International Journal of Applied Research 2021; 7(2): 463-465

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2021; 7(2): 463-465
www.allresearchjournal.com
Received: 03-12-2020
Accepted: 19-01-2021

Santosh Kumar
Research Scholar, Department of Physics, J.P. University, Chapra, Bihar, India

Dr. Ramsagar Yadav
Assistant Professor, Department of Physics, N.L.S College, Jaitpur, Daudpur, Saran, Bihar, India

Corresponding Author:
Santosh Kumar
Research Scholar, Department of Physics, J.P. University, Chapra, Bihar, India

Study of electromagnetic scattering by bodies of revolution

Santosh Kumar and Dr. Ramsagar Yadav

Abstract
The objective in this paper is to the scattering of an arbitrary plane wave by a body of revolution (BOR) with multiple attached wires has been calculated by the method of moments (MoM). Numerical results for monochromatic plane wave scattering by smooth and nonsmooth axis. symmetric objects, the accuracy and computational efficiency associated with the use of properly constructed spectral methods. We compute plane wave scattering and find satisfactory agreement.

Keywords: Study, electromagnetic, scattering, bodies, BOR

Introduction
The problem of electromagnetic scattering from rough surfaces has been the subject of intensive investigation over the past several decades for its application in a number of important remote sensing problems. Radar remote sensing of the oceans, soil moisture, and mine detection using wide-band radars are such examples. For these problems, where the rough surface is either the primary target or the clutter, the understanding of interaction of electromagnetic waves with the rough surface is either the primary target or the clutter, the understanding of interaction of electromagnetic waves with the rough surface is essential for developing inversion or detection algorithms. An exact analytical solution for random rough surfaces does not exist. However, approximate analytical solutions exists for rough surfaces with specific types of surface roughness conditions. For surface with small root mean square (RMS) height and slope, the small perturbation method (SPM) is the most commonly used formulation. Formulations based on SPM exist for perfectly conduction [1], homogeneous di-electric [2] and inhomogeneous dielectric [3] rough surfaces. Another classical solution that is valid for surfaces with large radii of curvature is based on the tangent plane approximation [4]. The region of validity of these classical approaches are rather limited. In recent years, much effort has been devoted to extend the region of validity of these models [5, 6], however, the improved techniques still have the basic limitation of the original models.
A new computer developments dramatically increase computational capabilities, it becomes less cost effective to develop highly efficient but specialized codes for treating certain classes of geometries than to use less efficient but existing general purpose codes that can handle a wide variety of problems. For these reasons there has been a growing interest in the use and development of computer codes for treating scattering by arbitrarily shaped conducting bodies.

Formulation
Overall accuracy and the computation time. The method is applied to one-dimensional perfectly conduction random rough surfaces to demonstrate the improvements achieved. In the Monte Carlo analysis presented here, the tapered resistive sheet approach is used to suppress the edge current for plane wave illumination. The numerical results are also compared with the approximate analytical solutions. We confine our attention to the case of perfectly electrically conducting (PEC) objects, the boundary conditions takes the general form

$$\bar{n} \times E = 0, \ \bar{n} \cdot H = 0$$

where $\bar{n} = (u_r, \bar{n}_\phi, \bar{n}_z)$ represents an outward Pointing unit-vector at the object.
For the sake of simplicity, we shall deal with the azimuthal components separately and introduce the (r, z) plane outward pointing normal vector $\hat{n} = (u_r, 0, \hat{n}_z)$.
Let us introduce the scattered field formulation as

$$E = E^{inc} + E^s,\ H = H^{inc} + H^s$$

where the incident fields, E^{inc} and H^{inc}, are prescribed at all times. Considering the electric field we obtain, due to the symmetry, the condition

$$E_\phi^s = -E_\phi^{inc} \tag{1}$$

While a second condition is obtained by requesting

$$\hat{\phi}\cdot\left(\hat{n}\times E^{inc}\right) = -\hat{\phi}\cdot\left(\hat{n}\times E^s\right) = \hat{n}_r E_z^s - \hat{n}_z E_r^s \tag{2}$$

