SAR Evaluation for an RF WPT Array Antenna System in Indoor Environment

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Recently, the concept and practical applications of a radio-frequency wireless power transfer (RF WPT) technology are attracting an increased interest [1]. Unlike an inductive coupling WPT, the RF WPT systems transmit RF power by means of a high-gain antenna or beamforming array antenna. According to the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines, the human exposure limits above 100 kHz using the specific absorption rate (SAR) as the assessment criteria are defined. However, very few studies of the RF WPT operation including the human exposure from the RF directive sources have been reported so far. Therefore, this work aims at establishing the exposure assessment method for the RF WPT systems. We have developed an evaluation method of the SAR for the transmitting array antenna operation with a human body.

The EM simulation considered the human exposure from the beam-scanning phased array antenna in the free space and in the indoor environment with the reflection from the concrete walls as shown in Fig. 1. Both whole-body average and localized SAR values have been calculated with the full-wave simulation using the finite difference time domain (FDTD) method. A transmitting antenna of the WPT system is a simple 4x1 patch phased array operating at 5.8 GHz with 45dBm input power. The high-resolution anatomical whole-body model has been used in the simulations [2]. The distance between the transmitting antenna and the human body model has been fixed at 1 m. The main beam angle of the transmitting antenna with respect to vertical axis has been varied as A = 0~50° which corresponds to sending the RF power to a receiver and avoiding the human body. In this scenario, the whole-body average SAR of the human body model has been calculated and compared to SAR values obtained for the free-space RF exposure with the same distance to array antenna. The results are presented in Fig. 2. It has been confirmed that the SAR values decrease as the beam angle increases and the SAR level remains higher for the indoor environment scenario. The reason of such a change of SAR is the wave reflection from the concrete walls, especially for the increased beam angle of the transmitting antenna. The results obtained must be considered for the practical implementation of RF WPT systems in the indoor applications.

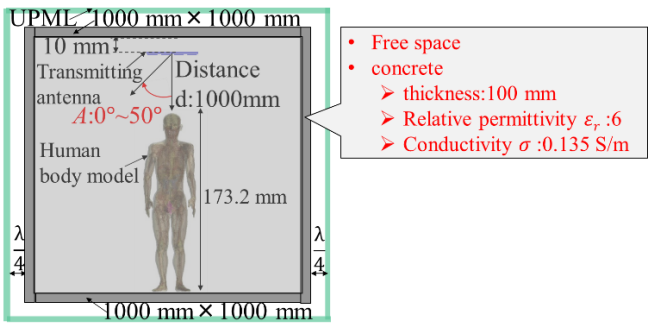

Fig. 1 Front view of simulation model.

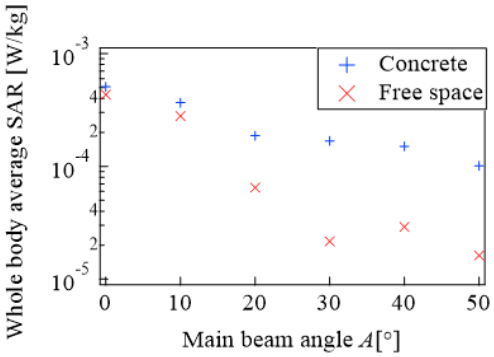

Fig. 2 Whole body average SAR.

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References

[1] Report ITU-R SM.2392-0, June 2016.

[2] T. Nagaoka, et al., Phys. Med. Biol., vol.49, pp.1-15, Jan. 2004.