On the Intraocular Impedance of an Epiretinal Stimulator Array

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Retinal implants can help restoring partial vision to patients suffering from degenerative diseases of the retina, such as Age-related Macular Degeneration and Retinitis Pigmentosa by replacing the functionality of no longer working photoreceptors with systematic electrical stimulation to neural cells further down the optical neural path.

The equivalent electrical impedance seen by the stimulating electrodes is an important parameter for the design of the implant. To precisely determine the impedance seen by a 60 electrode epiretinal stimulation array, a three-dimensional 100um resolution discrete model of a human eye, implanted epiretinal electrode array, associated electronics and surrounding tissue was built and simulated. Because of the low frequency of stimulation a quasistatic approximation was used for the numerical solution.

The model was formulated in terms of lumped circuital element admittances and solved using a multiresolution variant of the Admittance Method to reduce the size of the resulting linear system. The retina was approximated with a dual layer geometry; the inner layer captures the effect of the inner retinal cell layers, including the Optical Fiber Layer and Ganglion Cell layer, and the outer, less conductive layer, helps modeling the influence of the Pigment Epitelium in the current spread. The choroid, sclera and rectus muscles of the eye were also included in the model, as well as surrounding fatty tissue.

Various options for the implanted epiretinal stimulators have been numerically simulated using stimulating arrays having different firing patterns and positioned at different distances from the retinal surface. The intraocular impedance was approximated as the electrolyte impedance of the Randles model, and the obtained values compared with experimental data available in the literature. The effect of the different arrangements for stimulation on intraocular impedance will be discussed in the presentation.