This only yields on equation for the two unknown scattered field components. A third condition is arrived at by recalling the behaviour of hyperbolic problems at solid walls, at which the outgoing characteristics are simply reflected [7]. Hence, for consistency we must also require that

$$\hat{n}\cdot E^s = \hat{n}_r E_r^s + \hat{n}_z E_z^s = \hat{n}\cdot E^{s,c} \tag{3}$$

Where $E^{s,r}$ signifies the computed scattered field. This yields the additional equation required to enforce the boundary condition on the electric field.
The situation for the magnetic field is very similar. Indeed, the physical condition yields

$$\hat{n}\cdot H^{inc} = -\hat{n}\cdot H^s = -\hat{n}_r E_r^s - \hat{n}_z E_z^s \tag{4}$$

While an additional condition appears as

$$\hat{\phi}\cdot\left(n\times H^{sc}\right) = \hat{n}_z H_r^s - \hat{n}_r H_z^s - \hat{n}_r H_z^s = \hat{\phi}\cdot(\hat{n}\times H^{sc}) \tag{5}$$

Where $H^{s,r}$ refers to the computed scattered field.
The EM scattering from bodies of revolution (BOR) with attached wires as shown in Fig. 1 is the application of the method of moments to the electric-field integral equation.

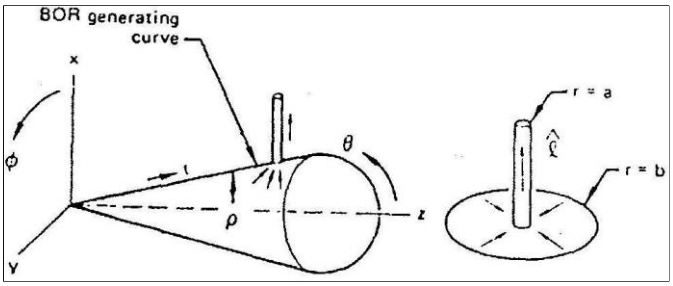

Fig 1: EM scattering bodies of revolution (BOR) with attached wires

Each geometric part of the body has its own class of current expansion function(s). The wire-basis functions are overlapping triangle functions with a vector direction coinciding with the wire. The system matrix elements Z^{SS}, Z^{SW}, Z^{sj}, Z^{ww}, Z^{wj}, Z^{jj} defined explicitly in [8], represent the following interactions such as BOR–BOR, BOR–wire, BOR–junction, wire-wire, wire-junction, and junction-junction. The voltage of excitation vector on the right side of the system matrix equation has only a few nonzero elements that correspond to the applied excitation at given ports on the body. For scattering problems, the entire column voltage vector is full. Each element corresponds to the excitation caused by the electric field of the incident wave at each port and is computed formally as [8].

$$V = \left\langle \vec{W}, \vec{E}_r^u \right\rangle = \left\langle \vec{J}*, \vec{E}_r^u \right\rangle \tag{6}$$

Where $\vec{W}$ is the appropriate testing function corresponding to the BOR, the wire, or the junction and is the complex conjugate of the corresponding basis function. The incident plane wave is given by

$$\vec{E}_r^u = \hat{u}e^{jk(\rho\sin\theta_i\cos(\phi-\phi_i)+z\cos\theta_i)} \tag{7}$$

Where the polarization unit vector

$$\hat{u}\left(=\hat{\theta}\ or\ \hat{\phi}\right)$$

is defined in a spherical coordinate system and (θ, ϕ_i) are the angles of incidence of the incoming wave. The generalized voltage vector r (6) was computed using the subroutines developed in [8] for the radiation transfer matrix [9, 10].

$$R_i = \left(\vec{J}_i, \vec{E}_r^u\right) \tag{8}$$

Which is used to obtain the far radiated field from the BOR, wire, and junction currents. For the wire and junction voltage elements, whose basis functions are real, V = R, while for the BOR, which has complex basis functions, $V_n^s = R_{-n}^s$. Bi-static radar cross section computations require R to be computed twice, for the more static case, R needs to be computed only once. The radar cross section is determined in the standard way as

$$\alpha^q = \lim_{r\to\infty} 4\pi r^2 \frac{\left(E_S^P\right)^2}{\left(E_i^q\right)^2} \tag{9}$$

Where E_S^P is the scattered field of polarization P and $\vec{E}_i^q$ is the incident field of polarization q (where p, q = θ or ϕ).

