Diffraction Components given by MER Line Integrals of Physical Optics across the Singularity on Reflection Shadow Boundary

Pengfei Lu, Makoto Ando
Department of Electrical and Electronic Engineering, Tokyo Institute of Technology
2-12-1-S3-19 O-okayama
Meguro, Tokyo, 152-8552 Japan

***Abstract*-It is investigated about the diffracted field of the accuracy by Modified Edge Representation in surface-to-line integral reduction of Physical Optics. This components is compared between two results, MER line and PO surface integrals. The performance of stability from MER on RSB is confirmed, and this characteristic is shown in this paper.**

I. INTRODUCTION

The field generated from the scatterer is the main topic in the electromagnetics. Physical Optics (PO) one of the widely used high frequency asymptotic techniques in scattered field analysis, it is given by the radiation integrals over the scatterer. The surface-to-line integral reduction is important for reducing the computation and extracting the diffraction components. The Modified Edge Representation (MER) [1] is the concept to be used in the surface-to-line integral reduction [2], [3] for computing the scattered field derived from PO surface radiation [4] integrals. If Stationary Phase Point (SPP) exists on the scatterer, PO surface integrals will be reduced into two MER line integrals; one is diffraction components given by the integration along the periphery of the scatterer, another is the infinitesimally small indentation around inner SPP producing the reflected field [5]. The reflection components from SPP for various curvature of scatterer equals to Scattering Geometrical Optics (SGO) by using correction term has been shown in [6]. In this paper, the stability of diffraction at RSB calculated by MER has been stated.

II. MODIFIED EDGE REPRESENTATION AND PHYSICAL OPTICS

A. *Modified Edge Representation Line Integration*

MER line integration is an alternative methodology for the PO radiation pattern calculation of surfaces as shown in Fig. 1.

The wave diffracted from periphery is defined by the MER line integration as,

$$E_{MER}^{per} = j\frac{1}{4\pi}\oint_{\Gamma} \hat{r}_o \times [\hat{r}_o \times \eta J_{MER} + M_{MER}] \frac{e^{-jkr_o}}{r_o} dl \tag{1}$$

the MER unit vector $\hat{\tau}$ is defined as,

$$(\hat{r}_i + \hat{r}_o)\cdot\hat{\tau} = 0 \,;\, \hat{n}\cdot\hat{\tau} = 0 \tag{2}$$

equivalent electric and magnetic line currents along the actual edge $\hat{t}$ are defined using the modified edge vector $\hat{\tau}$ as,

$$\begin{aligned} J_{MER} &= \frac{\{\hat{r}_o \times (\hat{r}_o \times J_{PO})\}\cdot\hat{\tau}}{j\left(1-(\hat{r}_o\cdot\hat{\tau})^2\right)(\hat{r}_i+\hat{r}_o)\cdot(\hat{n}\times\hat{\tau})}\hat{t} \\ M_{MER} &= \frac{\eta(\hat{r}_o \times -J_{PO})\cdot\hat{\tau}}{j\left(1-(\hat{r}_o\cdot\hat{\tau})^2\right)(\hat{r}_i+\hat{r}_o)\cdot(\hat{n}\times\hat{\tau})}\hat{t} \\ J_{PO} &= 2\hat{n}\times H^i \end{aligned} \tag{3}$$

It was also confirmed that PO surface integration can be well approximated to MER line integration if only the radiation term is used in the definition of H^i in (3).

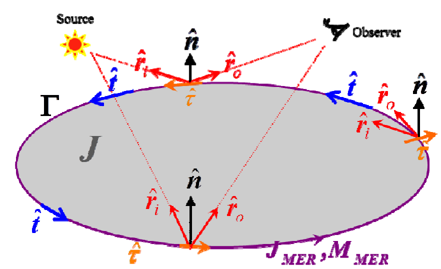

Figure 1 Parameters used in MER line integration.

B. *Physical Optics*

In PO, the scattering wave E_{PO}^S is expressed as the surface radiation integral of the currents on the scatterer as,

$$\begin{aligned} E_{PO}^S &= j\frac{k\eta}{4\pi}\int_S \hat{r}_o \times \hat{r}_o \times J_{PO} \frac{e^{-jkr_o}}{r_o} dS \\ J_{PO} &= 2\hat{n}\times H^i \end{aligned} \tag{4}$$

where J_{PO} is PO surface current.

III. AGREEMENT BETWEEN MER AND PO IN DIFFRACTION AND ITS DEPENDENCE UPON INTEGRAL PATH OF PERIPHERY

A. *Agreement between MER and PO in diffracted field*

The diffraction components calculated by E_{MER}^{per} and $E_{PO}^S - E_{SGO}$ are compared in Fig. 3 from the convex scatterer model as shown in Fig. 2, and the difference appears if the observer located at RSB.

