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Seizure Onset Zone (SOZ) Localization from rs-fMRI in Pediatric Epilepsy

Epilepsy is a debilitating disorder that affects 50 million people worldwide, including one in 150 children. About 20-40% of children with epilepsy suffer from refractory seizures despite treatment with anticonvulsants, i.e. pharmaco-resistant epilepsy (PRE), which results in increased morbidity and mortality. Early identification and surgical intervention of PRE, not only correlates to better outcomes, but also is crucial to avoid development complications which may cause sudden death. Surgical intervention, however, requires precision localization of SOZ for resection/disconnection or ablation. While resting-state functional MRI (rs-fMRI), combined with signal decoupling using independent component (IC) analysis shows promise in SOZ localization capability to guide iEEG lead placement, it requires manual expert sorting, which limits reproducibility and availability in presurgical screening.

Researchers at Arizona State University have developed a novel machine expert-in-the-loop solution for automatic IC sorting called DeepXSOZ. DeepXSOZ is able to overcome the performance drawbacks of many SOZ localization strategies by exploiting the synergy between deep learning based spatial feature and shallow learning based expert knowledge encoding. This technique incorporates expert knowledge and reduces the manual effort by presenting relevant SOZ signals which are then sorted by the expert in the end to enable greater confidence on the SOZ localization. When tested on 52 children with PRE, DeepXSOZ, compared to state-of-the art, shows a sensitivity of 89.79%, precision of 93.6% and accuracy of 84.6%.

This tool reduces the number of ICs to be sorted, increases the confidence of the surgical team and may expedite diagnostics and enhance implementation feasibility.

Potential Applications

- Could enable the usage of rs-fMRI as a low-cost outpatient presurgical screening tool
- Reduces the presurgical expert sorting workload for a neurosurgeon and team

Benefits and Advantages

- Automated identification of SOZ localizing ICs which are relatively infrequent in a dataset
- Reduces expert sorting workload by 6.7 (±2.2)-fold
  - Reduced costs and time
- Enables the usage of rs-fMRI as a low-cost outpatient pre-surgical screening tool
- This tool does not require prior training data
- May reduce false positives and increase true positives of SOZ localizing ICs
- Comparison with state-of-the art, on 52 children with PRE, shows a sensitivity of 89.79%, precision of 93.6% and accuracy of 84.6%
  - Achieves significantly higher and consistent results across age, sex, and Engel outcomes in both PLM and ILM
- Reduces the time commitment for presurgical evaluation

For more information about this opportunity, please see

Kamboj et - arXiv - 2023

For more information about the inventor(s) and their research, please see

Dr. Gupta's departmental webpage