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**BRAIN COMPUTER INTERFACE (BCI) BASED ON  
ELECTROENCEPHALOGRAPHIC (EEG) PATTERNS  
DUE TO NEW COGNITIVE TASKS**

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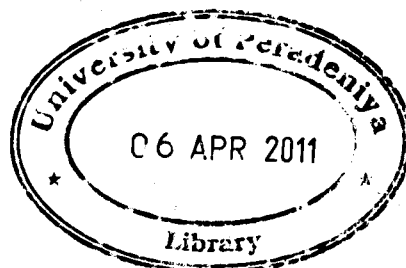
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# **BRAIN COMPUTER INTERFACE (BCI) BASED ON ELECTROENCEPHALOGRAPHIC (EEG) PATTERNS DUE TO NEW COGNITIVE TASKS**

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Several new mental tasks were investigated to find their suitability in Brain Computer Interface (BCI). Electroencephalography (EEG) signals were collected after amplification while subjects were performing certain mental tasks. Later, collected EEG signals were analyzed to identify changes in EEG due to these mental tasks. Recordings were carried out using an electro-cap containing 20 EEG electrodes which were placed according to the standard 10-20 system.

Microsoft windows based software with user friendly features was developed for analyzing and classifying recorded EEG data. With this software, unnecessary frequencies were filtered out with Bandpass filtering. In order to identify the best feature vector construction for a given mental task, feature vectors were constructed using Bandpower, Principal Component Analysis, and Downsampling separately. These feature vectors were then classified with Linear Discriminant Analysis, Linear Support Vector Machines, Critical Distance Classifier, Nearest Neighbor Classifiers and their Non-Linear counter parts to find the best performing classifier.

For comparison purposes, performances of already well known mental tasks in BCI community were computed along with that of new mental tasks introduced in this thesis. In the preliminary studies it was found that most promising new mental tasks

... the most heavily used mental tasks in these studies were the binary  
performances of other two subjects for the same mental tasks were 95% and 88%  
with the over all performance of 89% and 78%. Performances of same three subjects  
for mental tasks in all were relatively good. The average performances were 92%,  
76% and 71% while the best performance was 77%.

which could be identified by a BCI system is *imagination of hitting a given square by an imaginary arrow from above (or below) and right, (or left) to the screen*. The group of these mental tasks was named as “*Hit Series*” (HS). A detail investigation of HS was carried out and compared it with the performance of Motor Imagery (MI) events which are the most heavily used mental tasks in EEG based BCI systems.

One subject achieved the maximum average performance for HS, 100% in the binary classifications while 99% in overall combined performance. The best average performances of other two subjects for the same mental tasks were 93% and 87% with the over all performance of 89% and 78%. Performances of same three subjects for mental tasks in MI were relatively poor. The average performances were 92%, 78% and 92% while over all performances were 87%, 69% and 88%.