



GUJARAT TECHNOLOGICAL UNIVERSITY

(Established by Government of Gujarat under Gujarat Act No. : 20 of 2007)

ગુજરાત ટેકનોલોજીકલ યુનિવર્સિટી

(ગુજરાત સરકારના ગુજરાત અધિનિયમ ક્રમાંક : ૨૦/૨૦૦૭ દ્વારા સ્થાપિત)

Accredited with A++ Grade by NAAC

Abstract of the Thesis



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Faculty: Engineering and Technology

Discipline/Branch: Electronics & Communication

Title of the Thesis: Epilepsy detection using EEG brain signal

Abstract

In the clinical management of epilepsy, a strategic shift from reactive seizure detection to proactive pre-ictal prediction is essential to mitigate the premature death and enhance the quality of life for the millions affected globally. This research presents a robust framework for seizure prediction by optimizing feature-channel pairs from EEG datasets. Epileptic seizure prediction represents a critical frontier in neuro-informatics, offering the potential to transform clinical diagnostics into proactive therapeutic interventions. This work synthesizes the current state of the art, tracing the evolution from traditional machine learning (ML) paradigms to reduced feature-channel pair computation. Central to this progression is the precise detection of the “pre-ictal” phase—the stochastic transitional state

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Ph.D. Programme

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preceding seizure onset. Various time domain, frequency domain and time-frequency domain features are extracted from 30 and 60 minutes of preictal phase and inter ictal phases to train the various classifier. This research evaluates the advancements across gold-standard datasets, specifically the CHB-MIT Scalp EEG Database, the University of Bonn Database, and the Database from Neurology & Sleep Centre, providing a comprehensive assessment of diagnostic accuracy and computational efficiency. Support Vector Machine with linear kernel gives better results with duration of preictal phase of 60 minutes over the test datasets with average accuracy of 97.61%, sensitivity of 97.6 % and misclassification rate of 0.02. To reduce the feature matrix individual band analysis is done which improves the results using features from 30 minutes of pre-ictal phase of beta band with average sensitivity of 92% and false positive rate of 0.14 per hour. In order to overcome difficulties in managing high-dimensional data feature selection is achieved with rank-based selection methods like: F-test, ANOVA test, mRMR (Minimum-Redundancy–Maximum-Relevance), and Chi-square for epilepsy prediction. Results show sensitivity of 97.34 % and accuracy of 93.60% with mRMR method which outperforms compare to ANOVA and chi square approaches. These methods effectively reduce feature dimensionality, enhancing efficiency and model interpretability, while multi-domain feature fusion further improves detection performance. However, variability in EEG data and limited generalizability across heterogeneous datasets remain challenges. This synthesis of signal processing and machine learning addresses the clinical necessity for early warning systems, establishing a new state of the art in automated neuro-engineering.

This PhD thesis is anticipated to assist scholars and researchers working in the field of epilepsy detection. Additionally, by facilitating early identification and fast intervention for people with epilepsy, it may enhance clinical practice by lowering the risk of serious consequences, including death, through proper and timely treatment.



List of Publication(s):

Journal Articles

1. Chapatwala, N., Paunwala, C. N., & Parmar, S. (2025–2026). Impact of EEG rhythm on the prognosis of epilepsy. *International Journal of Image, Graphics and Signal Processing*. <https://doi.org/10.5815/ijigsp>
2. Chapatwala, N., & Paunwala, C. N. (2025–2026). A comparative analysis of rank-based feature selection methods for epileptic seizure prediction using EEG signals. *International Journal for Multidisciplinary Research*. <https://www.ijfmr.com/papers/2025/6/64321.pdf>

Conference Papers

3. Chapatwala, N., Paunwala, C. N., & Doctor, A. (2023, October 16–18). *SVM-based pre-ictal phase detection for epileptic seizure analysis*. 11th IEEE Region 10 Humanitarian Technology Conference (R10 HTC), Marwadi University, Rajkot, India. DOI: [10.1109/R10-HTC57504.2023.10461894](https://doi.org/10.1109/R10-HTC57504.2023.10461894)
4. Chapatwala, N., Paunwala, C. N., & Dalal, P. (2022, November 24–26). *An explainable AI approach towards epileptic seizure detection*. IEEE Indicon 2022. DOI: [10.1109/INDICON56171.2022.10039982](https://doi.org/10.1109/INDICON56171.2022.10039982)

Book Chapter

5. Chapatwala, N. H., & Paunwala, C. N. (2023). Evolution of automatic epilepsy detection and classification techniques: A survey. In *Disruptive developments in biomedical applications* (pp. 161–172). CRC Press. <https://www.taylorfrancis.com/chapters/edit/10.1201/9781003272694-14>