Result and Discussion

The number of resolution levels were shown to play a significant role in determining the sparsity of the matrix and the accuracy of the solution. It was shown that the higher the number of resolutions, the more sparse the matrix could be made without compromising the bistatic scattering pattern. The comparison is for a cylinder with flat-faced ends for horizontal polarization as in Fig. 2

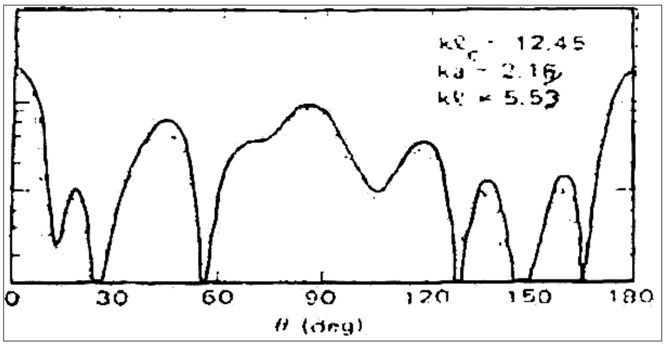

Fig 2: Cylinder with flat-faced ends

The cylinder diameter is d/λ = 0.687 (*ka* = 2.15), its length is l_c/λ = 1.97 (kl_c= 12.45), and attached wire length is *l*/λ= 0.880 (*kl*= 552).
The computed results for this case was obtained using a BOR only analysis a algorithm. One attached wire at the cylinder centre, Fig. produces a result with twofold symmetry. The single wire has the greatest effect in altering the cylinder cross section when the wire is illuminated, i.e. incident angles of 25^0–110^0. At broadside, θ = 0^0 and 180^0, the incident polarization is normal to the wire such that the resulting cross section is that of the cylinder alone. On the backside of the cylinder, θ > 110^0, where the wire is hidden from view of the incident wave, the resulting cross section is close to that of the cylinder alone.

Conclusion

The electric field integral equation by the method of moments for the class of problems described as wires attached to a body of revolution. The computed and measured results for the sphere and cylinder configurations are in excellent agreement.

References

1. Rice SO. Reflection of electromagnetic waves by slightly rough surfaces, Commun. Pure Appl. Math 1951;4:357-378.
2. Nieto-Vesperinas M. Depolarization of electromagnetic waves scattered from slightly rough random surfaces – A study by means of the extinction theorem, J Opt. Soc. Amer 1982;72:539-547.
3. Sarabandi K, Oh Y, Ulaby FT. A numerical simulation of scattering from one-dimensional inhomogeneous dielectric random surfaces, IEEE Trans, Geosci. Remote Sensing 1996;34:425-432.
4. Beckmann P, Spizzichino A. The Scattering of Electromagnetic Waves from Rough Surfaces. Norwood, MA: Artech House 1987.
5. Axline RM, Fung AK. Numerical computation of scattering from a perfectly conducting random surface, Trans. Antennas Propagat 1978;AP-25:482-488.
6. Rodriguez E, Kim Y, Durden SL. A numerical assessment of rough surface scattering theories – Horizontal polarization, Radio Sci 1992;27:497-513.
7. Gottliele D *et al*. On numerical boundary treatment for hyperbolic systems, SIAM J. Numr. Anal 1982;19:671-697.
8. Mautz JR, Harrington RF. Radiation and scattering from bodies of revolution, Appl. Sci. Res 1969;20:405-435.
9. Harrington RF, Mautz JR. Radiation and scattering from bodies of revolution, Syracuse, U., Syracuse, N. Y., Final Rep. ARCRL, 1969, 69-0305.
10. Harrington RF, Mautz JR. Computation of Green's functions for bodies of revolution-, AFCRL, 1970, 70-0393.