Karlsruher Institut für Technologie

Institute of Biomedical Engineering

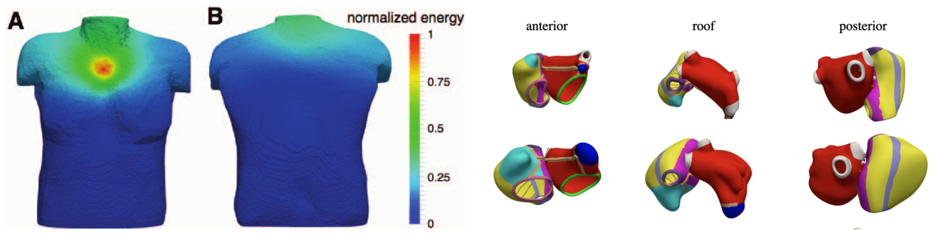
IBT

Master Thesis

Optimizing Electrode Placement for Atrial Cardiomyopathy Diagnosis Using in Silico Modeling

Motivation

Atrial cardiomyopathy (ACM) is associated with low-voltage areas and therefore prolonged total atrial conduction time.
Jadidi et al. demonstrated that total atrial conduction time correlates with amplified P-wave duration (APWD). Consequently, APWD in a 12-lead-ECG can be used to diagnose atrial cardiomyopathy.
To accurately determine APWD, high-quality P-wave signals are essential. Therefore, identifying a lead with the best APWD characteristics—such as high amplitude, high signal-to-noise ratio (SNR), and a clear onset and offset—is crucial. This approach could enhance the accuracy of APWD calculation and facilitate the use of wearables for broader patient screening.



Task

Utilizing volumetric statistical shape models of the human heart and torso, electrophysiological simulations will be conducted. The finite element method (FEM) or the lead field approach will be employed to calculate body surface potential maps (BSPM). Features representing the quality of the APW will be defined and used to identify the optimal electrode positions for APWD within the analyzed virtual cohort.
In a second step, a realistic modeling of fibrotic tissue will be incorporated into the simulations to account for ACM (via fibrosis extent) and therefore longer APWDs. The integration of a realistic fibrosis distribution and corresponding tissue properties into the shape model will be carried out during this project. Simulations with different extents of fibrosis will be conducted. A sensitivity analysis will be performed to evaluate the optimal electrode positions for APWD in relation to the extent of fibrosis. Additionally, these electrode positions will be assessed concerning the heart axis of the virtual patients.
The identified optimal electrode positions will be approximated using a linear combination of the 12-lead ECG, and this approximation will be compared to the optimal leads. In the final step, the determined electrode positions will be validated on patients at the Universitäts-Herzzentrum Freiburg - Bad Krozingen.

Notes

- Programming skills in python advantageous
- Basic knowledge of cardiac physiology is beneficial

The weighting of individual elements can be customized according to your preferences.

Area of Research
Cardiac modeling

Project
Optimizing Electrode Placement for Atrial Cardiomyopathy Diagnosis Using in Silico Modeling

Applicable Study Fields
Electrical Engineering,
Physics,
Informatics,
Mathematics

Start
Available from October

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