5th SASTech
Iran | Mashhad
May 12 - 17 | 2011
5th Symposium on Advances in Science & Technology

Early Recognition for Mild Alzheimer's Disease

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ABSTRACT

The initial aim and motivation of this research is planning and providing a system for Diagnosis and identification of Alzheimer patients on light step from the old health individuals.Considering the specifications of EEG[1] and the way of this sickness with different specifications in brain signal، this sickness may be diagnosed within the primary step through an adequate process.

First of all، the brain signal has been registered in four state of: closed eye، opened eye، booster and irritation from three Pz،Cz،Fz channels.Seeing the registered protocol، on the booster period، during 1 minute to the signal registration while the patient remembers the images and during the irritation state and considering the audible sample، the responding manner of subject to the voice of aim are investigated: then، other processes within the frame of time and frequency such as indicating statistical specifications correlation، spectral analysis and deduction of different non linear specifications such as liapanov exponent،correlation dimension and anthropy are done by considering the nonlinear and turbulent nature of the brain signals. Then، by using the variance analysis the optimum specifications were drawn out by using the two claaaifier LDA[2] and Elman.

According to the drawn out results، it became clear that among the three channels Pz،Cz،Fz and four states of closed eye، opened eye، booster and irritation، the exactitude Pz channel and the state of irritation are more in comparison with the channels and other states. The accuracy of channel Pz result during remembering and irritation period with the selected specifications of the variance analysis through linear selector are respectively 59/4% and 66/4% and in nervous system the exactitude is respectively 92/3% and 94/1%.

Keywords: Mild alzheimer's disease, EEG, variance analysis ,LDA, Elman.

1-Introduction

[1] Electroencephalography
[2] Linear Discriminant Analysis

Alzheimer is a disease which decreases the mental power and is commonly seen in elderly people. Among the dominant symptoms of this disease are-memory loss, lack of judgment ,rationality power ,and crucial changes in behaviors. At the present time there is no way of diagnosing and certain method of cure for this disease[7]. The number of Alzheimer patients in Iran has been doubled to 2.2 during 13 years[2]. Furthermore, the treatment costs are too expensive and caring and nursing them are much difficult. It last too many years from the occurrence of early symptoms to approaching to sever status of disease. in case of not diagnosing it in the proper time ,the new method of cure will not be effective. The best solution is to identify the mechanism of this disease an d its effect on the brain signals and attaining this goal is demanding and extremely difficult, because of dynamic characteristic of ERP[3],EEG signals as well as the sophisticate nature of this syndrome. For the time being, there are different methods in the field of imaging for diagnosing it. At the same direction, two issues are of great importance. First is the substantial cost of the processes of cure and the second is lack of certainty in the result attained[7],[8]. Therefore, it is vital to seek for less expenditure methods with the appropriate accuracy and precision.

2-Methods and materials

In this study, 32 people including healthy, patients with severe and less severe state have been selected. Prior to any activity, they have been examined by a physician through clinical test. The procedures are as following.

2-1- Clinical diagnosis of testees

One of the suitable criterion for labeling testees is MMSE[4]. There is also another test named DRS[5]

Illiterate	Literate	State
22≤ MMSE < 30	23≤ MMSE < 30	healthy
0< MMSE < 22	0< MMSE < 23	AD[6]
19≤ MMSE < 22	20≤ MMSE < 23	Slight AD

[3] Event Related Potential
[4] Mini-Mental State Examination
[5] Dementia Rating Scale
[6] Alzheimer Disease

0< MMSE < 19	0< MMSE < 20	Severe AD

Table 1.MMSE threshold for literate and illiterate person

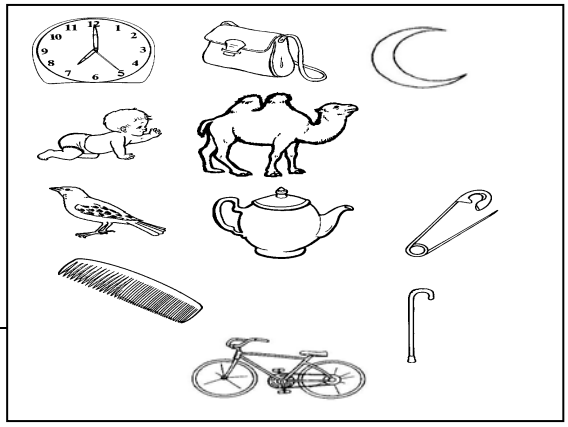
2-2-Recording the brain signal

To record brain signals, three canals P_z ,C_z, Fz of uni-polar have been used.Because the goal is to record total activities of brain and for the study of EOG activity procedure and its effect on electrical activity of brain in an Alzheimer patient, a bi-polar canal has been applied to record electrical activity of the eye.

