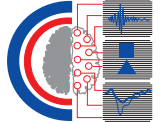


Computer-assisted EEG diagnosis: a new system for integrative EEG analysis



Visbeck-A¹, Herrmann-CS², Arnold-T², Hopf-HC¹

¹ Dept. of Neurology, University of Mainz, Germany
² Max Planck Institute of Cognitive Neuroscience, Leipzig, Germany



Introduction

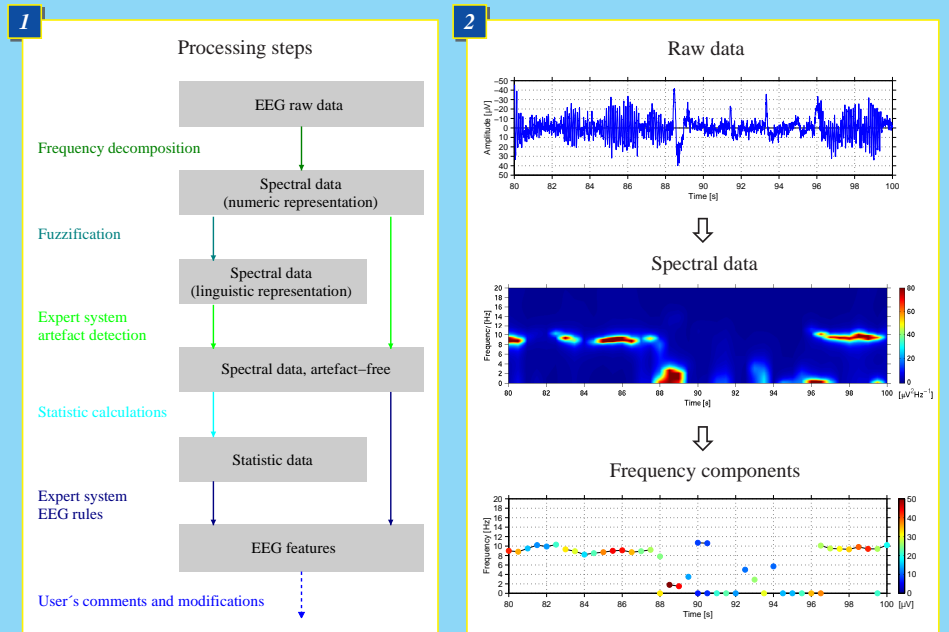
Computer-assisted analysis supports EEG-interpretation. Different techniques have been developed for application in long-term-monitoring and quantification (1,2,4,5). Such systems focus on the extraction or calculation of special EEG features (e.g. frequency changes) which often accept loss of information concerning the spatial and temporal context. The interpretation of a clinical routine EEG requires an integrative evaluation of the recording.

Objectives

The subject of this study was to build a hybrid system for automatic analysis of clinical routine EEG. The system is aimed to support the neurologist in the formulation of a summarizing report.

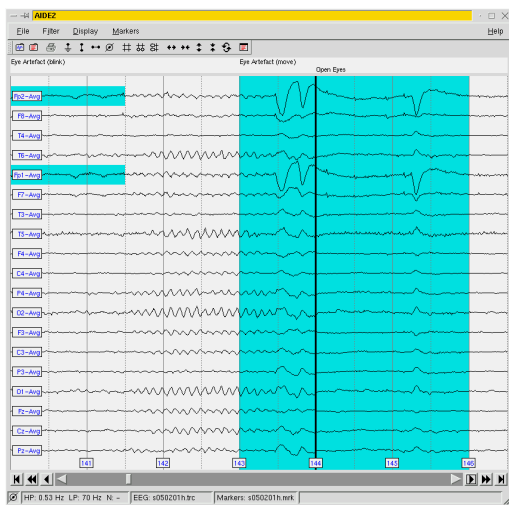
Methods

EEG raw data is pre-processed by the Adaptive Frequency Decomposition, a method which, based on spectral analysis, extracts dominant frequency components. Spectral features of the EEG signal are then transformed into linguistic representation by means of fuzzy logic. This allows the use of verbal attributes for EEG description. The linguistic features (e.g. "high-voltage-delta activity") are then processed in a rule-based system (expert system). In a first step, artifacts are detected and excluded from further analysis. Then the remaining data is analysed with respect to EEG patterns. Final evaluation of the full record is based on the knowledgebase of the expert system offering the possibility of modifications and comments to the user.

