

EEG SIGNAL AS AUTHENTICATION SYSTEM

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Abstract –In security related areas human identification holds a key factor. This paper discusses the usage of EEG signal for biometric system as EEG signal varies from person to person and is impossible to replicate. Data was collected from 10 persons while resting with their eyes closed at four different instants of time. A single channel portable equipment was used for data collection. Fast Fourier Transform was used for feature extraction process of the data signal and Linear Discriminant Analysis was used for classification.

Keywords – EEG, Feature Extraction, Fast Fourier Transform, Classifier, Linear Discriminant Analysis

I. INTRODUCTION

Biometrics is to identify or measure individuals based on unique physical or behavioural characteristics as a mean to recognize or authenticate their identity. The factors on which biometric is evaluated are universality, uniqueness, permanence, measurability, performance, acceptability and circumvention [1]. Biometrics such as fingerprint, voice and retina can be damaged physically. In recent times researchers have succeeded in applying the EEG signal for identification of individuals. The EEG is the summation of electrical activity of billions of nerve cell connection inside the brain. It is measured using electrode placed on various locations on the scalp depending on number of electrodes used. Electroencephalographic reading is a completely non-invasive procedure that can be applied repeatedly to patients, normal adults, and children with virtually no risk or limitation. When brain cells (neurons) are activated, local current flows are produced. EEG measures mostly the currents that flow during synaptic excitations of the dendrites of many pyramidal neurons in the cerebral cortex. Poulos et al. suggested the use of EEG signal for biometric purpose[2]. Brain signals have several advantages over other biometrics. Brain signals are not exposed and they are very difficult to fake which leads to a very secured biometric. EEG can be recorded continuously which allows for continuous authentication. Brain signals are related with the subject's genetic information making them unique for each individual.

II. DATA EXTRACTION

The EEG signals collected or the analysis were got from the single channel portable equipment which collects signals from the forehead sensor without any skin preparation or gel. Reference sensors were placed at the left earlobe. In this paper EEG data were recorded for 10 subjects for 2 minutes duration. Four samples were got from each subject at different intervals of time. Each part of the brain is responsible for a certain mental or physical activity. The identification technique will require that the user perform a certain mental task. Accordingly this task will trigger neurons in a certain parts of the brain that is responsible for handling such task. Several

tasks can be given to the subjects to perform while acquiring the signal which was described by R.Palanippan [3]. Those were:

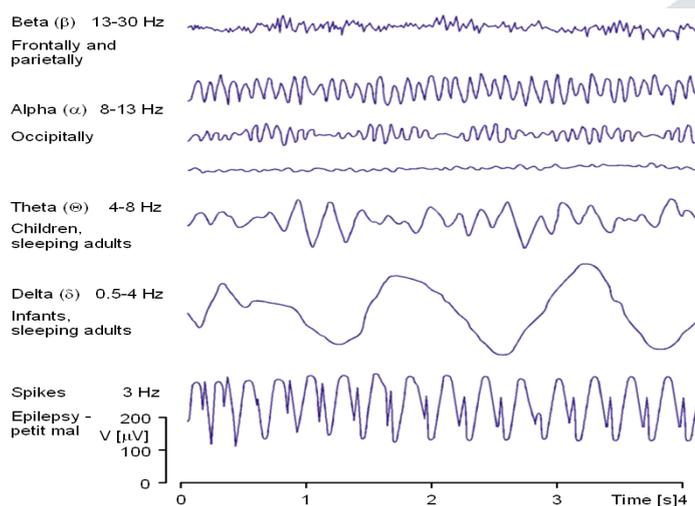
- Baseline task: The subjects were asked to relax with their eyes closed and think of nothing in particular. This task was used as a control and as a baseline measure of the EEG signals.
- Geometric figure rotation task: The subjects were given 30s to study a particular three-dimensional block object, after which the drawing was removed and the subjects were asked to visualize the object being rotated about an axis. The EEG signals were recorded during the mental rotation period.
- Math task: The subjects were given nontrivial multiplication problems and were asked to solve them without vocalizing or making any other physical movements. The tasks were non-repeating and designed so that an immediate answer was not apparent. The subjects verified at the end of the task whether or not he/she arrived at the solution and no subject completed the task before the end of the 10s recording session.
- Mental letter composing task: The subjects were asked to mentally compose a letter to a friend or a relative without vocalizing. Since the task was repeated for several times the subjects were told to continue with the letter from where they left off.
- Visual counting task: The subjects were asked to imagine a blackboard and to visualize numbers being written on the board sequentially, with the previous number being erased before the next number was written. The subjects were instructed not to verbalize the numbers but to visualize them. They were also told to resume counting from the previous task rather than starting over each time. Different tasks have been used; the most used task was just letting the subject stay still in a quiet environment and relax; then capture the signal for a period of time to identify the user. The EEG signal was sampled at 512Hz to get samples of 10240 for data acquisition. The headset used in this, filters out the noise which exist from 3Hz-100Hz.

