Abstract

A solution of Laplace's equation relating the transmembrane potential distribution of an active fiber in a volume conductor to its extracellular field distribution utilizing a Fourier-transform method [4] has been reformulated as a one-dimensional linear filtering problem. Formulation of the solution in this manner allows the application of well-known techniques in linear system theory and optimal linear filtering, thereby facilitating the solution for both the forward (from transmembrane to field potential distribution) and inverse (from field to transmembrane potential distribution) problems. The forward problem is shown to be a simple two-stage filtering process composed of a membrane and medium filter. In the inverse case, the field potential distribution is considered in the presence of additive measurement noise, and the best estimate in the least-mean-square sense is obtained for the transmembrane potential distribution. Discrete Fourier-transform techniques are applied to this reformulated Fourier-transform method, resulting in a fast, efficient algorithm for solution of the forward and inverse field problems.

Citation

E. C. Greco, J. W. Clark and T. L. Harman, "Volume-Conductor Fields of the Isolated Axon," Mathematical Biosciences, Vol. 33, pp.235-236, 1977.