Cardiac EGM Automatic Screening of egms transmitted by Implantable Electronic Devices

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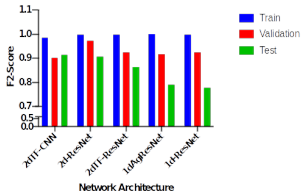
Introduction: The objective of this work is to benchmark different deep neural architectures for noise detection against cardiac arrhythmia episodes recorded by cardiac implantable electronic devices (CIEDs) and transmitted for remote monitoring.

Methods: The database consisted of 805 patients representing a total of 10471 recordings, each composed of right ventricular bipolar signals, and possibly 1 or 2 additional EGM signals depending on the type of device (single, dual, or triple-chamber pacemaker or CIED). The highly unbalanced dataset (6% of noisy records vs 94% of ventricular events) was divided into 3 datasets: training (417 patients, 4998 recordings), validation (142/2621), and test (328/2843). Five deep learning approaches were trained and optimized to test three key aspects of the classifier; i) the input space for handling 1d signals; ii) the unbalanced dataset with missing signals, and iii) the deep network architecture. Results were evaluated using a clinically relevant $F2$ score.

Results: A CNN-based network(2DTF-CNN) that used 2D time/frequency maps of the ventricular bipolar signal as input gave the best results on the test set($F2 = 0.914$), outperforming pre-trained ResNet (2DTF-ResNet) ($F2 = 0.863$). However, a CNN network based on a naive ResNet architecture trained on 2D images of the ventricular signal time traces (2D-ResNet) also performed very well ($F2 = 0.906$). Both architectures surpassed networks with 1D signals as input (1D-ResNet: $F2 = 0.779$, 1D-AgResNet: $F2 = 0.791$). Additional information given by the extra signals slightly improved the results (1DAg-ResNet vs 1D-ResNet). Imbalance in the dataset was handled either by a specific weighted cost function or by ad-hoc balancing in the training data (0.90 vs 0.82, respectively).



Conclusion:This study proposes deep learning approaches for the analysis of remote monitoring recordings from CIEDs. The detection of noise allows efficient management of this large daily flow of data. The results presented here allow us to consider the deployment of these solutions in clinic.