Optimal Excitation of Multiapplicator Systems for Deep Regional Hyperthermia

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Abstract—A method is proposed for determining the excitation amplitudes and phases of the elements of electromagnetic multiapplicator systems for optimizing the specific absorption rate (SAR) distribution around a deep-seated tumor. In this method, the ratio of the power dissipated in the tumor to a weighted summation of the powers supplied to the surrounding regions is optimized. The optimization procedure is combined with a recently proposed effective technique for analysis of various electromagnetic scattering and interaction problems. The general principle is applied to a two-dimensional problem of a piecewise homogeneous cylinder heated by an array of electric current filaments placed outside the cylinder. Numerical simulations are performed to check the effectiveness of the approach. The results demonstrate that using this optimization method, improved SAR distributions can be achieved. The extension to three-dimensional configurations is discussed.

of applicators in the array, to obtain improved field patterns, [2] is perhaps the only work proposing a method for determining an optimal excitation for a multiapplicator system which applies a full wave analysis to the electromagnetic problem. In this work, Morita *et al.* have tried to induce a specified electric field distribution in the body, choosing the simple zero-order Bessel function, optimal for heating the center of homogeneous circular cylinder, as the target field distribution in a rather complicated piecewise homogeneous cylindrical structure.

This paper presents a simple and efficient procedure for optimizing the relative electromagnetic power absorbed by a deep-seated tumor region, which is a quantity of interest in hyperthermia treatment. The outputs of the pro-