Chapter 3
Enhanced Sleep Disorder Prediction Using Improved Harris Hawk Optimization and Ensemble Deep Learning Model

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ABSTRACT

Sleep disorder diagnosis is considered a milestone toward timely intervention and treatment. Diagnostic tools, such as polysomnography, are highly resource-intensive and plagued by issues with access. A developed sleep disorder prediction framework integrating feature selection through improved Harris Hawk Optimization algorithms and a deep ensemble learning model is proposed here. Filtering redundant data noise during feature selection in an improved HHO is used to consider only selecting relevant features during the model-building process. In this effort, the applicability of deep learning models, specifically ensemble CNNs and LSTM networks, to extracting spatial and temporal dependencies in the signal of the sleep

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disorder is attempted. The method proposed here is tested using publicly available sleep disorder datasets and aims to arrive at better classification accuracy, sensitivity, and specificity than existing techniques.

INTRODUCTION

The growing global burden of sleep disorders, as attested to by Hariprasath et al. (2024) and Pandit (2023), signifies impending future effects on health. These disorders, like sleep apnea, insomnia, narcolepsy, and restless leg syndrome, are generally linked with serious medical illnesses like cardiovascular disease, diabetes, and mental incapacities. Optimal control is dependent on early and accurate diagnosis of the disorder. Standard techniques, such as polysomnography, are expensive and require specialists whose availability often limits their access to most patients. This shortage has driven the need to utilize computational models, specifically machine learning (ML) and deep learning (DL) techniques, as studied by Kumar et al. (2023), to predict and classify sleep disorders automatically more economically and efficiently. A series of studies, such as those by Blumenthal et al. (2022), have established the potential of machine learning (ML) and deep learning (DL) in handling rich physiological signals, including electroencephalogram (EEG), electrocardiogram (ECG), and actigraphy. The signals are information-dense, noisy, and time-consuming, making them challenging to design quality prediction models.

Reis et al. (2022) and Mampitiya et al. (2022) found that feature extraction and feature selection are particularly relevant to those projects to enhance the performance of DL and ML models. Studies by Priyadharshini et al. (2023), Kumar and Sinha (2020), Odoemena and Elufidodo (2024), and Bala Kuta and Bin Sulaiman (2023) have attested to the success of retrieving significant patterns from raw data using Fourier transforms, wavelet transformations, and time-frequency analysis. The removal of redundancy from the data is typically achieved through methods such as mutual information, independent component analysis (ICA), and principal component analysis (PCA). Aside from this, new developments in deep learning, as explicated by William et al. (2024) and Malibari & Alzahrani (2021), have seen the progression of models like convolutional neural networks (CNNs) and recurrent neural networks (RNNs) capable of learning automatically hierarchical features directly from raw input data with zero forms of human intervention.

Despite such innovations, such challenges remain ever-prevalent in one way or another, e.g., heterogeneity and variation of sleep measures over settings and groups, for testimony to which see Sehrawat (2024) and Karthikeyan et al. (2024). Deep learning algorithms remain plagued by the challenge of explainability, making it desirable to have more understandable, deeper models that facilitate better-informed

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