A New Real-Time EEG Source Localization Method
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I. CONTEXT
• Electroencephalography (EEG) is a widely used functional neuroimaging technique generally considered as having an excellent temporal resolution, but a poor spatial resolution.
• Scalp EEG can be input to the ill-posed source localization inverse problem for characterizing the electric currents in the brain generating them.
• Our idea was to adapt an approach initially developed to solve a source term estimation problem for atmospheric dispersion of nuclear, radiological, biological or chemical (NRBC) substances, called “Renormalization”.
• Using anatomically faithful high-resolution 3D head models, our approach can provide valuable insights for neurophysiological & cognitive monitoring:

II. AIMS
• Improve the real-time interpretation of EEG signals for:
  • Neurophysiological & cognitive monitoring.
  • Development of brain-machine interfaces (BMI).
• Assess the complementarity between our source identification method and classical approaches (signal processing, AI, ...).
• Determine whether our approach brings valuable additional information for real-time feedback.

III. METHOD
• The “Renormalization” method uses the lead field theory to define the concept of “EEG visibility tensor”.
• Workflow:
  1. We compute the lead field matrix A from a sensor point of view.
  2. We generate the so-called “Visibility matrix” W, corresponding to a tensor field, by a 3D renormalization process.
  3. To estimate the source s at each time step, we simply apply the inverse operator G to the measurement vector μ.

IV. RESULTS
• The source estimation s enables:
  • Accurate real-time mapping of electrical brain activity.
  • Characterization (location, orientation, intensity) of single punctual or distributed sources.

V. CONCLUSION
• We expect the “Renormalization” method not only to open new perspectives in the field of BMIs but also to contribute to a better understanding of the brain functions and improve the care of brain-injured patients:
  • Refined rehabilitation assessments by detecting brain activity changes correlated with cognitive disorders.
  • Better evaluation of post-TBI rehabilitation benefits.

REFERENCES

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