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Plane-wave Arrival Angle Dependency of Whole-body Averaged SAR for Epidemiological Research on Children's Health in Cellular Frequency bands

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The purpose of this study is to clarify the numerical uncertainty in the estimation of radiofrequency exposure of adolescents in the general environment. An epidemiologic study is now being conducted to determine the effects of RF exposure on neurodevelopment in adolescents. The important part of this epidemiologic study is to estimate the exposure dose from the whole body average SAR of the subject over the entire test period. However, because the whole-body average SAR is a volume average of the total energy absorbed by the whole body, the value varies depending on the angle of arrival of the RF wave, the subject's physique, posture, and so on, even in the same exposure environment. Therefore, in this study, we used the FDTD method to evaluate the differences in whole-body average SAR for different body sizes and angles of arrival of the exposed plane wave. Two numerical human body models were used, one assuming a child of approximately 7 years of age and the other assuming a young man of approximately 17 years of age who has completed his physical development. The exposure frequencies used in this analysis are 1.8 GHz and 3.7 GHz, and the analysis is performed for each horizontal/vertical polarization. The direction of arrival of the radio waves is varied in 45° increments from the front to the back of the human body at elevation angles of 0°, 30°, and 60°, and the angular characteristics are evaluated.
The results of the analysis are used as an evaluation index by calculating the difference in the whole-body average SAR using the following equation.

$$SAR\ index = \ 10\log_{10}\frac{Whole\ body\ average\ SAR\ (7\ years\ old\ child)[W/kg]}{Whole\ body\ average\ SAR\ (17\ years\ old\ child)[W/kg]}\ [dB] \qquad (1)$$

The results of the numerical analysis show that under the same conditions of radio wave exposure, differences in whole-body average SAR of about 2.2 dB to 3.8 dB occur due to differences in body size. This difference in whole body average SAR was found to be particularly large when the radio waves arrived from the 60° elevation angle direction. This is thought to be because when body size is large, radio wave absorption to the whole body occurs, while when body size is small, radio wave exposure to the head accounts for a large proportion, and the total amount of radio wave absorption to the whole body is small. We also observed that the difference in whole-body average SAR tends to be larger when radio waves arrive from the side of the human body. This may be because the ratio of the surface area of the front and side of the human body changes with body size.
In the future, we plan to study the angular characteristics at different frequencies in more detail. Based on these estimation results, we plan to study protocols for statistical exposure dosimetry of large-scale data.

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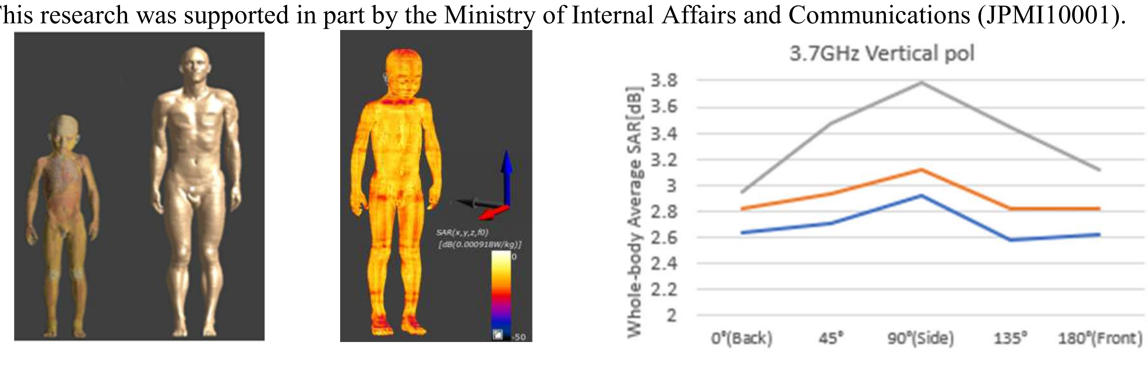

Figure 1. Human Models for SAR estimation and arrival angle dependency of SAR@3.7GHz, Vertica pol..