COMBINATION OF FDTD AND TIME-DOMAIN EQUIVALENT CURRENTS METHOD FOR SAFETY ASSESSMENT IN HUMAN EXPOSURE TO BASE-STATION ANTENNAS

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Abstract:

Current assessment of human exposure to mobile-phones base-stations antennas radiation are mainly based on the comparison of the electromagnetic field level on a certain point, where a person can stand, with the reference levels, defined by the ICNIRP [1] and National guidelines, which must not be exceeded. The specific absorption rate (SAR) values inside the exposed person must also be below the basic restriction defined in these regulations. The difficulty to compare the SAR inside the person exposed to the field of the antenna with the basic restrictions of the regulations is obvious, requiring calculation by using numerical methods. In most cases, the compliance with reference levels is enough to guarantee safety, but there are certain situations where the assessment of guidelines compliance by using reference levels can be inadequate. This can be the case of the exposure in the near field of base-station antennas or, in other cases, when the presence of scattering obstacles produces reflected and diffracted fields in different directions so that the incident field on a potentially exposed person could give place to local SAR values above the admissible ones, even though the spatially averaged field is below the reference level.

The finite-difference time-domain method (FDTD) is the most widely used technique for SAR assessment because it allows both a precise simulation of the field source and a detailed modeling of non-homogeneous scatterers of arbitrary geometry, as is the case of a human body, but in large exposure environments including large scattering objects the computational resources required can be too high. Several formulations have been developed to overcome these problems, as near to far field transformation algorithms, or methods combining FDTD with the Kirchhoff integral or with the uniform geometrical theory of diffraction (UTD). Nevertheless, to avoid numerical problems, a procedure for guidelines compliance assessment based in techniques always formulated in the time domain is desirable.

In this work, a high-frequency time-domain equivalent currents solution for the calculation of the far diffracted fields from perfectly conducting obstacles is presented to be combined with FDTD for dosimetry studies when scattering obstacles are present in large computational domains. The equivalent currents are developed from the physical theory of diffraction in the time domain (TDPTD), and an expression for the diffracted field is given in terms of a line integral along the edge, with the proper delays, and with diffraction coefficients, which depend only on the geometry of the problem, similar to those of the frequency domain techniques. This diffracted field is added to the incident

field at the corresponding timestep in a given point, and the total field so calculated is introduced in the FDTD formulation to calculate the SAR in a realistic 3D highfidelity human body model developed from REMCOM and the Hershey Medical Center. Several models of actual basestation antennas made from dipole arrays have been used, and several scenarios have been considered including metallic plates in the surroundings of the person. Results that demonstrate the accuracy and efficiency of the methodology are presented.

REFERENCES

[1] ICNIRP, International Commission on Non-Ionizing Radiation Protection, “Guidelines For Limiting Exposure To Time-Varying Electric, Magnetic, And Electromagnetic Fields (Up To 300 GHz),” Health Physics, Volume 74, Number 4, pp. 494-522, April 1998

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