III. FEATURE EXTRACTION

EEG signals are sinusoidal waves their amplitude is normally between 0.5 and 100 μ V. The EEG waves are classified into following types based on frequency:

- Delta:** It has a frequency of 4 Hz or below. It tends to be the highest in amplitude and the slowest waves. It is normal as the dominant rhythm in infants up to one year and in stages 3 and 4 of sleep. It may occur focally with subcortical lesions and in general distribution with diffuse lesions, metabolic encephalopathy hydrocephalus or deep midline lesions. It is usually most prominent frontally in adults and posteriorly in children.
- Theta:** It has a frequency of 4 to 8 Hz and is classified as "slow" activity. It is perfectly normal in children

up to 13 years and in sleep but abnormal in awake adults. It can be seen as a manifestation of focal subcortical lesions; it can also be seen in generalized distribution in diffuse disorders such as metabolic encephalopathy or some instances of hydrocephalus. **(iii)Alpha:** It has a frequency between 8 and 13 Hz. Is usually best seen in the posterior regions of the head on each side, being higher in amplitude on the dominant side. It appears when closing the eyes and relaxing, and disappears when opening the eyes or alerting by any mechanism (thinking, calculating). It is the major rhythm seen in normal relaxed adults. **(iv)Beta:** Beta activity is "fast" activity. It has a frequency of 13 and greater Hz. It is usually seen on both sides in symmetrical distribution and is most evident frontally. It is accentuated by sedative-hypnotic drugs especially the benzodiazepines and the barbiturates. It may be absent or reduced in areas of cortical damage. It is generally regarded as a normal rhythm. It is the dominant rhythm in patients who are alert or anxious or have their eyes open. The wave pattern of EEG signal is shown in Figure 1.



Figure(1): Brain wave with dominant frequencies

Feature extraction involves extracting those features of the signal that display certain characteristic properties of EEG signal that are unique to the signal and are thus suitable for the classification purpose. Extracting these features also reduces the amount of data that is fed to classifying machine and thus reduce the processing time. Alpha waves predominantly originate from the occipital lobe during wakeful relaxation with closed eyes. For this reason we extract Alpha waves from the EEG signals. Features can be extracted using Fourier Transform [4], AR Model [5]. In this paper we use Fast Fourier Transform for feature extraction. Features are extracted by selecting frequency band of interest two different frequency bands are used for feature extraction. Figure (2) shows power spectral density of two subjects in the band. The spectral distribution is unique that is the interclass variation of the power spectrum in the alpha band is large. Therefore the spectral analysis is effective for feature extraction from the alpha wave. Figure 2 shows the power spectral density of two subjects.

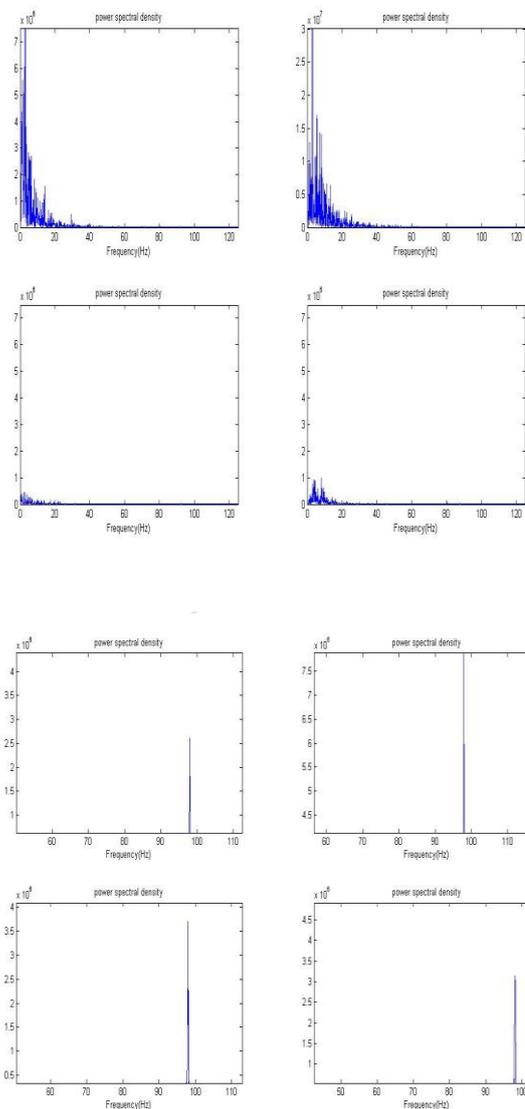


Figure (2) Power Spectral Density of 2 subjects

IV. CLASSIFICATION

Some of the classifiers used for classification of EEG signals are Artificial Neural Network Classifier, Support Vector Machine. One way to classify data is to first create models of the probability density functions for data generated from each class. Then, a new data point is classified by determining the probability density function whose value is larger than the others. Linear discriminant analysis (LDA) is an example of such an algorithm. W.Khalifa et al. [6] proposed that one of the efficient method of classification of EEG signals was by using Linear Discriminant Analysis. Figure (3) shows the LDA classification between 2 subjects.

