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# Weighted 1D-local binary pattern features and Taylor-Henry gas solubility optimization based Deep Maxout network for discovering epileptic seizure using EEG

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## Abstract

Epilepsy represents chaos in nerves which can affect the world's population. Such type of abnormal activities of the brain can lead to seizures. Hence, precise and timely treatment of seizures is important to minimize financial and living costs. Electroencephalogram (EEG) is considered an imperative tool for analyzing epilepsy to diagnose epilepsy. This paper devises an optimization-aware deep model for detecting epilepsy using EEG signals. Here, the EEG signals undergo feature extraction wherein several features like relative amplitude, spectral entropy, logarithmic band power, power spectral density, Multiple kernel weighted Mel frequency cepstral coefficient (MKMFCC), tonal power ratio. The proposed weighted one-dimensional Local Binary Pattern (1D LBP) is obtained by combining weighted function in 1D-LBP are extracted. After extraction of features, data augmentation is carried out by flipping the EEG signal with the circular shift. The training of the Deep Maxout network is trained is done by the devised Taylor Henry gas solubility optimization (Taylor HGSO), by merging the Taylor Series and HGSO. The developed Taylor HGSO-based Deep Maxout network offered enhanced performance with high accuracy of 93.6%, sensitivity of 94.7%, and specificity of 93.4%.

## Introduction

The brain of humans operates the sensory data obtained by exterior or interior stimuli. The brain is considered an unprocessed workstation as neurons utilize chemical effects for producing electricity. The EEG is a graph-based signal that records the fragmentary activities of electricity that evaluates different electrodes located on the brain. In terms of the clinic, the major treatment of EEG is to determine the tasks of brain abnormalities known as epileptic seizures. The seizure happens whenever the neurons produce clumsy electrical pardons. Epilepsy becomes a persistent disorder of seizure occurred with irregular discharges through the brain cells. EEG also diagnoses coma, sleeping pattern disorder, brain death, and encephalopathy. In addition, the EEG can be utilized in several domains like recognition of emotion, quality of video assessment, measurement of alcoholic utilization, detection of sleep stage, alterations in brainwaves by increased usage of mobile phones, and smoking [24]. Therefore, EEG is considered a crucial part of determining epilepsy. It evaluates the difference amongst the changes of voltage between electrodes and scalp of subjects by sensing the ionic currents flowing through the brain's neurons and offers spatial and temporal data regarding the brain. However, the discovery of EEG needs an undeviating assessment by physicians and considerable effort and time. In addition, the experts having varying levels of experience in diagnostic report opinions on the diagnostic results. Hence, the design of an automatic technique for epilepsy is required [23].

The attributes obtained from the EEG signal [29] are beneficial for an epilepsy diagnosis. The spectral assessment is a widespread method utilized for assessment of EEG signal as discloses frequencies contained in the signal. A basic supposition of Fourier transform is considered, but the signal was evaluated with variance, mean, and frequency which changes concerning time [25]. EEG is extensively utilized for examining the diseases of the brain as EEG signal comprises prosperity of information regarding the functions of the brain as there are several efforts to adapt spectral assessment methods. The signal processing based on the [33] time period analysis is used. To utilize this data in medical, the spectral assessment of signals should be carried out using spectral analysis techniques, and it is essential for making the automation. These days, the EEG is considered the most cost-effective and harmless technique in diagnosing common sicknesses. In most events, it is utilized to determine the brain point that causes epilepsy throughout the diagnosis [26]. Epilepsy is featured by persistent seizures wherein the abnormal activities of electricity in the brain lead to perception. The patient's experience varies symptoms throughout the seizures based on the position and scope of pretentious brain tissue. Till now, the particular reason behind epilepsy is undetermined, and the

seizure techniques are implicit. Hence, the research in epilepsy diagnosis is in high demand in the medical field [27].

