Performance evaluation of time-frequency distributions for ECG signal analysis

ABSTRACT

The non-stationary and multi-frequency nature of biomedical signal activities makes the use of time-frequency distributions(TFDs) for analysis inevitable. Time-frequency analysis provides simultaneous interpretations in both time and frequency domain enabling comprehensive explanation, presentation and interpretation of electrocardiogram (ECG) signals. The diversity of TFDs and specific properties for each type show the need to determine the best TFD for ECG analysis. In this study, a performance evaluation of five TFDs in term of ECG abnormality detection is presented. The detection criteria based on extracted features from most important ECG signal components (QRS) to detect normal and abnormal cases. This is achieved by estimating its energy concentration magnitude using the TFDs. The TFDs analyse ECG signals in one-minute interval instead of conventional time domain approach that analyses based on beat or frame containing several beats. The MIT-BIH normal sinus rhythm ECG database total records of 18 long-term ECG sampled at 128 Hz have been analysed. The tested TFDs include Dual-Tree Wavelet Transform, Spectrogram, Pseudo Wigner-Ville, Choi-Williams, and Born-Jordan. Each record is divided into one-minute slots, which is not considered previously, and analysed. The sample periods (slots) are randomly selected ten minutes interval for each record. This result with 99.44% detection accuracy for 15,735 ECG beats shows that Choi-Williams distribution is most reliable to be used for heart problem detection especially in automated systems that provide continuous monitoring for long time duration.

Kayword: Choi-Williams distribution; Dual-tree wavelet transform; Energy concentration estimation; Non-stationary signals; Normal ECG analysis; Time-frequency distribution.