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Boosting BCI accuracy using wavelet enhanced CBLE scores as a classifier feature

Md Rakibul Mowla[1], Jane E. Huggins[2], David E. Thompson [1*]
[1]*Department of Electrical and Computer Engineering, Kansas State University, Manhattan, KS, USA*
[2]*Department of Physical Medicine and Rehabilitation, University of Michigan, Ann Arbor, MI, USA*

*1701D Platt Street, 3091 Engineering Hall, Manhattan, KS, USA, 66502. E-mail: davet@ksu.edu

Introduction: Thompson et al., 2013 proposed a classifier based latency estimation technique (CBLE) for estimating Brain-Computer Interface (BCI) performance [1]. The method itself provides the classifier scores as a function of time shifts, which can be used to estimate P300 latency. Here, we have used the wavelet approximation coefficients of the CBLE output to predict characters in an attempt to account for latency jitter.

Material, Methods and Results: This work is an offline analysis of data from [1]. We used only data from the 10 participants with amyotrophic lateral sclerosis (ALS). In [1] there were three data files on each of three days; this study includes data from all three files on day one, and only one file each from day two and three.

Figure 1 shows the classifier scores as a function of time shifts from an ALS participant. We can see smooth peaks around 0 time shift in the scores for target characters that are absent for non-target characters. We computed the wavelet approximation coefficients of those scores and used them as classifier features for a support vector machine (SVM). Using only one data file from the first day, we selected the daubechies-4 mother wavelet.

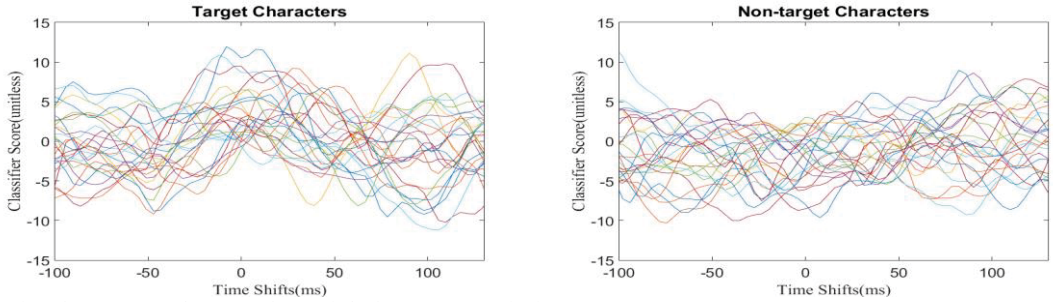

Figure 1. *Classifier scores as function of time shifts from CBLE method.*

Table 1 shows the performance of the proposed technique. Session one accuracy is the average of three files. The technique outperformed the original classifier for the four participants with the lowest online accuracies. The improvement was consistent across days: three participants had improved accuracy while a fourth was equivalent.

Subjects		**K145**	K146	K147	K152	K154	**K155**	K156	K158	**K159**	**K160**
Average Accuracy in Session 01 (%)	Online	58.89	96.29	95.14	90.26	93.22	59.90	93.05	88.00	81.14	70.56
	Wavele	61.11	94.44	93.86	91.33	93.22	62.96	93.05	86.00	82.00	73.94
Average Accuracy in Session 02 & 03 (%)	Online	85.00	86.65	82.42	49.07	0	69.36	88.14	57.83	80.67	32.14
	Wavele	91.93	88.37	85.60	45.37	0	73.34	86.29	58.67	83.42	32.14

Table I. Performance in different environments on Session 01 and performance on other Session.

Discussion: The technique appears to be helpful for the users with low accuracy. Note that while the accuracy changes are small, the change in user-corrected throughput can be significant. K155's 3 and 4 percentage-point improvements in accuracy correspond to 46.25% and 20.54% improvements in BCI-Utility [2]. For K145 and K159 improvements are 15.30%, 18.18% and 3.21%, 8.94%, respectively.

Significance: This method may help to improve the accuracy of the BCI system for those users who have low online accuracy with least-squares classifiers. Users with accuracies near 90% will not benefit.

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References

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