Clustered Standard Deviation and its Benefit to Identify Atrial Fibrillation

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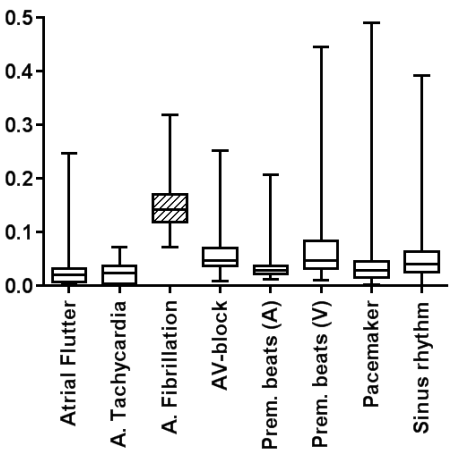
Background: Atrial fibrillation (AF) is a dysfunction of heart atriums shown as irregular heart activity; it is also connected with a higher risk of heart failure. Since AF may occur episodically, it is usually diagnosed using ECG Holter recordings. However, the automated detection process is complicated by the occurrence of other pathologies and noise. Here, we present a new feature to distinguish AF from sinus rhythm as well as from other common pathologies. It is a modification of a standard deviation of RR intervals: Clustered Standard Deviation (CSTD). It uses the fact that RR intervals during AF do not form clusters.

Method: QRS complexes are extracted from the ECG signal, and resulting RR intervals are ordered by their length. Then, RR clusters are found whenever the gap between ordered RR intervals is bigger than maximal clustering gap (based on the mean difference of ordered RR intervals). When RR clusters are defined, the mean value is computed for each RR cluster. Finally, CSTD is computed using a formula for standard deviation using cluster-specific mean values instead of a global mean.

Results: CSTD was evaluated for 3717 files from a private dataset (MDT company, Brno, Czechia), 60 seconds length, 1-lead, 250 Hz sampling frequency. Files were classified by rhythm type. CSTD showed high values for AF while remaining low for other classes; CSTD between AF and other classes showed AUC 0.95. For comparison, a standard deviation of RR intervals leads to AUC 0.65 due to its sensitivity to other pathologies. Test on public MIT-AFDB dataset using CSTD on a balanced set of 520 recordings shown AUC 0.92.



Clustered Standard Deviation is high for atrial fibrillation and low for other classes