Study of Traditional and Enhanced Poincare Plot Descriptors for Atrial Fibrillation Detection

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Background: Atrial Fibrillation (AF) is a common cardiac arrhythmia associated with a higher risk of stroke. Therefore, detecting AF versus normal sinus rhythm (NSR) and other rhythms is an active research area. This article studies extracted descriptors/features from the Poincare Plot of RR intervals for AF detection.
Methods: We used AF, NSR, other rhythms, and noise from PhysioNet/Computing-in-Cardiology Challenge 2017 training dataset in this study (NSR: 5050, AF: 738, other rhythms: 2456, and noise: 284). After QRS detection, a 2D and 3D Poincare plot of RR intervals was constructed. The 3D Poincare plot is obtained from the 2D Poincare plot, where the number of occurrences at the same points is added as the third dimension. Three traditional Poincare plot descriptors (SD1, SD2, and SD1/SD2) and nine geometric features extracted from the 3D Poincare plot (e.g., area, perimeter, angles, height, and the length of the sides of the obtained pseudo triangle from the points distribution in 3D Poincare plot) were calculated. ANOVA test was used to identify significantly different features between AF and other groups. K-Nearest Neighbors (KNN) was trained on 70% of the data as a train set, and the accuracy was evaluated on 30% as a test set.
Result: The ANOVA result shows that extracted descriptors of the 3D Poincare plot were significantly different between groups ($p<0.001$). Using significant features identified with ANOVA for KNN training, the F1 score was 93.8% and 61.7% for NSR and AF detection, respectively.
Discussion: The results show that extracted features from the 3D Poincare plot have the potential to capture the differences in the pattern in this space for AF compared to NSR and other arrhythmias. Therefore, extracted features might be integrated into automated AF detection algorithms.