In recent days, various automatic techniques have been devised to detect the activities of epilepsy. Most of them adapted Fourier spectral analysis for extracting the EEG signal based on EEG signals, they transform from the time-frequency domain. The techniques allowed the researchers to learn the data that are distinctive to the frequency. However, previous literary studies have established that EEG frequency can change over time. Thus, the -frequency assessment techniques are needed to remove these kinds of dilemmas. A well-known short-time Fourier transform (STFT) technique is devised that moved concerning time to evaluate the density of spectrum of EEG signals. In addition, the wavelet transform techniques are devised based on time-frequency estimation, frequency domain [30] techniques for analyzing the EEG signal [28]. Several nonlinear techniques are devised for extracting attributes associated with brain activities. Amongst these attributes, the Lyapunov exponent can discover the alterations of EEG, and the correlation dimension method comprises information regarding the neurological states of the brain. Here, the entropy and fractal dimension evaluate the complexities or disorder degree of EEG. In addition, the correlation integral is utilized to measure the nonlinearities to distinguish elliptical regions of the brain. Here, the current techniques revealed that EEG signal poses noteworthy nonlinearities. Several schemes are devised considering approximation entropy (ApEn) and discrete wavelet transform (DWT) for detecting epilepsy [25]. The most accurate detection of epileptic seizure is employed using machine learning [32] and with optimization techniques [31].

An approach is devised for detecting seizures from EEG signals. At first, the EEG is splitted into diverse channels that perform feature withdrawal. Thus, the feature extraction is done with proposed weighted 1D LBP, which is the combination of weighted function in 1D-LBP, along with relative amplitude, spectral entropy, logarithmic band power, power spectral density, MKMFCC, tonal power ratio and is considered for mining best features for improved processing. Once feature extraction is completed, the data augmentation is performed. Furthermore, the Epileptic Seizure is detected using the Deep Maxout network with Taylor HGSO. Finally, the Taylor HGSO is obtained by incorporating Taylor Series on HGSO.

The noteworthy contributions are

- **Developed Taylor HGSO-based Deep Maxout network for detecting epileptic seizures:** The developed Taylor HGSO-based Deep Maxout network is devised for detecting epileptic seizure. Here, the Deep Maxout network is trained by the devised Taylor HGSO that combines Taylor Series and HGSO.

The remaining part is arranged as Section 2 displays classical epileptic seizure detection methods. Section 3 devises the proposed model for detecting epileptic seizure. Section 4 discusses efficiency of proposed method in comparison with classical techniques. Section 5 offers a conclusion.



## Section snippets

### Motivations

This section comprises a brief illustration of eight epileptic seizure detection techniques along with their merits and demerits. The challenges of existing techniques are also included, which motivates to develop a new epileptic seizure detection model. …

### Proposed Taylor HGSO-based Deep Maxout network for epileptic seizure detection

Epilepsy is generated from asymmetrical electrical tasks of brain areas. The ultimate goal here is to design an approach for finding seizures using EEG signals. The signals are classified as number of channels and every channel adapts feature acquisition. Feature extraction is performed here with developed weighted 1D LBP and is devised by combining weighted function in 1D-LBP, relative amplitude, spectral entropy, logarithmic band power, power spectral density, MKMFCC, tonal power ratio are …

### Results and discussion

The competence of the devised approach is checked and analyzed with certain measures. …

### Conclusion

This paper presents an optimization driven deep model for diagnosing the seizure from EEG. Here, EEG signals are passed to various channels and each channel performs a set of phases that includes feature extraction, data augmentation and epileptic seizure detection. In this model, the feature extraction is performed to extract features, like

relative amplitude, spectral entropy, logarithmic band power, power spectral density, MKMFCC, tonal power ratio and proposed weighted 1D LBP, which is …

## CRediT authorship contribution statement

**G. Jaffino:** Software, Validation, Writing – review & editing. **M. Sundaram:** Supervision. **J. Prabin Jose:** Conceptualization, Data curation, Investigation, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing. …

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. …

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