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Article / Book Information

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種別(和文)	論文要旨
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（博士課程）
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論 文 要 旨

THESIS SUMMARY

専攻： Department of	International Development Engineering 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （ Engineering ）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This research aims to investigate the unexpected results observed in body area propagation measurements in anechoic chambers, which might be caused by the influence of reflection from electromagnetic wave absorber installed on the inner walls of the chamber. This doctoral thesis consists of five chapters as follows.

Chapter 1 Introduction: this chapter firstly gives the overview of electromagnetic anechoic chamber. Then, followed by the overview of the electromagnetic wave absorber. Next, wireless body area network (WBAN) and literature of BAN propagation characteristics is summarized. Then, research motivation is presented. After that, research objective and methodology are described. Finally, the contribution and the outline of thesis are given.

Chapter 2 Relevant techniques for modeling absorber and BAN measurement: this chapter firstly describes the complex relative permittivity of dielectric materials expressed by Debye relaxation model. Then, the formulations and algorithm using the finite-difference time-domain (FDTD) method with the absorbing boundary conditions (ABC) and the periodic boundary condition (PBC) for the development of the electromagnetic field solver as a simulation tool for this study is detailed. The convolutional perfectly matched layer (CPML) and the constant horizontal wavenumber method are used and implemented as the ABC and the PBC, respectively. In this study, both dielectric absorbing material and human body tissue are frequency dependent and are expressed by the multi-pole Debye relaxation model. Therefore, the auxiliary differential equation (ADE) algorithm is used to integrate with FDTD method. This is due to the fact that a number of polarization terms of Debye relaxation model can be included as many as needed. The ADE-FDTD algorithm is modified to reduce large computational memory. The FDTD code is implemented in FORTRAN and it is using OpenMP for parallel processing. The code is also validated for a plane scattering by a lossy dielectric sphere through a comparison with Mie theory.

Chapter 3 Modeling of dielectric absorbing material for time-domain broadband simulation: in this chapter, a broadband parametric permittivity model of expanded polystyrene (EPS) mixed with graphite powder is proposed using a two-variable (frequency and carbon content) multi-pole Debye relaxation model with additional static conductive term to be applicable in time-domain electromagnetic wave simulation containing this material. This modeling is accomplished by using a non-linear least-square approximation technique. The parameters of the proposed model are empirically derived as linear and quadratic functions of carbon content, which can reduce the computational complexity of recalculating them from the non-linear least-square fitting. The effectiveness of the proposed model for time domain broadband calculations for two structures of the electromagnetic wave absorbers (multi-layer planar and pyramid) is shown by FDTD method. It is found that the proposed Debye model provides good approximation of the complex permittivity and good accuracy for characterizing the broadband reflectivity of the wave absorbers.

Chapter 4 Effect of unexpected reflections from absorbers on BAN propagation measurements: In this chapter, a body area propagation measurement in an anechoic chamber is modeled by using a simulation approach to study the influence of reflections from wave absorber on the measurement. Only the impact of absorber installed on the floor of chamber is investigated since it is closer to human test subject than the absorber installed on wall and ceiling of chambers. In addition, the performance of electromagnetic wave absorber without human body near transmitter is analyzed and discussed. These analyses are discussed with several conditions such as structures of wave absorber (the eight-layer planar and pyramid absorber with various

periodic lengths), Rx-Tx antenna orientation, and relative transmitting positions above the pyramid tip. Then, the influence of reflections is evaluated by the absolute error of root-mean-square (RMS) time delay between the model with and without absorber. As a result, either absorber-tangential (normal) Rx or Tx, the *u*-directed with body-tangential Tx, and the pyramid absorber with large periodic length (larger than two times of the operating wave length in free space) produced major influence of reflection, followed by the multi-layer planar one. The body-normal Rx-Tx direction gives good performance in removing the influence of reflections from wave absorbers.

Chapter 5 Conclusion: this chapter provides the conclusion of this research. The influence of the reflection from the floor electromagnetic wave absorber in the WBAN propagation measurement in anechoic chamber is revealed by the simulation approach. Then, the major impact conditions are obtained. Also, suggestions are drawn to mitigate the influence of reflections from electromagnetic wave absorber to the BAN measurements. Finally, the direction of future research is given.