Discriminative Analysis of Migraine with Aura using Non-Linear SVM Classification

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Bottom-Line

Migraine with Aura (MwA) can now be tested on non-pain days using our new EEG feature analysis methodology. We **identified discriminant features and classified MwA from normal controls (NC) during the non-pain period**. The most discriminative features tended to comply with current findings in migraine studies. They were used to train a **non-linear support vector machine[5,6] (SVM) classifier** to perform the discrimination. This classifier generated an **accuracy rate of 92.9%.** This pilot study was performed between and not during migraine attacks. **We believe that the inter-attack electrical features that we have found represent the electrical predisposition to MwA**. On the basis of this research Headache Sciences Inc. is commercializing a test which it calls the **F**requency[2] **S**ynchronization[3] **T**ransients[4] test (FST). These three feature groups were combined in this study to generate the high accuracy rate.

Objective

The objective of this work is to implement a technique to characterize and extract significant, robust and informative electrical features from EEG signals which are representative of the non-pain period of the migraine with aura (MwA) brain state. We have utilized EEG signals because they contain critical, spatial and temporal information about neural bioelectricity.

Data

HSI Database:

- 24 MwA patients (8 males/16 females)
  - Mean age 31.1 +/- 9.2
  - Mean frequency of attack of 5.6/month
- 24 NC individuals (9 males/15 females)
  - Mean age 28.5 +/- 9.5
- Subjects with migraine symptoms were screened using the International Headache Society criteria schedule II (ICHD-II)

Recording:

- 32 Ag/AgCl electrodes 10-20 electrode system
  - average referenced
  - digitally sampled at 1024 Hz

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Method

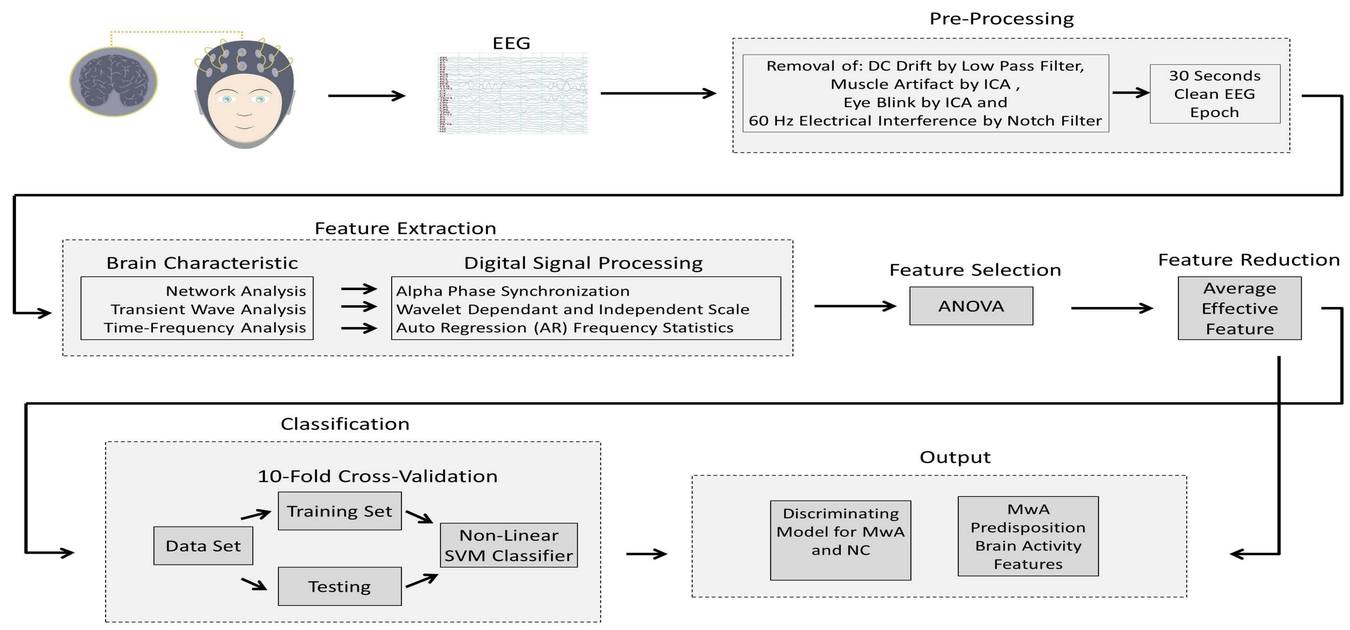

Figure 1. Workflow diagram of the proposed algorithm to differentiate MwA from NC on non-pain day

Results and Future Work

- Interpretation of the reduced features correspond to those found in previous migraine studies in the literature[1]. Combining all three feature groups created complimentary features and increased their overall discriminative capabilities.
- To further illustrate the capabilities of our algorithm we plotted the decision hyper-plane onto the feature space, whereby each axis corresponds to one of the FST feature groups. The hyperplane is shown in gray. It clearly seen separates MwAs (blue) from NCs (red).
- **Future work** could explore the possibility that our inter-attack features are modifiable in the hope that they can be used to design and guide future new treatments. Such treatments could conceivably be in the form of new drugs, behavioral treatments, sleep, relaxation and meditation techniques and biofeedback.

Table 1. Baseline benchmark comparison results of the binary classification task on various electrical characteristic combinations

	Accuracy (%)	Sensitivity (%)	Specificity (%)
PLV	69.7	69.2	70.4
Wavelet	80.0	80.6	78.5
AR	86.6	87.5	85.7
PLV/Wavelet	78.6	78.6	78.6
PLV/AR	85.7	89.3	72.9
Wavelet/AR	80.0	80.7	78.6
Proposed	**92.9**	**92.9**	**92.9**

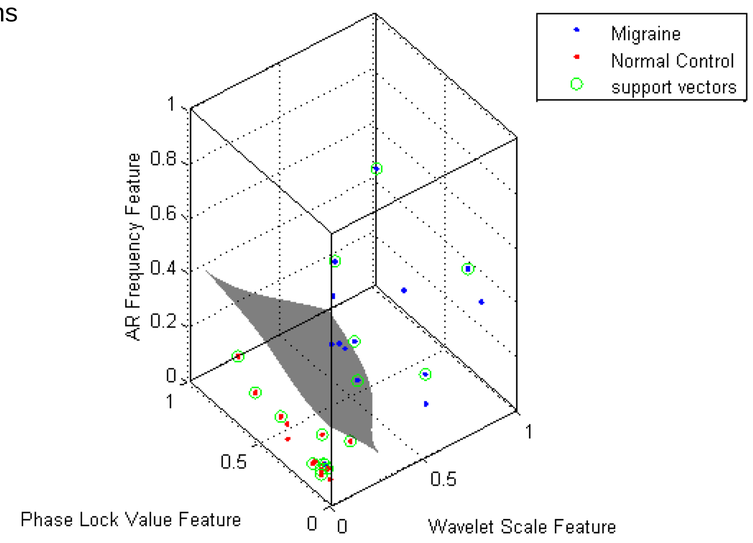

Figure 2. Feature space graph and decision hyperplane showing MwA and NC discrimination

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