

nFOPT-Driven AI Sleep Analytics for OSA Risk Stratification and Sleep Quality Estimation

Introduction: Obstructive Sleep Apnea (OSA) significantly impairs sleep quality and daytime alertness, especially in military personnel who face high operational and cognitive demands. Polysomnography (PSG), while being the diagnostic gold standard, is impractical for large-scale or continuous monitoring. This study aims to develop and validate a contactless sleep monitoring system using AI-enhanced smart mattress data integrated with machine learning (ML) algorithms to classify OSA severity and estimate sleep quality among hospitalized military personnel.

Materials and methods: Sleep data from military inpatients will be collected using a smart mattress system (Huijia Health Life Technology Co., Ltd.) that records physiological signals (heart rate, respiratory rate, body movement) simultaneously with PSG. Supervised ML models-random forest, support vector machines, and deep neural networks-will be trained to classify OSA severity and predict sleep quality. SHAP values will be applied to interpret model outputs and identify key contributing features.

Results: We expect to establish a high-performing and interpretable model capable of classifying OSA severity with high accuracy and estimating sleep quality non-invasively. The model may also uncover latent relationships between OSA and degraded sleep, enabling early intervention and clinical decision making.

Conclusions: Integrating smart mattress technology with ML provides a novel, non-contact, and scalable solution for OSA risk detection and sleep quality assessment. This approach could transform sleep monitoring and enhance military healthcare strategies.

中文題目：以智慧床墊訊號建構之 AI 睡眠分析：OSA 風險分層與睡眠品質估測
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