On the Use of the Multiresolution Impedance Method for Optimal Stimulating Electrode Designs in an Implantable Retinal Prosthetic Device

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Retinal degenerative diseases such as Retinis Pigmentosa and Age Related Macular Degeneration cause blindness by progressively disabling the photo receptor cells in the human eye. Clinical studies have shown that in many cases the rest of the visual pathway (such as the ganglion cell layer and the optic nerve) has remained largely intact and functional. It has been demonstrated that some form of vision can be induced among patients who suffer from these diseases through electrical stimulation of the retina; further, the spatial location of the induced stimulation appears to correspond to the spatial location of points of light in the patient's field of vision. Thus, partial sight can be restored by using systematic electrical stimulation of the retina, using an array of electrodes. While several designs of stimulating electrode arrays for such a retinal prosthesis have been proposed, optimal stimulation and physical parameters must still be identified. In this presentation, we will demonstrate how the Mutliresolution Impedance Method can be used together with Fourier decomposition to simulate the interaction between a stimulating electrode array and the human retina, thus allowing us to compare different designs for the electrode array used in the retinal prosthesis. We will present results that compare current and potential gradients for arrays of 16, 64, and 144 electrodes (arranged in 4x4, 8x8, and 12x12 grids, respectively) at different distances of the stimulating electrode array from the retina in order to simulate realistic conditions of operation. Lastly, the effect of the shape of the electrodes on induced currents and voltages will be discussed.