Numerical Estimation of RF Propagation Characteristics of Wireless Terminal in a Commercial Aircraft Cabin

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Demand for wireless broadband access services in long-distance transportations, such as trains and aircrafts, continues to grow. Recently, some airlines have begun in-flight call and in-flight wireless LAN access service. The final goal of this study is to develop an accurate and reliable numerical estimation tool of electromagnetic fields distributions inside aircraft so as to advance radio link design of wireless terminals operated inside the cabin. The authors previously proposed an EMF estimation method for an aircraft based on FDTD analysis and parallel computing (Kinoshita, et al., proc. Asia-Pacific Microwave Conference, 82-85, 2011). The EMF distributions established in the cabin of a Boeing 777-200 model due to a cellular radio were evaluated. In that modeling, the wings of the aircraft were not modeled in the analysis due to the limit of computational memory capability (Hikage, et al., proc. IEEE International Symposium on Antennas and Propagation and USNC-URSI National Radio Science Meeting, 166.1, 2012).

This paper evaluates the propagation characteristics in cabin of Boeing 777-200 by using newly developed numerical model of the aircraft which has the wings. In order to make the correct modeling of structures with details feasible, non-uniform gridding technique is employed. EMF distributions created by a 2 GHz-band wireless transmitter inside the cabin are analyzed and propagation loss characteristics are obtained. In the analysis, the maximum grid size is limited to 15 mm, which corresponds to $\lambda/10$ at 2GHz. The total problem space, including CPML absorbing boundary condition, is 4,300×1,397×6,400 cells. Subsequently, the memory required to execute the analysis is about 4,000 GB. The simulation results, 3-dimensional electric field distribution inside the cabin, were obtained including the effects of reflections due to the wings. We confirmed that the computational results of the electric field distribution inside the cabin agree well with measured values. Furthermore, homogeneous human models are added to the model in order to estimate the energy absorption effects of the passengers' bodies quantitatively. Other estimations that consider more antenna sources and new cellular radios include smart phones include multiple mode such as wireless LAN and Bluetooth enabled will be conducted in the future.