Sleep Apnea Detection using Multi-lag PoincarePlot

Shahab Rezaei[1], Sadaf Moharreri[2], Nader Jafarnia Dabanloo[3], Saman Parvaneh[3,4]

[1]Islamic Azad University, Central Tehran Branch, Tehran, Iran
[2]Islamic Azad University,Khomeini Shahr Branch, Isfahan, Iran
[3]Islamic Azad University, Science and Research Branch, Tehran, Iran
[4]Edwards Lifesciences, Irvine, CA, USA

Background:
Poincare plot is a geometrical representation of RR time series to study heart rate dynamics. Analysis of Poincare plot with different lags provides insights into the autonomic control of the heart. In this research, geometry descriptors of points in the Poincare plot of RR time series reconstructed in 10 different lags are used for detecting sleep apnea.

Methods:
The Poincare plot of RR time series was reconstructed using ten different lags (1-10). For each lag, traditional (SD1, SD2, and SD1/SD2) and advanced features were extracted. More specifically, advanced features including angle, area, perimeter, and the average of point's distances relative to the line of identity proposed to quantify points' distribution in the Poincare plot. For evaluating the new features and their application for apnea detection, two groups of 70 ECG recordings (Apnea-ECG database and Normal Sinus rhythm database from the Physionet database) from the PhysioNet were used. The duration of all the recording was 5 minutes. Kruskal-Wallis test was used for univariate analysis to find significant features between two groups. *K* nearest neighbor (KNN) was trained on 70% of data as a train set, and the accuracy was evaluated on 30% of data as a test set.

Result:
The univariate analysis results show that features related to the line of identity were significantly different between the two groups ($p<0.001$). The accuracy, sensitivity, and specificity of the KNN for distinguishing sleep apnea versus NSR were 91%, 89% and 90%, respectively.

Discussion:
The results show that by increasing the lags in the Poincare plot, the point's distribution focused on the center of the line of identity, while in the smaller lags, the shape of the point's dispersion is more stretched. So, by increasing the lags, the angle increase while the area decrease.