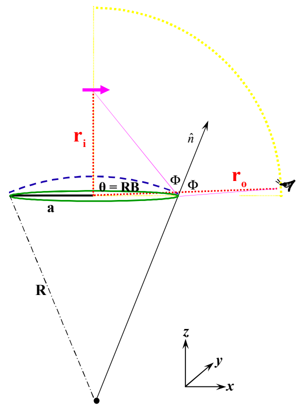

Figure 2   Convex scatterer from partial sphere.

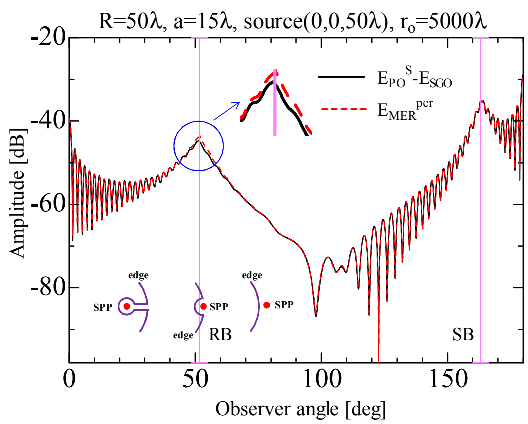

Figure 3   Diffraction field generated from convex scatterer.

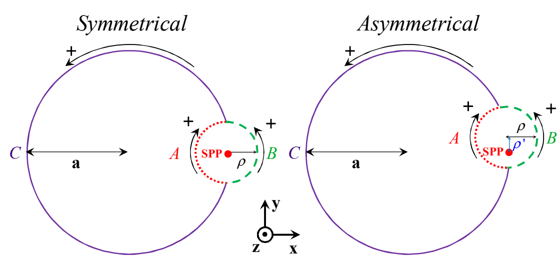

Figure 4   Top view from Fig.2 (a), (b).

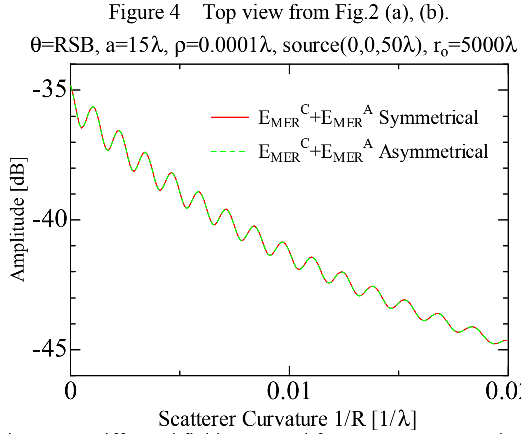

Figure 5   Diffracted field generated from convex scattered at RB.

B. Comparison between MER and PO in scattered field at RSB along different paths

The reflection point (RP) is the singularity for MER, the integral path along the periphery should bypass the RP if it is located on the edge. The amplitudes of diffracted field observed on RSB given by PO and MER along A respectively for various surface curvature are drawn in Fig. 5 from the top view of the scatterer shown in Fig 4 (a) and (b). The fields given by different integral paths are compared, both symmetrical and asymmetrical to SPP. The errors of MER should be compensated in the future. E_{MER}^{A} is almost identical with SGO/2 as shown in Fig. 6, which is much bigger than E_{MER}^{C} and is dominant in the diffraction. It is confirmed that the field given by symmetrical and excluding the SPP integral path calculated by MER contributes more agreeable field to PO. With the increasing of the surface curvature, the error between MER and PO is arising.

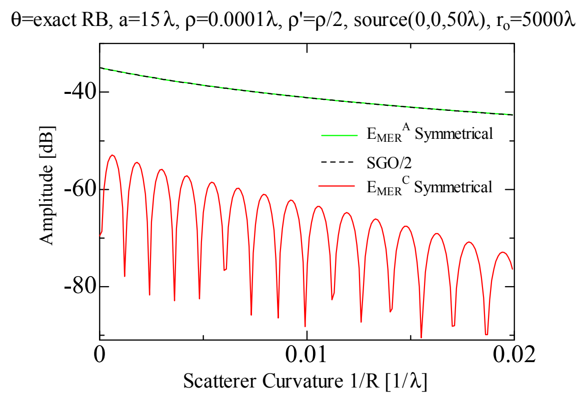

Figure 6   Various components generated from convex scattered at RB.

IV. Conclusion

The diffraction components calculated by PO and MER have been compared. It is investigated that the integral path along the periphery which gives the fields by MER should bypass the RP if it is located on the edge.

Acknowledgment

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