Mental task discrimination using EEG signals with genetically trained Fuzzy ARTMAP

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We show that it is possible to discriminate accurately between human mental tasks based on electroencephalogram (EEG) signals only. We study two different mental tasks performed by four subjects across two different sessions. The EEG power spectral densities (PSD) from 0 to 30 Hz are extracted using Wiener - Khintchine theorem with Parzen window smoothing and are trained with a Fuzzy ARTMAP classifier (FA) [1] instead of frequency band power values commonly used. FA classification performance varies for different order of pattern feeding. To solve this problem, we propose a novel method of fusing genetic algorithms (GA) instead of voting strategy proposed in [1] and Table 1 shows the improvement of our method over the latter.

This technique is general and is applicable to any optimisation and/or classification problems. A higher performance can be obtained with more training data and the removal of muscle artifact like eye blinks. The results also show that it is possible to discriminate between different mental tasks using EEG signals only and this can be used say, as a form of communication for paralysed patients.

Table 1: FA classification performance between mental multiplication and visual image rotation task

Voting strategy

	1st user	2nd user	3rd user	4th user	All users
1st session	82.56	76.92	97.44	75.9	69.55
2nd session	85.9	86.15	78.72	80.77	67.31
Both session	77.44	75.26	81.41	73.97	62.05

Genetically trained FA

	1st user	2nd user	3rd user	4th user	All users
1st session	94.87	92.31	100	92.31	82.05
2nd session	94.87	97.44	92.31	94.87	77.56
Both session	88.46	88.46	89.74	87.18	70.51

[1] Carpenter et. al. Fuzzy ARTMAP: A neural network architecture for incremental supervised learning of analog multidimensional maps. *IEEE Transactions on Neural Networks,*3(5):698-713,1992.