Hermite Based Parametric Representation of Magnetohydrodynamic Effect for the Generation of Synthetic ECG Signals During Magnetic Resonance Imaging

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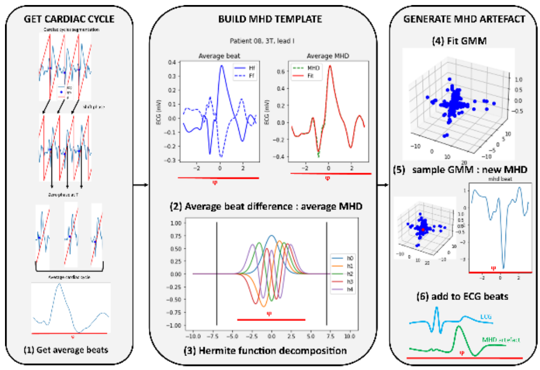

Figure 1 Pipeline to build MHD artefacts

Aim. ECG signals during Magnetic Resonance Imaging (MRI) are often distorted by a strong magnetohydrodynamic (MHD) artefact. This effect is induced by charged particles in blood flowing under the MRI static magnetic field. Models of this artefact are hard to assess due to the absence of ground-truth measurements for this phenomenon. While large annotated ECG databases have been publicly released, there are only few small databases containing ECG signals acquired during MRI. This scarcity of data hinders the development of reliable automated ECG in MRI analysis solutions. We proposed a model to generate synthetic MHD artefacts to augment a dataset of standard ECG and to train deep learning models more robust to this artefact. **Methods.** An open database of ECG in MRI was used to extract a median MHD template over a small subject population. These templates were decomposed on a basis of Hermite functions to represent the MHD effect by a set of 29 parameters. A Gaussian mixture model was fitted on these coefficients, which allows MHD artefacts to be generated by sampling this probability distribution. The model was assessed on a heartbeat classification task on an in-house database of ECG signals acquired in a 1.5T MRI scanner during standard clinical examination. A convolutional neural network (CNN) trained on the MIT-BIH arrhythmia (MITAR) database without pretraining was compared with models pretrained on the CinC 2021 database using the proposed MHD specific data augmentation. **Results.** The randomly initialized CNN, and the proposed augmentation obtained average F1 scores of 0.26, and 0.59 respectively on the in-house MRI database. **Conclusion.** The proposed MHD artefact generator can be used to effectively augment ECG data and learn a representation robust to MRI environment distortions.