Premature Ventricular Contraction Recognition for Wearable ECGs using Modified Frequency Slice Wavelet Transform and Convolutional Neural Network

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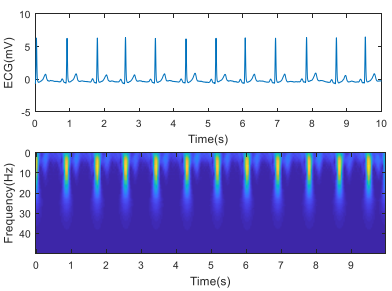
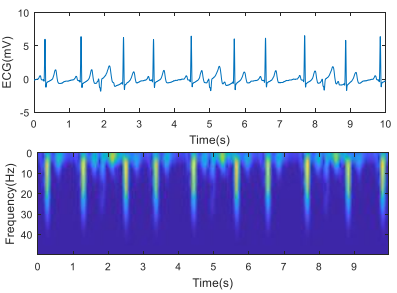
Progress in wearable techniques makes the long-term daily electrocardiogram (ECG) monitoring possible. It allows the physician to diagnose heart diseases and risks more accurately. Premature ventricular contraction (PVC) is one of the most common cardiac arrhythmias and its accurate detection is particularly important for real-time monitoring life-threatening arrhythmias. This paper proposed a method by combining the modified frequency slice wavelet transform (MFSWT) and convolutional neural network (CNN). Training data are from the 2018 China physiological signal challenge (934 PVC and 906 non-PVC recordings). The first 10-s ECG waveforms in each recording were transformed into 2-D time-frequency images using MFSWT, with a fixed pixel size of 300×100. Then, the 2-D images were fed into a CNN model for feature extraction and PVC/non-PVC classification.

A 25-layer CNN structure was constructed. Except the input and output layers, it includes five convolution layers with kernel size of 3×3, five dropout layers, five ReLU layers, five maximum pooling layers with kernel size of 2×2, a flatten layer and two fully connected layers. Then, we employed a balanced image data set to train the model. Test data were recorded from 12-lead Smart ECG vests. ECGs were segmented into 10-s episodes and were further manually labeled as PVC or non-PVC by clinical experts, including 775 PVC recordings and 742 non-PVC recordings. Results on the test data showed that, the proposed combination method achieved a high accuracy of 97.89% for PVC/non-PVC episodes classification, indicating that the combination method of MFSWT and CNN provides possible to accurately identify PVC from the wearable ECG recordings.



Non-PVC episode and its MFSWT image



PVC episode and its MFSWT image