

Deep Learning-Based Sleep Stage Classification Using Wavelet-Based Features from PPG Signals

Rashmi Kumari^{*+}, Pabitra Das^{*+}, Surita Sarkar^{*+}, Somarouthu Kaarthikeya^{*+}, D.V. Samhita^{*+}, Amit Acharyya^{*+}

^{*} Indian Institute of Technology, Hyderabad, ⁺ Sense Health Technologies Private Ltd, Hyderabad

Aim: Our aim is to predict five different classes of sleep stages.

Methods: A deep-learning based model was used to predict 5 classes of sleep stages (Wake", "N1", "N2", "N3" and "REM"). We utilized the 2nd Order DWT of PPG and Root Mean Square of the Successive Differences (RMSSD) as input to the model for training. MESA dataset version 0.3.0 dataset, containing 2056 subjects data was used for this task, it provides sleep stages labels for every 30 sec of data. Pre-processing step comprised first filtering the PPG with a 4th order Butterworth filter, having a cutoff frequency range 0.5-8Hz. Filtered signals were then reshaped to 30 sec data window. Signal Elimination process was done after finding RMSSD of each 30 sec PPG signal window and applying the condition if signals having RMSSD > 600 then eliminate signal or else keep it. Any RMSSD value > 150 is medically insignificant for any healthy or even for unhealthy persons but to keep in the safe place we keep this value till 600. Instead of resampled PPG signals to 64Hz, as the sleep stages analysis did not require minor details of changes in PPG morphology, we applied the 2nd order DWT to the signal to prevent the loss of any data. At last total pre-processed data was splitted into an 8:2 ratio, indicating that 80% of the total combined data was kept for model training and 20% for testing. Later further 8:2 split was done on the train data for train and validation data.

Results: F1 Score(Avg.): 0.71063, Accuracy: 0.71092, Cohen's kappa coefficient: 0.6373.

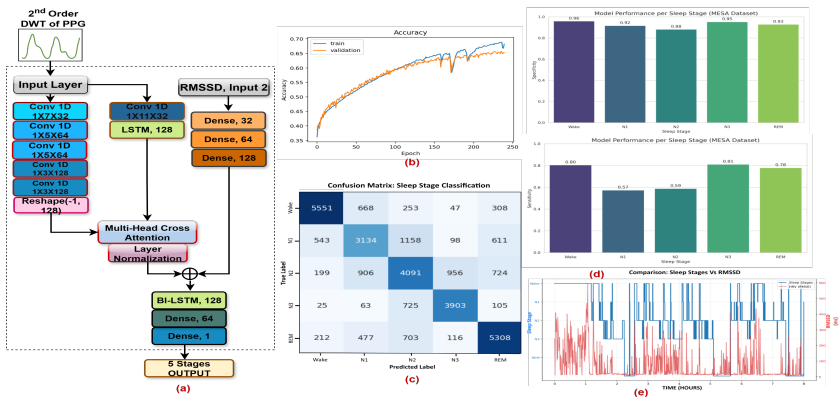


Figure 1: (a) Proposed Architecture (b) Training and Validation accuracy curve (c) Confusion Matrix for 5 sleep stages (d) UP— Specificity, Down— Sensitivity (e) Sleep Stages Vs RMSSD graph to show the same pattern changes.