Accurate R Peak Detection and Advanced Preprocessing of Normal ECG for Heart Rate Variability Analysis

Devy Widjaja*, Steven Vandeput, Joachim Taelman, Bea Van den Bergh and Sabine Van Huffel

Department of Electrical Engineering, Katholieke Universiteit Leuven, Leuven, Belgium

Heart rate variability (HRV) analysis is well-known to give information about the autonomic heart rate modulation mechanism. In order to avoid erroneous conclusions, it is of great importance that only sinus rhythms are present in the tachogram and therefore, preprocessing the RR interval time series is necessary. R peaks have to be detected accurately in the ECG and missed peaks or false peaks have to be corrected. Also ectopic or supraventricular beats have to be removed. This paper presents an advanced automated algorithm to preprocess RR intervals obtained from a normal ECG. In case of too many (and falsely) detected R peaks, the algorithm deletes redundant R peaks by seeking the most optimal summation of consecutive small RR intervals, according to an adaptive reference RR interval which is composed of a weighted average of some previous RR intervals. The location of missed R peaks is detected if an RR interval is more than 1.8 times the reference interval and corrected by inserting new R peaks. If no optimal summation (less than 30% difference with the reference interval) of small RR intervals is possible or the RR interval is between 1.3 and 1.8 times the reference interval, the R peak is flagged for manual revision.

Validation of this algorithm was performed on one hour ECG signals of 20 pregnant women. R peaks were detected using the Pan-Tompkins algorithm after which the preprocessing algorithm was executed. R peaks before and after preprocessing were manually revised for redundant and missed R peak detections. Before preprocessing, more than 1% of the detected R peaks were incorrect while preprocessing corrected more than 94% of these errors leading to an overall error rate of 0.06%.

Our automated preprocessing technique therefore restricts the manual data check to the absolute minimum and allows a reliable HRV analysis.