Multicomponent Organization Analysis in Spatial Domains of Atrial Fibrillation

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Introduction. Atrial fibrillation (AF) is one of the most common cardiac arrhythmias, and it is related to the risk of suffering stroke, heart failure, and clots apparition. Different phenomena, such as ectopic single activity, wavebreaks, or reentries, can cause AF. **Methods and materials.** This work presents a novel method based on regression models capable of detecting these tissue areas. We carefully inspected the frequency components in different arrhythmogenic substrates, performed an elastic net regression (ENR) to extract major contribution frequencies, and designed a 3D map representing the probability of the existence of arrhythmogenic focus. The proposed method was tested on different 2D and 3D AF simulations from our lab and EDGAR Database and benchmarking on the advantages of ENR to least-squares (LS) algorithmic implementations. **Results.** The 2D simulations using harmonics for a single dominant frequency of 21.5 Hz allowed us to identify the two main regions (stable rotor and wavebreaks) with both optimization algorithms, though some harmonics were lost. Stable rotors in atria with normal substrate identified clear regionalized maps with a significant number of harmonics of 5.9 Hz when rotor sources were at the left atrium, whereas regionalization for rotor sources in the right atrium yielded a smaller rotor region, but some harmonics were lost. Stable rotors in the left atrium with fibrotic substrate were also consistent with harmonics of 7.8 Hz. **Conclusions.** Multicomponent domains can generalize organization analysis based on harmonically related and fluctuating components. Different estimation algorithms can give similar results, and moderate harmonic loss can localize the spatial location of AF active sources.