vocabulary knowledge, everyday communication requires the timely retrieval and processing of words (i.e., lexical efficiency). Word production and word comprehension both require efficient selection and discrimination of the intended words from potentially competing words. Such processes typically implicate activation in left frontal lobe regions (Noppeney, Phillips, & Price, 2004; Thompson-Schill, D'Esposito, & Dan, 1999; Wagner, Pare-Blagoev, Clark, & Poldrack, 2001). If so, inter-subject variability in lexical efficiency may correlate with structural differences.

I.I Brain Activation areas for Hearing effort

Significant brain activations can be observed in fMRI (Images)& EEG signals related to speaking effort(hearing). When a person is trying to speak we can observe the intensities of blood flow and oxidization in the brain in a area of interest and we can distinguish to that of normal speech generation. The human brain is one of the most intriguing aspects of biological, medical and also philosophical research. The research deals with increased activations in articulation, cerebellum, brocas, supramarginal gyri areas and the results related to EEG and wavlet sub band coding are discussed in terms of cognitive neuro and language control process. Then a FPGA based filter array may be designed to analyze and understand the EEG speech signals.

Using the basic example fMRI image fig 1.1.1 which is processed on SPM8 package on MATLAB we may be able to know the basic areas of interest where activations are more in the brain (articulation (anterior insula) , cerebellum, brocas, supramarginal gyri areas). We can understand the brain functional areas for hearing effort can be summarized using the table .Here we can understand various brain areas responsible for hearing effort ,hearing process and communication process and speech.



The image is taken On the SIEMENS 3.0 Tesla fMRI machine (fig 1.1.1)

These prior studies provide good evidence that brain structure correlates with vocabulary knowledge, but do not indicate if these regions are sensitive to the efficiency of word use. Bilingual and multilingual speakers vary in the efficiency with which they use words and also in the age at which they acquired their second language. Both factors may influence or be influenced by different brain regions. Even the sheer number of languages learned might influence inter-subject variability in brain structure We first describe our measures and then our predictions and expectations.

These brain activation areas theory can be well used for electrode placement in EEG data acquisition. Then we can collect data from electrodes related to gyrus.

II EEG SIGNAL PROCESSING

II.I Electroencephalograph

Electroencephalographic Signals are very complex that will provide underlying electric activity of brain . The waves are taken from scalp they have very less electric potentials 1 to 400µV and frequency ranges
Delta (δ) 0.5-4.0 Hz,
Theta(Ǿ) 5-7 Hz,
Alpha(α)(8-13Hz),
Beeta (β) 14-30Hz,and
Gamma(γ) ≥30Hz
The EEG signals characteristics are highly dependent on
Degree of cerebral activity.

This research paper will explore options to recognize human emotion from brain signals measured with EEG device. Literature survey will be performed to establish a suitable approach and determine the limited number of electrodes for emotion recognition.

This research will be carried out relaying on scientific methods and experimentation.The field research and subject studies are designed considering the assumption that there is not just a single answer for any situation.Subject studies will be conducted in laboratory environments and the data will be gathered by using 32 channel EEG signal acquisition. This contains Controlled experiments where subject need to concentrate on what he/she try to say and Think free experiments. Interaction assessment will be carried by physiologist and other team members. Post experiment survey will be conducted.As the main goal of this research is emotion recognition, the optimal electrode placement for the five electrodes will be chosen .A suitable paradigm will be designed to take samples this will be done based on empirical validation and validation through interaction.

II.II EEG STEPS

The use of EEG signals as a vector of communication between men and machines represents one of the current challenges in signal theory research. The principal element of such a communication system, more known as "Brain Computer Interface", is the interpretation of the EEG signals related to the characteristic parameters of brain electrical activity.

