Chapter 1
A Hybrid Swarm Intelligence and Machine Learning Approach for Predictive Analysis of Sleep Disorders

G. Surekha
https://orcid.org/0009-0003-6278-8411
Bharath Institute of Higher Education and Research, India

Edwin Shalom Soji
https://orcid.org/0009-0004-2829-0481
Bharath Institute of Higher Education and Research, India

ABSTRACT

Millions of patients suffer from sleep disorders, which is a global problem. It leads to severe health problems such as cardiovascular diseases, depression, and impairment of cognitive activity. Traditional polysomnography is expensive and time-consuming. Clinical supervision is required during the diagnosis process; hence, the method needs to be changed to enhance the accuracy of the diagnosis. By reducing dimensionality and optimizing models with the help of swarm intelligence algorithms, such as PSO and ACO, feature selection feeds the optimized features into numerous machine learning classifiers for training, including SVM, random forests, deep neural networks, and many more. Additionally, validation on benchmark sleep disorder datasets demonstrates better classification accuracy, sensitivity, and specificity

DOI: 10.4018/979-8-3373-6796-5.ch001

compared to traditional methods. This also suggests that a hybrid model, combining swarm intelligence for feature optimization with machine learning classification, exhibits substantial predictive accuracy with minimal computational complexity.

INTRODUCTION

Sleep disorders are prevalent, affecting millions of individuals across the globe and occurring in many different forms, including insomnia, sleep apnea, restless legs syndrome, and narcolepsy. Sleep disorders not only affect the sleep pattern of individuals but also garner severe consequences to their mental as well as physical health. Sleep disorder patients will tend to acquire a heightened risk of experiencing any kind or degree of chronic diseases in health, like cardiovascular diseases, obesity, diabetes, depression, and mental retardation. The risky effect of insufficient or inadequate sleep is not only confined to direct unhappiness. Still, it can potentially result in long-term health complications with catastrophic implications for overall health. Conversely, sleep apnea, the nocturnal periodic temporary cessation of breathing, is causally linked to hypertension, heart disease, and stroke (Greenlund and Carter, 2022). Long-term sleep deprivation or wakefulness can lead to elevated levels of stress, compromised immune systems, as well as unlimited quantities of mental illnesses like depression and anxiety (Hu et al., 2023). On the other hand, restless leg syndrome induces a strong urge to move the legs while resting, leading to disrupted sleep and an increased vulnerability to hypertension (Sheta et al., 2023).

Likewise, narcolepsy, characterized by sudden and uncontrollable sleep attacks, can significantly impact a person's performance at work during daily activities, ranging from productivity to safety (Controne et al., 2022). Because the wide-ranging effects of sleep disorders, if not treated or diagnosed late, may develop into severe health problems, they must be diagnosed early enough for effective treatment with the help of quality-of-life enhancement and prevention of future health complications. However, although early diagnosis is of the highest importance, the present gold standard in diagnosing sleep disorders, i.e., polysomnography (PSG), is beset with variability. PSG is an expensive and time-consuming test in which brain waves, heart rate, sleep breathing, and muscle activity are measured (Alzyoud et al., 2024). Since the most accurate method of sleep disorder diagnosis, unaffordability, together with the requirement for clinical supervision, rules out access by most patients, particularly those from the developing world. The treatment is also prolonged and requires patients to stay overnight in sleep centers, a significant access barrier for most patients (Aiyer et al., 2022). Thus, there is a greater demand for more affordable and accessible diagnostic tests that can be conducted in other locations (Sheta et al., 2021). These also ease the healthcare systems' load and improve patient outcomes