Contactless Dosimetry with a Regularized Integral Equation Based Method

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Cellular phones, laptops, Bluetooth systems, they are all devices that emit middle-to-high doses of electromagnetic radiation that penetrates materials and biological tissues in their vicinities. Recommendations from various institutions in Europe and United States dictate strict limits on the amount of electromagnetic radiation that can be tolerated within tissues and anatomical parts surrounding a radiating source. Currently available technologies that industry uses to assess the electromagnetic exposure and field levels are largely based on internal probes and phantoms. Phantoms are suitably designed dielectric structures obtained by filling with a dissipative liquid a container mimicking the shape of different anatomical parts whose electromagnetic exposition is desired to be studied. The measuring probes penetrate the phantom and effectuate measures of the electric and/or magnetic field. Unfortunately however, such an invasive measurement procedure presents several drawbacks. It is costly since necessitate of ad-hoc mechanical set-ups that in addition present severe issues in terms of repeatability of results and to crown it all, the need of repeatedly penetrating the dielectric phantom prevents from the use of solid dielectric materials and, as a consequence, liquid filled phantoms only can provide isotropic dielectric profiles.

To solve these limitations, this talk will present a source inversion algorithm that is capable to recover the field within a model of the human head in the presence of a radiating source (such as a mobile phone), starting from external field measurements and without a need for the numerical modeling of the source. The latter in fact will be replaced by an appropriately chosen simplified model that will avoid the detailed characterization of the electrically irrelevant details. This aspect of the method will be especially important for complex, hard to discretize and model, sources such as all the commercially available mobile phones. Moreover, differently from other inverse source formulations, the approach we are proposing relies on suitably regularized integral formulations both for modeling the dielectric parts and for discretizing the Helmholtz screens. The new regularized formulation is leveraging on a newly developed hierarchical spectral partitioning. The formulation has conditioning properties that are completely independent on the discretization density. This allows for the source to reside very near to the human head phantom under study.

A rigorous analysis will show the theoretical underpinning of the new approach. Moreover, the theoretical developments will be matched with numerical results, arising from real case scenarios, that will corroborate the theory and confirm the practical effectiveness of the newly developed method.