The common structure of a Brain-Computer Interface is the following:
1) Signal Acquisition: the EEG signals are obtained from the brain through invasive or non-invasive methods (for example, electrodes).
2) Signal Pre-Processing: once the signals are acquired, it is necessary to clean them.
3) Signal Classification: once the signals are cleaned, they will be processed and classified using Discrete wavlet transform to find out which kind of mental task the subject is performing.
4) Computer Interaction: once the signals are classified, they will be used by an appropriate algorithm for the development of a certain application.
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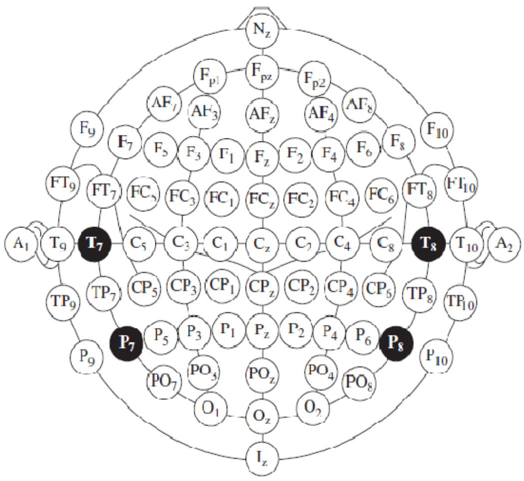


From Wikipedia

II.III EEG Elctrode placement

Imagined speech (silent speech or covert speech) is thinking in the form of sound – "hearing" one's own voice silently to oneself, without the intentional movement of any extremities such as the lips, tongue, or hands.
Logically, imagined speech has been possible since the EEG data may be interpreted to convert it into words.

So electrode placement is very important .as well as data obtained using alternative non-invasive, brain–computer interface (BCI) devices.

Healthy control EEG data collection

Arousal: excitation presented a higher beta power and coherence in the parietal lobe, plus lower alpha activity.
Dominance: strength of an emotion, which is generally expressed in the EEG as an increase in the beta / alpha activity ratio in the frontal lobe, plus an increase in beta activity at the parietal lobe.

Here subjects / Healthy controls EEG recordings are taken once they don't have any questions .Initially we will be checking whether the data taken from EEG is readable then from the EEG recordings features may extracted and healthy control will write which word he imagined using notebook .Then they will stored in a training system .Many experiments need to be conducted so as to get the output for wide variety of words. So the training process goes for very long duration.

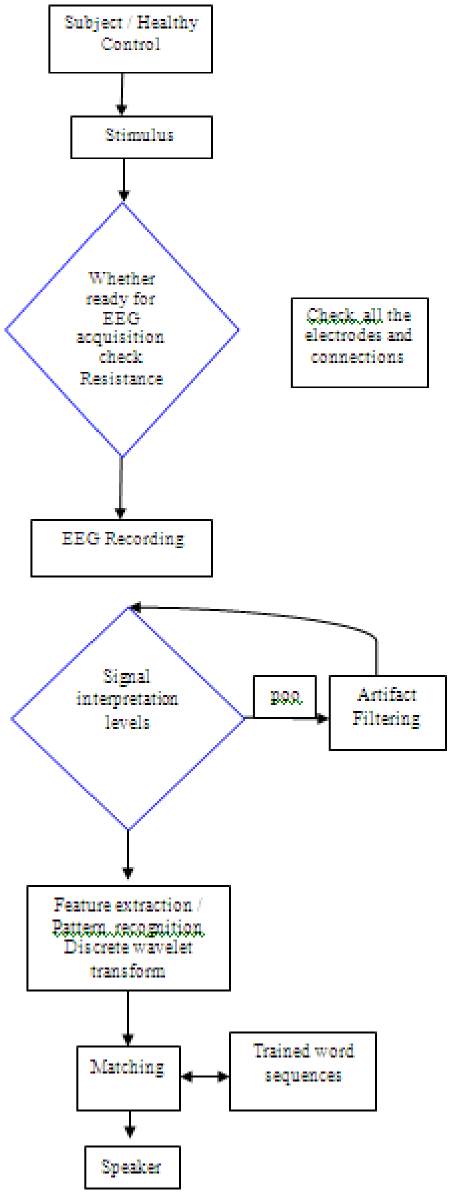
Once the training process is completed now we can go for trail experimentation on subjects who may locked or other people with speaking disabilities this section their EEG are recorded and then artifact filtering is done .Then the data will be processed to match the words from training section .

EEG is typically recorded by contact electrodes with conductive paste, while MEG detectors are in an array slightly removed from the head. Remote detection of brain rhythms by electrical impedance sensors is described. Though non-contact is the only remote descriptor for EEG, this same detector design is applied to monitoring electrocardiogram with wrist sensor location. Passive brain wave fields extend as far as 12 feet from man as detected by a cryogenic antenna. This device is entirely adaptable to clandestine applications, and pointed comments are made on the disappearance of physiological remote sensing literature since the 1970's for animals and humans, while all other categories of remote sensing research greatly expanded.

