A Novel Multi-lead Method for Clustering Ventricular Ectopic Heartbeats

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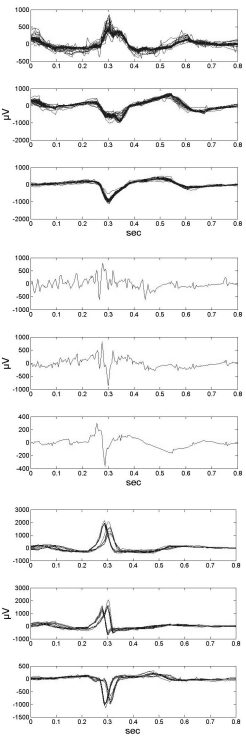
An ectopic heartbeat initiated by the ventricles is considered as premature ventricular contraction (PVC) beat. For any individual, unifocal PVCs are typically monomorphic, whereas multifocal PVCs have polymorph contour. The ectopic rate especially of multimorphic PVCs is significantly associated with sudden death and many other main arrhythmic events. In order to group PVCs upon their morphology a robust clustering method has been developed.

In this work, the already existing approach of combining Principal Component Analysis (PCA) and Self Organizing Maps (SOM) for patient specific beat clustering is used and optimized to deal with a variable number of leads and to attenuate artifacts:

Using the discrete Wavelet Transform for every detected and isolated PVC certain approximation coefficients are selected. Afterwards a PCA is performed on these coefficients separately for every lead. The weight vectors of a representative number of principal components are the input of a SOM. Choosing the size of the SOM to 7x7 enables to distinguish among 49 classes; hand in hand with HES® HOLTER. The output of the SOM, a reduced representation of the data, is the input for agglomerative hierarchical clustering using centroid-distance. The presence of an "elbow" in the intra cluster dissimilarity function relative to the number of clusters indicates a sharp change in homogeneity of the merged clusters.

In the case of several elbows, the corresponding cluster numbers are candidates for optimal clustering. Using a "resolution index" most promising cluster groups (up to six) are organized in an ascending order according to their cluster number.

The algorithm is tested on manually annotated multi-lead records using three leads. The performance is evaluated visually, since no reference data for PVC clustering is available. All major classes are successfully identified using a resolution index of only three.



PVC classification BS-06 in three leads