Automatic Detection of Atrial Fibrillation Using Electrocardiomatrix and Convolutional Neural Network

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Background: Long term electrocardiogram (ECG) monitoring is a standard clinical routine in cryptogenic stroke survivors to assess the presence of atrial fibrillation (AF). However, manual evaluation of such records is time consuming even for experienced cardiologist. Computer-based detectors of AF have shown to be helpful in diagnostic procedures to avoid further life-threatening conditions. The electrocardiomatrix (ECM) technique allows compact and bidimensional representation of the ECG preserving morphology and rhythm characteristics, thus facilitating its analysis. In this study, we present a convolutional neural network (CNN) approach for automatic detection of AF based on ECM images.

Methods: ECG segments of ten heartbeats were converted into ECM images. A CNN – composed of 3 convolutional layers, 3 batch normalization, 3 ReLu activation, 2 max pooling, 1 fully connected, 1 softmax, and 1 classification layer – was implemented to classify the ECMs between non-AF and AF. Using the MIT-BIH-AFDB and considering an overlapping of 50%, 239880 and 215920 images were generated for non-AF and AF, respectively; 80% were used for training and 20% for validation. Three-fold cross-validation was performed with datasets selected manually, such that validation sets were always taken from different records than training data. An average accuracy of 87.71%$\pm$7.03 was achieved during validation. An independent database consisting of 38 ECG signals with manual annotations on AF and non-AF was used for testing; 7397 and 22455 non overlapping images were generated for non-AF and AF, respectively, and classified with an accuracy of 86.08%.

Results: The proposed methodology for AF detection suggest that automatic analysis of ECM images is a potential way to classify AF episodes, even as brief as ten heartbeats.