Remote electric field determination of such a resultant waveform for decoding the encephalogram does have covert development indication by news reports. The potential for thought reading and such a remote capacity is cautioned by French government scientific panel. At various levels of remoteness numerous methods or potentially exploitable mechanisms for detecting brainwave activity are described in open literature.

EEG cortical potentials are detected for both actual movement, and movement readiness potentials (bereitschafts potential). EEG sufficiently differentiates just the imagination of movement to operate switches, move a cursor in one or two dimensions, control prosthesis grasp, and guide wheel chairs left or right for prompted responses. EEG detects such potentials to play Pac Man, and imagining the spinning of cubes, or arm raising in appropriate direction guides robots through simulated rooms, both achieved without response prompting. Unprompted slow cortical potentials also can turn on computer programs. Signals from implanted brain electrodes in monkeys achieve even more complex grasping and reaching robot arm control without body arm movement. Some ability to recognize evoked responses to numbers and tones in real time by a commercial system called Brain Scope has limited report.

Though victims will regard their experience to affirm such a thought reading capability, professional prejudice classifies such complaints as within Schneiderian symptoms defining psychiatric condition. The certain fact is that these claims have had no adequate investigation, and the available evidence questions the routinely egregious denial of civil rights to such individuals. Complaints involving mind reading must at least receive rational investigation rather than ignorant professional dismissal convenient to practice with lucrative livelihood benefit.



III WAVELET SUB BANDING OF EEG SIGNALS

Wavelet transformation has been applied in wide variety of engineering analysis. It includes machinery fault diagnosis, in particular, time–frequency analysis of signals, fault feature extraction, singularity detection for signals, de-noising and extraction of the weak signals, compression of vibration signals and system identification. By combining the time domain and classical Fourier analysis, the wavelet transform provides simultaneously spectral representation and temporal order of the signal decomposition components, which is also applied to perform the analysis of NDE ultrasonic signal received during the inspection of reinforced composite materials. Wavelet transform can be used to process acoustic emission signals to find faults such as micro-failure modes and their interaction in composites.

$$w(a,b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} f(t)\psi\left(\frac{t-b}{a}\right)dt$$

Where
a is the dilation factor,
b is the translation factor and
$\psi(t)$ is the mother wavelet.
$1/\sqrt{a}$ is an energy normalization term that makes wavelets of different scale has the same amount of energy.
The digital filter used in the EEG waves classification is 4th order pass band Elliptic filter, and the setting of the band pass frequencies is from (3-to-30) Hz. The filtered signals have only EEG waves (delta, theta, alpha, and

beta) so this means that undesired frequencies (such as spikes) have been rejected. The main feature extracting from this is that the signals contain low frequencies

IV PROPOSED EXTRACTION METHOD

The coefficients of DWT for a particular decomposition level represent the degree of correlation between the EEG signal, x(t) and the wavelet function, ψ(l,n)(t) at different instances of time. These coefficients carry useful information about the transient activity of the EEG signals. Therefore, we propose to use these DWT coefficients as features for the emotion recognition experiment. The proposed feature extraction method fully utilizes the time-frequency analysis of the DWT by preserving the temporal information contained in the coefficients.

In this paper, we also study the effect of using different wavelet functions on the performance of the emotion recognition system. The waveforms of the wavelet function should be as similar to the transient activity to be detected in the EEG signals. However, since the optimal waveform for isunknown, various types of wavelet function were considered: Daubechies ('db4') Order 1 to 20, Symlets ('sym') Order 1 to 20 and Coiflets ('coif') order 1 to 5.

V CONCLUSION

Experimental results showed large variation in emotion classification performance for other types of wavelet functions. These results indicate the critical importance of choosing the right type of wavelet function for emotion recognition from EEG signals. With this knowledge I strongly believe that unspoken speech may be seen as text. My speaking aid may be helpful for disabled and it significantly improves their confidence. However substantial improvements are required both in algorithm and EEG device to elevate this sevice to a commercial scale.

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