To record brain signals of testee the following procedures have been employed:

1. teaching testee,2.recording with closed -eye for 1 minute,3. Recording with open- eye for 1 minute,4.recording the testee's signals during performing tasks assigned to him including remembering the shapes displayed and counting the targeted and untargeted sounds in the listening Oddbbal exemplar[7] . Labeling on the testee, the physician explained the four steps and procedures and the characteristics of targeted and untargeted sounds. When the testee is prepared the second step is administrated. The signals are recorded in closed –eye state for 1 minute. In the third step, the testee is required to open his eyes to register the signals for 1 minute. Following this step. some pictures figure 1 were showed to testee for 1 minute. Then he was asked to close his eyes and retrieve them in his mind while his signals are recorded for one minute and consequently he was required to open his eyes and describe the pictures one by one with a loud voice. In the final stage, the testee is taught to distinguish the targeted and untargeted sounds by pressing the right key for target sound an d the left key for untargeted sound. Then the two sounds with the frequencies of 1 and $1.5k_{hertz}$, were played randomly. The interval between stimuli is 2 seconds. Regarding this point that 75% of stimuli are targeted and 25% of them are untargeted. If it is supposed that the total number of stimuli is 120 the number of targeted stimulus is 30 and untargeted stimulus is 90 which were played randomly among one another[4],[9].

which is not appropriate due to its time consuming factor. The labels according to tests administered they are 1.healthy.2-less severe patient,3-severe patient .During the test ,there should be a difference beaween the two groups of literates and illiterates[1],[2].



[7] Auditory Oddball

Fig 1: some pictures were showed to test

2-3- The cases of the research

In this study 32people were employed for recording their signals.the range is between 60-88 years old.(the average age is 68.43 and the standard deviation of is 8.86).from among them,19 healthy with the points attained of MMSE in the range of 23-30,average 27.57, and standard deviation 2.19; 7 less severe patients with the points attained of MMSE in the range of19-22, the average 20.71, and standard deviation .95; and 6 severe patients with the points attained of MMSE in the range of 3-18, average 13,and standard deviation 6.09.

2-4- The preprocessing of the brain signals

To process the signals appropriately, the first step is to take the suitable EEG to avoid interference and turbulences. To attempt this issue ,five steps are intended including deletion of deviation from baseline, deletion of artifacts of high and low frequency ,deletion of electrical noise ,and the reduction of sampling rate and part assembling. It goes without saying that through the removing of redundant information from EEG signals, the quality and accuracy of next processing are increased. The artifacts in EEG signals are of two types –the artifacts of high frequency of EEG such as the muscles of head and neck ,and the artifacts of low frequency resulted of electrode movements and sweating. To remove these artifacts as well as electrical noise, amid -pass filter with the cut frequencies .05 to 45 $_{hrtz}$ have been applied.

2-5- The selection of the optimal characteristics

Prior to appropriate preprocessing of signals, the statistical, spectral,, timed, frequency, and linear features have been taken into consideration.

After the identification of different features, computation and optimal feature is targeted. To approach this, the analysis of variance (ANOVA[8]) has been used. In this study ,axis of features in three state of closed eye, open eye, and recall period containing 37 features. In the recording stet of stimulation period. The axis of features contains 45 features. First, the analysis of variance is done and the features of three classes which possess significant difference are determined[3].

[8] Analysis Of Variance

2-5-1-The analysis of variance

The analysis of variance is a method for examining and evaluation of three or more means of statistical community. The t-test was not used because the rate of errors would increase. This analysis was applied to extract optimal features. This method requires -1-the distribution of statistical community must be normal.2. The existent features in statistical community should be independent from each other.3.the sample difference in a statistical community must be interactively classified.

In this method three types of variances were defined as the following- the between-groups variance, the within- groups, variance and the total variance. Thus regarding to the importance of normality of data, the normal distribution of features is done through Kolemogrov-simonovand the diagram of p-p,in SPSS. In the figures 2 and3 the way of study of these tests on some features were displayed[5],[6].

