ABSTRACT

Detecting epileptic seizures from EEG recordings remains a challenging task due to the non-stationary, complex nature of the signals and the limitations of manual analysis. This study presents an automated classification method that integrates Modified Variational Mode Decomposition (VMD) with cross-correlation-based IMF selection and Support Vector Machine (SVM) classification. EEG data from the Hauz Khas and Bonn University datasets were decomposed into 10 Intrinsic Mode Functions (IMFs) using VMD. Instead of using all IMFs, which can introduce redundancy and increase computational load, a cross-correlation strategy was applied to evaluate the similarity of each IMF with the original EEG signal. Across both datasets, the most informative IMFs were consistently low-frequency components; for Hauz Khas, IMF 10 showed the highest correlation ($r = 0.726$, frequency = 2.82 Hz), while for Bonn, IMF 2 was most frequently selected ($r = 0.64$, frequency = 7.11 Hz). This selection process significantly reduced feature dimensionality (from 110 to 11 features for Hauz Khas, and 110 to 44 for Bonn) without sacrificing relevant signal characteristics. Selecting only the top 1 IMF for Hauz Khas and the top 4 IMFs for Bonn yielded optimal classification results with reduced computational cost. Modified VMD further improved efficiency, reducing computation time by 90.16% and memory usage by 23.05% for Hauz Khas, and by 66.39% and 10.02% respectively for Bonn. The proposed method achieved 100% accuracy, precision, recall, and F1-score, outperforming conventional all-IMF approaches in performance and efficiency, demonstrating a minimal set of representative IMFs can maintain accuracy while optimizing computational resources.

Keywords: EEG, epileptic, VMD, cross correlation, SVM.