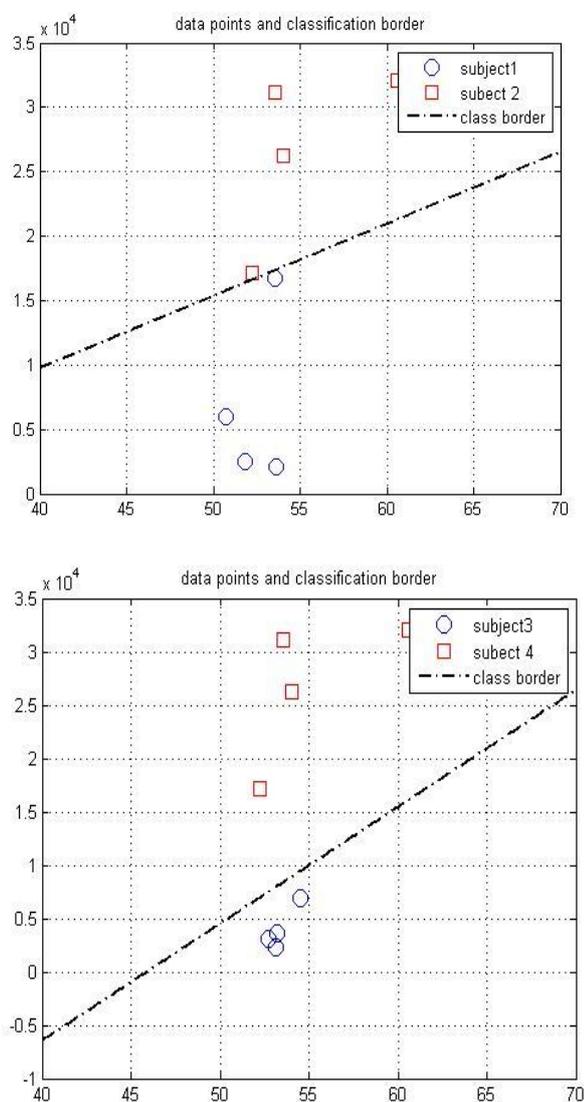


Figure 3: Classification result of 2 subjects

V. CONCLUSION

In this paper, the single channel EEG signals were recorded by portable equipment with subject is in resting state and eyes closed. The overall system performance was achieved with an average accuracy of 70% on a dataset of 10 subjects. This study showed that EEG based personal identification could be implemented practically. Further other factors which might affect the identification performance will be taken up to study and also the feasibility of this system for large number of subjects will be checked. Also the alternate methods of feature extraction and classification can be checked.

REFERENCES

- [1] A.Jain,R.Bolle and S.Pankatti, "Biometrics Personal Identification in Networked Society",KluwerAcademic Publishers, Massachusetts ,2001
- [2] M.Polous ,M .Rangoussi, N . Alexandris "Person Identification based on parametric processing of the EEG" .IEEE Proceedings on Electronics Circuits and System ,(1):283-286
- [3] Ramaswamy Palaniappan,"Multiple Mental Thought Parametric Classification :A New Approach for Individual Identification", Proceeding of International Journal of Signal Processing ,Volume 2, pp.222-226,2006
- [4] Isao Nakanishi, Sadanao Baba and Chisei Miyamoto "EEG Based Biometric Authentication Using New Spectral Features" 2009 International Symposium on Intelligent Signal Processing and Communication Systems", pp.651-654, December 2009
- [5] Hu Jian-Feng , "Biometric System based on EEG signals by feature Combination", Proc of 2010 International Conference on Measuring Technology and Mechatronics Automation
- [6] W.Khalifa,A.Salem,M.Rousdy,K.Revett "A Survey of EEG Based User Authentication Schemes" The 8th International Conference on Informatics and Systems 2012, BIO55-60
- [7] Zhu Dan, Zhou Xifeng, Guo Qiangang "An Identification System Based on Portable EEG Acquisition Equipment" 2013 Third International Conference on Intelligent System Design and Engineering Applications, pp 281-284.
- [8] Howida Abdel Fattah Shedeed "A New Method for Person Identification in a Biometric Security System Based on Brain EEG Signal Processing" IEEE 2011 World Congress on Information and Communication Technologies, pp 1205-1210
- [9] Daria La Rocca,Patrizio Campisi,Gaetano Scarano "EEG Biometrics for Individual Recognition in Resting State with Closed Eyes" 2012 International Conference of the Biometrics Special Interest Group .
- [10] Kenneth Revett, Farzin Deravi and Konstantinos Sirlantzis "Biosignals for User Aunthentication-Towards cognitive Biometrics?" 2010 International Conference on Emerging Security Technologies.