Incorporating the Diameter of the Central Disc and the Widths of the Concentric Rings into the (4*n* + 1)-Point Method of Laplacian Estimation for Noninvasive Concentric Ring Electrodes

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Currently, tripolar concentric ring electrodes (CREs) show great promise in a range of applications including brain-computer interface and seizure onset detection, demonstrating their superiority to conventional disc electrodes, in particular, in accuracy of Laplacian estimation. Recently, we proposed a general approach to estimation of the Laplacian for an (*n* + 1)-polar electrode with *n* rings using the (4*n* + 1)-point method for $n \geq 2$ and used it to derive novel multipolar and variable inter-ring distances CRE configurations with potential to improve Laplacian estimation compared to currently used constant inter-ring distances tripolar CREs. The main limitation of the proposed (4*n* + 1)-point method is that it does not allow optimization of the diameter of the central disc and the widths of the concentric rings. The goal of this study is to incorporate these two parameters into the method along with the currently included number of rings, size of the CRE, and inter-ring distances. Two analytic approaches are used, one based on representing the central disc and concentric rings as clusters of points with specific diameter and widths respectively as opposed to the currently used single point and a circle. The second approach is based on representing the areas of the central disc and concentric rings as areas of a circle and a difference between the areas of two concentric circles respectively. This work is a part of our continued effort to improve the electrode design for noninvasive electrophysiology via CREs with our ultimate goal being determining suboptimal CRE designs for specific applications.