Optimal Electrode Design of Cochlear Implants using Multiobjective Optimization

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We present a new procedure to design optimal electrodes for cochlear implants [1, 2]. The main objective of this study is to find an electrode design that maximize the focalization and minimize the power consumption simultaneously [3]. We propose an electrode formed by two conductive rings with a difference of potential between them. We analyze that the shape of the conductive rings and the difference of potential affects to the focalization ability and power consumption. The main steps involved in the procedure are: (1) Calculation of the electric potential induced by an electrode by solving the Laplace equation through the Finite Element Method (FEM); (2) Analysis of the response of a neuron to an applied field using NEURON with a compartmentalized cell model; (3) Optimization to find the best electrode designs according to power consumption and focalization by two evolutionary multiobjective methods based on the Non-dominated Sorting Genetic Algorithm II (NSGA-II) [4]: a straight multiobjective approach and a seeded multiobjective approach. To achieve these optimal designs, we have proposed objective functions to measure of electrode focalization and power consumption. Our procedure successfully achieves a non-dominated set of optimum electrode designs. A better focalization implies a lowest channel interaction and gives us the opportunity to include one extra electrode respect to the standard electrode array. Reducing the power consumption entail the extension of battery length. The non-dominated design with the same consumption that the standard electrode allows us to include three extra intracochlear electrodes. Ideally, we could include forty-six extra electrodes for the case of best focalization. Increasing the number of intracochlear electrodes could improve frequencial resolution and in consequence the hearing quality.

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