ECGI with a Deep Neural Network and 2D normalized Body Surface Potential Maps

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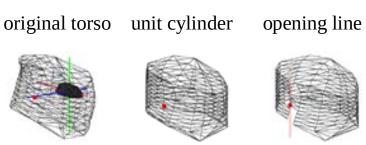
Aim: ECGI reconstructs heart-surface potentials from body-surface potentials using the transfer matrix for a patient-specific torso-heart geometry derived from CT or MRI. The aim of this study is to build a proof-of-principle Deep Neural Network (DNN) which directly maps a 2D normalized Body-Surface-Potential Map (BSPM) to a normalized heart-surface-potential Bulls-Eye plot, without using a transfer matrix.

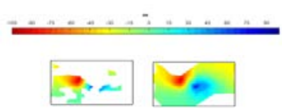
Data: 12000 different time-instants (and corresponding 2D normalized BSPM maps) originating from 92 QRS complexes of four dogs were used for training (7200), verification (2400) and testing (2400).

Methods: Deep neural networks are powerful in computer vision and image processing. The approach in this study is to represent BSPMs as well as heart surface potentials by images, and to train a DNN which models their relationship. For heart surface potentials, a 272 x 180 regular grid of pixels unfolded from the normalized BullsEye plots obtained with UNISYS is used. For BSPMs we developed normalized images following three steps: (1) The torso geometry containing the electrode locations is transformed into a normalized cylinder by radial projection. (2) The cylinder is opened on the back at the closest point to the heart and unrolled to produce a rectangle. (3) The measured potentials are used to generate a resampled image with a 312 x 220 regular grid of pixels by weighted interpolation. The DNN built for this study is a nine-layer neural network (five down-layers, four up-layers) for which the size of all convolution filters is 5 x 5.

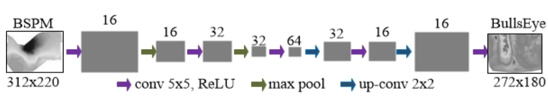
Conclusions: The paper offers a methodology to translate BSPM recordings as well as heart surface potentials into normalized 2D images. This allows the suggested DNN to provide a generalizable model to reconstruct epicardial potentials without transfer matrix. Performance of the DNN is currently under investigation and will be demonstrated with examples.



(a) unrolling process



(b) interpolation



(c) DNN