HARDC : A novel ECG-based heartbeat classification method to detect arrhythmia using hierarchical attention based dual structured RNN with dilated CNN

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ABSTRACT

Deep learning-based models have achieved significant success in detecting cardiac arrhythmia by analyzing ECG signals to categorize patient heartbeats. To improve the performance of such models, we have developed a novel hybrid hierarchical attention-based bidirectional recurrent neural network with dilated CNN (HARDC) method for arrhythmia classification. This solves problems that arise when traditional dilated convolutional neural network (CNN) models disregard the correlation between contexts and gradient dispersion. The proposed HARDC fully exploits the dilated CNN and bidirectional recurrent neural network unit (BiGRU–BiLSTM) architecture to generate fusion features. As a result of incorporating both local and global feature information and an attention mechanism, the model's performance for prediction is improved. By combining the fusion features with a dilated CNN and a hierarchical attention mechanism, the trained HARDC model showed significantly improved classification results and interpretability of feature extraction on the PhysioNet 2017 challenge dataset. Sequential Z-Score normalization, filtering, denoising, and segmentation are used to prepare the raw data for analysis. CGAN (Conditional Generative Adversarial Network) is then used to generate synthetic signals from the processed data. The experimental results demonstrate that the proposed HARDC model significantly outperforms other existing models, achieving an accuracy of 99.60%, F1 score of 98.21%, a precision of 97.66%, and recall of 99.60% using MIT-BIH generated ECG. In addition, this approach significantly reduces run time when using dilated CNN compared to normal convolution. Overall, this hybrid model demonstrates an innovative and cost-effective strategy for ECG signal compression and high-performance ECG recognition. Our results indicate that an

automated and highly computed method to classify multiple types of arrhythmia signals holds considerable promise.

KEYWORDS
Arrhythmia; BiGRU–BiLSTM; Dilated CNN; ECG; Hierarchical attention; Preprocessing

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