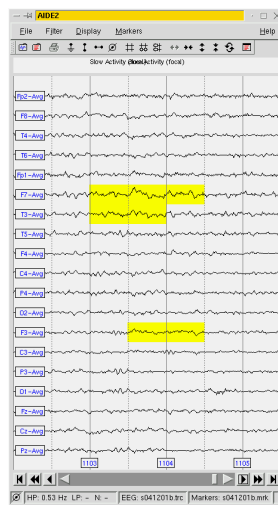


3

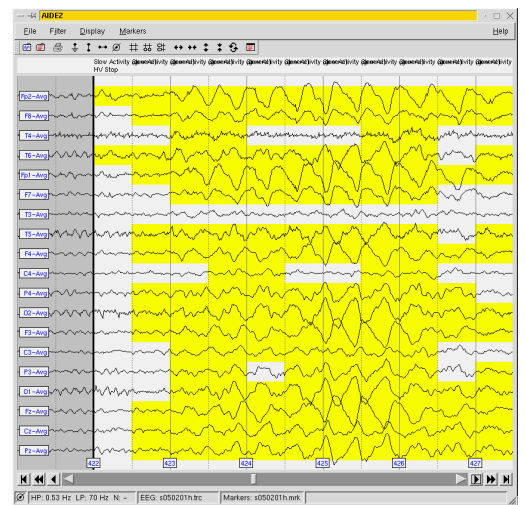
Eye movement artefacts



Focal slow activity

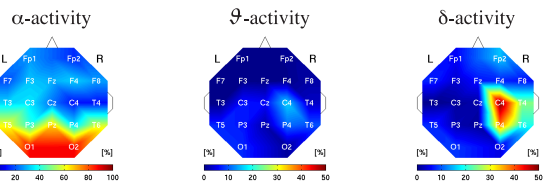


Generalized slow activity



4

Maps of temporal extent



Results

The system detects and describes features like background activity, alpha blocking response and response to hyperventilation and characterizes slow activity as being localized, unilateral or generalized. The features are displayed as linguistic terms, numerical values or maps of temporal extent. Evaluation of 20 EEG recordings showed a correspondence between automatic and visual analysis in the classification of background activity of 100% and of slow activity of 95%. The detection of eye movements, which often interfere with spectral data from frontal recordings, had a discrimination index P_r ($P_r = \text{hitrate} - \text{false alarms}$) of 87% across subjects (2). So far, detection of paroxysmal activity is not included in the system.

Conclusion

The system provides an integrative analysis of routine EEG, taking into account a broad variety of EEG patterns. The use of the expert system and the linguistic representation of rules and facts make system supervision easy and intuitive and allow modifications by the user. The system proved to be a useful assistant tool for the clinical neurologist.

This AIDE² project is funded by the Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (BMBF), Germany.

References:

- (1) Barlow, J.S. Methods of analysis of nonstationary EEGs, with emphasis on segmentation techniques: A comparative review. J. Clin. Neurophys., 1985, 2(3): 267-304
- (2) Gotman, J. The use of computers in analysis and display of EEG and evoked potentials. In: D.D. Daly and T.A. Pedley (Eds.), Current practice of clinical electroencephalography. Raven Press, New York, 1990: 51-84.
- (3) Herrmann, C.S., Arnold T., Visbeck A., Hundem H.P., Hopf H.C. Rule-based artifact rejection for pre-processing event-related potentials. Electroenceph. Clin. Neurophysiol., 1998, 107(3): 52p
- (4) Lopes da Silva, F. Computer-assisted EEG diagnosis: Pattern recognition and brain mapping. In: Niedermeyer, E. and F. Lopes da Silva, Electroencephalography. Basic principles, clinical applications and related fields. Williams & Wilkins, Baltimore, 1999: 1164-1189.
- (5) Nuwer, M.R. Assessing Digital and quantitative EEG in clinical settings. J. Clin. Neurophysiol., 1998, 15(6): 458-463