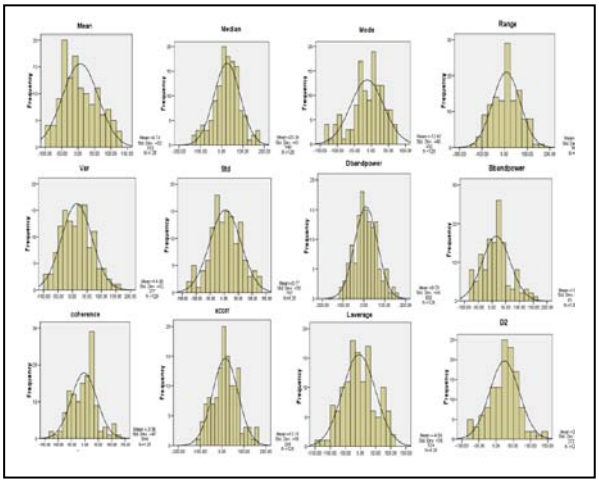


Fig 2: Analysis normality of data with Kolemogrov-simonovand

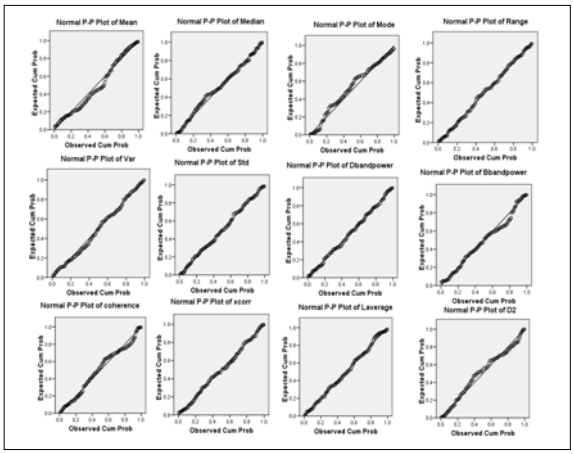


Fig 3: Analysis normality of data with p-p plot

2-6-The method of used classification

The ultimate aim in each problem is pattern identification, classification of samples in tow or some different classes. In the supervised method , a set of labeled data is applied as educational set for adjusting the classifying parameters. Therefore ,in this study, two linear classifying distinguishers (LDA)and neural network(Elman) have been used, the goal was to compare the classifiers of static and dynamic[6],[7].

3- Results

The extraction of optimal features through ANOVA is shown in the figures 4,5,6,7 in four states- closed-eye, open –eye, recall, and stimulation to compare the number, the sort of optimal features among the canals -P_z ,C_z,Fz . Then linear distinguisher is applied on three classes of optimal features attained from ANOVA. The accuracy of results of LDA applications on three canals of P_z ,C_z,Fz .is showed in the figure 8. In the figure 9,the evaluation of four states - closed-eye, open –eye, recall, and stimulation on the related canals has been applied. To abstract and processing of feature. The abstracted features of each section is labeled with a label of the same section In the final state regarding th e neural network due to the linear features of the question an the dynamic of non-linear signal of EEG ,the neural network of Elman has been used (figure 10).

