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Appendix: Summary of Best Papers Selected for the IMIA Yearbook 2023, Section Sensors, Signals and Imaging Informatics

Malik J, Devecioglu OC, Kiranyaz S, Ince T, Gabbouj M

Real-Time Patient-Specific ECG Classification by 1D Self-Operational Neural Networks

IEEE Trans Biomed Eng 2022 May;69(5):1788-801. doi: 10.1109/TBME.2021.3135622

This work addresses the development of a compact system with real-time capability and high accuracy for classification of patient-specific ECGs and arrhythmia detection. The method is based on 1D Self-organized Operational Neural Networks (1D Self-ONNs) and represents the first study ever to propose 1D Self-ONNs for a classification task that can surpass 1D CNNs. For training and validation of this method, 44 patient datasets from the MIT/BIH arrhythmia database were used, containing a total of 100,389 ECG beats. This approach has achieved an average accuracy of 98.0% and 99.04% and an average F1 score of 76.6% and 93.7% in the classification of supraventricular (SVEB) and ventricular ectopic beats (VEB), respectively, highlighting its excellent clinical applicability. Due to their self-organizing ability, self-ONNs are superior to conventional ONNs and showed the best classification performance reported so far.

Xia Y, Chen X, Ravikumar N, Kelly C, Attar R, Aung N, Neubauer S, Petersen SE, Frangi AF

Automatic 3D+t four-chamber CMR quantification of the UK biobank: integrating imaging and non-imaging data priors at scale

Med Image Anal 2022 Aug;80:102498. doi: 10.1016/j.media.2022.102498

Accurate 3D modeling of cardiac chambers is essential to study the correlation between cardiac morphology and other patient information. The authors introduced a Multi-Cue Shape Inference Network (MCSI-Net), with a statistical shape model embedded in a convolutional neural network and used both, phenotypic and demographic information from the cohort to infer subject-specific reconstructions of all four cardiac chambers in 3D. For training and validation of this method, CMR images from the UK Biobank were used including 40,000 subjects at 50 time-frames, in total two million image volumes. Interestingly, the model generates a more consistent heart shape than the manual annotations in the presence of inter-slice motion and demonstrates strong agreement with the reference ranges for cardiac structure and function across the cardiac ventricles and atria. This is the first work to use such an approach for patient-specific cardiac shape generation and highlights the positive impact of incorporating patient data on the accuracy of predicted shapes. In addition, MCSI-Net is capable of generating accurate 3D shapes with only a quarter to a half (approximately 23% to 46%) of the available image data, which accelerates patient-specific CMR scan acquisitions.