

A 3-DIMENSIONAL NON-UNIFORM MULTI-RESOLUTION
MESH CLUSTERING AND ELECTRIC NETWORK GENER-
ATION SCHEME FOR BIOELECTROMAGNETIC SIMULA-
TIONS

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As the detail of the available biological computational models for bioelectromagnetic simulations increase, new schemes are needed for the efficient solution of larger discretized models. In this work, a scheme to model low frequency bioelectric interactions by means of non-uniform, multi-resolution, 3-dimensional network of impedances is introduced, and its application to the computation of current spread in the human retina stimulated by an array of electrodes to restore partial vision to the blind is presented.

The core method is based on the impedance method. However, while typical impedance method algorithms utilize uniform sized voxels, our proposed algorithm allows to apply different clustering strategies to different portions of the model, resulting in the generation of different voxel sizes and geometries in different areas. This strategy results in significant memory and computational time savings. This article presents a 3-dimensional generalization of the clustering methods previously used by our group on 2-dimensional models, as well as a scheme for generating SPICE compatible files describing the model properties in terms of electric circuit elements.

In addition, our scheme allows defining model areas having different levels of detail, keeping adequate spatial resolution in the parts of interest while reducing overall system size. Spatial coordinates of the mesh model are preserved on the resulting SPICE file, allowing for cross referencing between the physical model and the resulting electric circuit model.

Results related to the utilization of the proposed method for electrical stimulation of the human retina in a retinal prosthesis system to restore partial vision to the blind will be presented.

Abstract Submission Form
2004 National Radio Science
Meeting

Abstract: lazzi2270

Date Received: September 24, 2004

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2. K - Electromagnetics in
Biology and Medicine
3. (a)
4. C - Contributed Paper
5. No special instructions