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THE SUMMARY OF Ph.D. DISSERTATION

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Title Physical optics approximation and boundary diffraction wave in electromagnetic scattering problem

Abstract

In recent years, the frequency used in commercial system becomes higher due to the miniaturization of electronic equipment and the increase of radio communication transmission speed. As increasing the frequency, the importance of the analysis in electromagnetic filed such as the effect of electromagnetic noise increases. For the analysis of electromagnetic field and electromagnetic scattering problem, the high frequency approximation method, so called the physical optics approximation using surface integration, has been used. Especially, for numerical calculation of far-field, stationary phase method is used to shorten the calculation time in which the surface integration is represented by asymptotic expression at infinite wave number. On the other hand, this stationary phase method can not be applied in case of analyzing near-field problem such as electromagnetic noise or small scattering object. In this case, physical optics approximation using surface integration which is based on the Kirchhoff's approximation is employed but which has a disadvantage of having longer calculation time. Then, it is possible to express the physical optics approximation by line integration instead of surface integration considering that the physical optics approximation is expressed by the sum of geometrical optics wave from mirror image, boundary diffraction wave of Rubinowicz's form, and boundary normal diffraction wave of Kottler's form.

According to this new analytical method, it is expected that the calculation time will be shortened by changing the surface integral approximation into line integral one. The numerical calculations of boundary diffraction wave and boundary normal diffraction wave from a dipole on square conducting plate are performed. Furthermore, the calculation of a monopole antenna on circular grounded plate is also carried out for its application of this method. These calculated results using this new method agree with that using conventional physical optics approximation using surface integration, the calculation time is decreased to 1/10, and the effectiveness of this method is shown.

Chapter 1 describes the background and the brief summary of the present work.

Chapter 2 describes the general expression of the present approximation including vector potential and scattered electro magnetic field.

Chapter 3 shows the numerical results using the proposed method for vertical and horizontal dipole placed above a square conducting plate. Results for various plate sizes are compared and the validity and computational advantage of the proposed method are confirmed.

Chapter 4 describes the analysis of monopole antenna centered on circular ground plate using boundary diffraction wave, as an application examples of physical optics approximation using boundary diffraction wave. In this chapter, current distribution, input impedance and radiation pattern of antenna are calculated.

Chapter 5 concludes the results of this study.

Appendix derives the equations in detail. Appendix A describes derivation on the equations of scattered electric and magnetic fields. Appendix B describes the derivation vector potential and electric and magnetic fields about vertical dipoles. Appendix C describes the derivation vector potential and electric and magnetic fields about horizontal dipoles.