BIOSIG: Advances in Biomedical Signal Processing

Editorial
Special Session at SIGNAL 2025

Ahmad Karfoul[1], Amar Kachenoura[1]
[1]Univ. Rennes, LTSI INSERM U1099, Rennes, France
ahmad.karfoul@univ-rennes.fr, amar.kachenoura@univ-rennes.fr

Abstract

This special session highlights innovative methodologies, encompassing advancements in signal processing, machine learning, neural networks, and wearable technologies. It offers an international platform for researchers and professionals to present their latest discoveries and innovative ideas.

1 INTRODUCTION

The field of biomedical signal processing is a cornerstone in the advancement of modern healthcare technologies. Focusing on the acquisition, analysis, and interpretation of complex electrophysiological signals plays a pivotal role in enhancing clinicians' ability to understand intricate physiological systems. These advancements enable more precise and timely diagnoses, improve disease prediction capabilities, and facilitate longitudinal monitoring of patient health. With the increasing complexity and volume of health data, biomedical signal processing stands at the forefront of developing solutions that integrate seamlessly into clinical practices, offering substantial contributions to personalized medicine, early detection, and the management of chronic conditions. The BIOSIG special session aims to explore the latest developments in this dynamic field, highlighting innovative approaches and methodologies that continue to shape the future of healthcare.

2 SESSION OVERVIEW

All paper submissions are relevant to the interests of this session. Here we explore patterns in two particular healthcare applications: Bipolar disorder diagnosis and epilepsy.

The first contribution in the special session titled "Combined EEG and ERG Features for Bipolar Disorders Diagnosis adresses" [1] focuses on the analysis of electroencephalogram (EEG) and electroretinogram (ERG) responses to light stimuli in order to differentiate patients with bipolar disorders (BD) from control subjects. As robust biomarkers are needed for a reliable and early diagnosis. Recent studies have demonstrated that electrophysiological ERG/EEG measurements hold relevant features for the diagnosis of BD. In this study, a combined analysis of these modalities with promising performance for the detection of BD subjects with respect to controls is discussed.

The second contribution is titled "A new 1D-CNN paradigm for onset detection of absence seizures in Children" [2]. This study presents an 1D-CNN-based algorithm for the early detection of childhood absence seizures in EEG traces. This detection aimed at enabling timely sensory interventions, such as acoustic or visual stimulation, to potentially abort seizures. On the clinical EEG database of 117 patients, the model achieved promising results, including a sensitivity of 0.859, precision of 0.819, F1-score of 0.837, and a mean detection delay of 0.522 seconds. The performance remained satisfactory when using fewer electrodes, with a sensitivity of 0.837, precision of 0.808, F1-score of 0.820, and similar detection delays. These results demonstrate the method's robustness and feasibility for clinical applications, as well as its potential to be embedded in wearable devices for continuous, real-time seizure monitoring and intervention in children with absence epilepsy.

The third contribution titled "An Integrative Strategy for Solving the EEG Inverse Problem and the Estimation of Brain Effective Connectivity in Epilepsy. A Proof-of-Concept Study" [3] presents an integrative strategy for simultaneously localizing brain sources and inferring effective connectivity. The proposed approach leverages the model underlying the events of interest as a regularizer in the electroencephalographic inverse problem. The effectiveness of this strategy is confirmed using realistic simulated high resolution electroencephalo-

graphic signals in the context of epilepsy, and compared to the conventional sequential strategy, where connectivity estimation is performed after solving the electroencephalographic inverse problem.

3 CONCLUSION

Several research results analyzing brain neural activities using ERG and/or EEG signals were presented in this special session. The main disorders being addressed were bipolar disorders and epilepsy. Further research of the authors has already been mentioned. For the research community as a whole, the following key questions were identified.

- For Bipolar disorders diagnostic: (i) How to include clinical data and human expertise for a fully integrated decision process? and (ii) Investigating the usefulness of new flash stimuli to isolate other cells' activity and increase discriminating performance.

- For the early detection of epileptic seizure onset, the main challenges are: (i) Reducing false detections caused by short spike trains, which clinicians do not classify as seizures, and (ii) Validating the robustness of the proposed pipeline in more diverse conditions, especially in wearable devices.

- Regarding the integrative strategy for brain connectivity and the EEG inverse problem, the main questions raised were: (i) How scalable is the proposed approach when a high-resolution discretizations of the cortical surface is required? (ii) How can priors be incorporated in the time-frequency domain? and (iii) What are the implications of using rapid discharges occurring at seizure onset instead of pre-critical epileptic spikes?

3.1 ACKNOWLEDGEMENT

Our sincere gratitude goes to the organizers for their warm reception of this special track at the conference, which undoubtedly involved significant administrative efforts. We extend special thanks to the reviewers for their valuable feedback and insightful suggestions. Of course, this track would not have been possible without the contributions of the authors. We deeply appreciate their engaging work and their willingness to publish and present their research.

References

[1] J. Muzzolon, X. Ren, S. Le Cam, T. Schwitzer, V. Louis Dorr, "Combined EEG and ERG Features for Bipolar Disorders Diagnosis," The Tenth International Conference on Advances in Signal, Image and Video Processing, Signal 2025, March 9-13, Lisbon, Portugal.

[2] M. Yochum A. Kachenoura M. Aud'hui A. Kaminska R. Nabbout F. Wendling M. Kuchenbuch P. Benquet, "A New 1D-CNN Paradigm for Onset Detection of Absence Seizures in Children ," The Tenth International Conference on Advances in Signal, Image and Video Processing, Signal 2025, March 9-13, Lisbon, Portugal.

[3] M. Greige, A. Karfoul, P. Benquet, M. Yochum, R. Le Bouquin Jeannès "An Integrative Strategy for Solving the EEG Inverse Problem and the Estimation of Brain Effective Connectivity in Epilepsy. A Proof-of-Concept Study," The Tenth International Conference on Advances in Signal, Image and Video Processing, Signal 2025, March 9-13, Lisbon, Portugal.