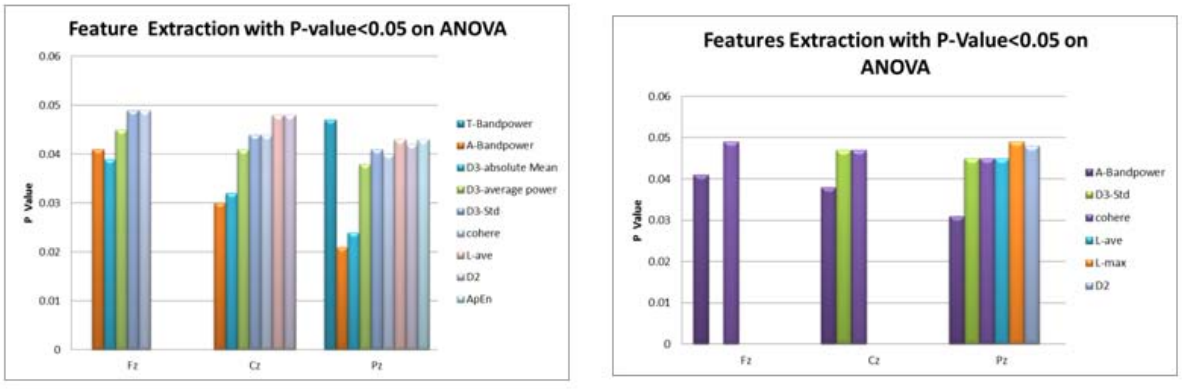


Fig 4 ,5 : Benefit Features with ANOVA in closed-eye and open –eye state

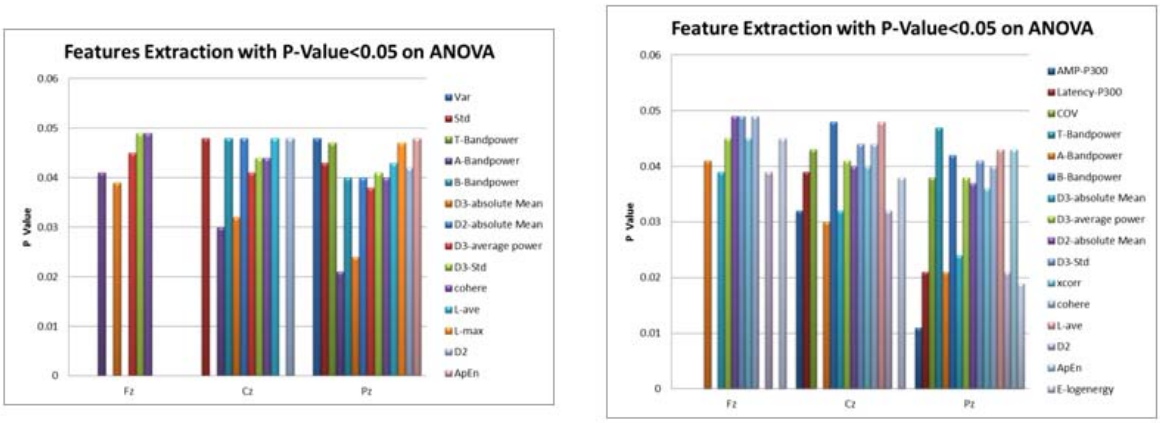


Fig 6,7 : Benefit Features with ANOVA in recall and stimulation state

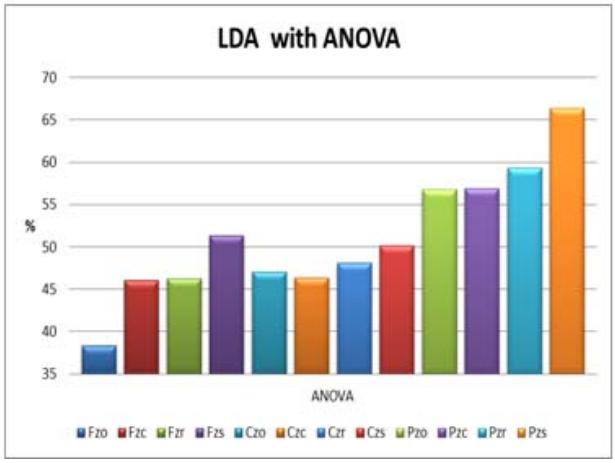


Fig 8 : Accuracy percent in LDA with ANOVA for Fz,Cz,Pz

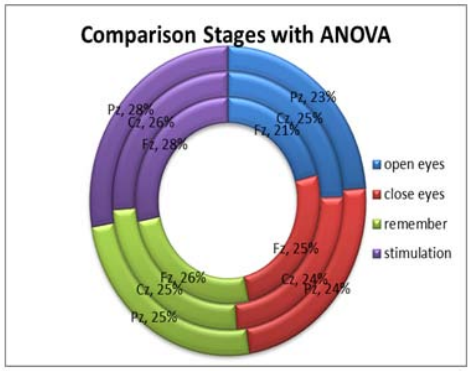


Fig 9 : Assessment Four state for Fz,Cz,Pz in ANOVA

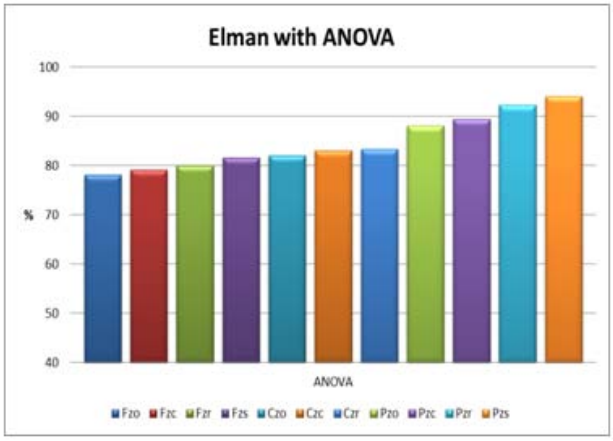


Fig 10 : Accuracy percent in Elman with ANOVA for Fz,Cz,Pz

4-Discussions and conclusions

Among the four states of - closed-eye, open –eye, recall, and stimulation for evaluation and extraction of feature, the states of recall, and stimulation are the best due to the addition of optimal characteristics of these two states for evaluation by the methods of the analysis of variance. On the other hand, from among the three canals of -P_z ,C_z,Fz for recording brain signal ., the canal P_z indicated that contain the optimal features for diagnosing the Alzheimer patients. That, s because of the having more optimal features, compared to two other canals. Concerning the methods of processing introduced for classification of three groups including –healthy, less severe ,and severe patients, the method of neural network of Elman contains the higher level of accuracy of distinguishing if compared to the linear distinguishing method. The correctness of results P_z canal in the state o f recall, and stimulation with the selected features of the analysis of variance through linear distinguisher are59.4, 66.4, and in neural network containing the correctness of distinguishing of 92.3 and 94.1 respectively. Regarding to these results, dynamic classifiers such as neural network of Elman possessing a higher correctness of distinguishing to diagnose the less severe Alzheimer disease. The linear distinguisher was not capable to classifies healthy levels, less severe and severe patients due to the more number of classes in question.

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