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PLANE WAVE SCATTERED BY N DIELECTRIC COATED CONDUCTING STRIPS USING ASYMPTOTIC APPROXIMATE SOLUTION

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Abstract—The paper aims at solving the problem of plane electromagnetic waves scattered by N dielectric coated conducting strips. The method used is based on an asymptotic technique introduced by Karp and Russek for solving scattering by wide slit. The technique assumes the total scattered field from each coated strip as the sum of the scattered fields from the individual element due to a plane incident wave plus scattered fields from factious line sources of unknown intensity located at the center of every element. The line sources account for the multiple scattering effect. By enforcing the boundary conditions, the intensity of the line sources can be calculated. Numerical examples are introduced for comparison with data published in the literature.

1. INTRODUCTION

The scattering of electromagnetic waves by perfectly conducting strip grating was the subject of many investigations [1] and [2]. Different methods have been used for solving such a problem, among them is the self consistent method [3]. This method is based on the previous knowledge of the responses of the isolated objects in the multi-object scattering problem. The incident field on each object is considered as the sum of the source field and the scattered fields from all other objects, which involves unknown scattering amplitudes. By applying the boundary conditions on each object surface, a set of algebraic equations in terms of the unknown coefficients are obtained. In an approximate treatment the self-consistent method was used by Karp and Russek [4]. The solution is restricted to the case where the spacing between the objects is much greater than the maximum dimension

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of any one object. This technique has been extended to the case of scattering of plane waves by wide double wedges (Elsherbine and Hamid [5]). Hansen [6] used the integral equation approach in order to calculate the diffracted field of a plane acoustic wave through two or more parallel slits in a plane screen. The scattering of plane waves by two or N co-planar strips was the subject articles of Saermark [7–9] who formulated the general problem for different orientation of the strips but gave only a solution for the co-planar case. He however, truncated the infinite series involved in the solution after one term assuming that the strip widths are small.

The basic element used in present work is the dielectric coated conducting strip which has been addressed in [10]. Moreover, the scattering by two parallel dielectric coated strips has also been also investigated [11]. Meanwhile, the electromagnetic wave scattering by single and multiple dielectric coated conducting elliptic cylinder has been presented [12–14].

In the present paper, approximate solution of a plane electromagnetic wave incident on N dielectric coated conducting strips randomly oriented is considered using the technique in [4]. The solution is much easier in calculation than the full wave solution approach. In addition, the full wave solution approach (exact) requires a coefficient matrix, for N elements, of a size $(N_m \times N_m)$ while this method requires $(m \times m)$ coefficient matrix. Accordingly this method will have a saving in computational time of the order of N^2. Moreover for large number of elements the matrix size of the exact method may produce some error when it is inverted. These two reasons are the advantages of the present method. The only disadvantage of the present method is that, it can not be used when the inter-element spacing is small. The geometrical arrangement of problem solved here can be used for simulating a reflector antenna surface. In fact any dielectric coated cylindrical surface can be simulated by such basic building blocks.

2. FORMULATION OF THE PROBLEM

Figure 1 shows the cross sections of dielectric coated conducting strips of infinite length with their axes parallel to the z axis. The ith conducting strip has a width $2d_i$ and coated with a dielectric of permittivity ε_i. The focal length of outer surface of the ith strip dielectric coating is equal to the conducting strip width while its semi-major axis and semi-minor axis are respectively a_i and b_i. The center of the ith dielectric coated strip is located at (r_i, ψ_i) with respect to the global coordinates (x, y, z). The ith coated strip is inclined by an angle β_i with respect to the x-axis. In addition to the global coordinate

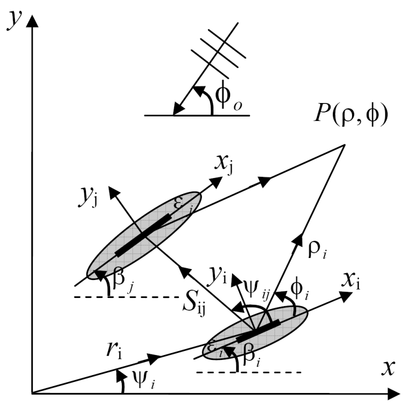

Figure 1. Geometry of the problem.

system, N coordinate systems are defined at the coated strip centers such that the plane of the ith strip lies in the x_i-z_i plane.

A plane wave, with $e^{-j\omega t}$ time dependence, is incident with an angle ϕ_o with respect to the x-axis of the global coordinate system and polarized in z-direction, i.e.,

$$E_z^i = e^{-jk_o(x\cos\phi_o + y\sin\phi_o)} \tag{1}$$

where k_o is the wave number of free space. The incident wave may be transformed and expanded in terms of the elliptic wave function expressed with respect to ith dielectric coated strip coordinates as:

$$\begin{aligned} E_{z_1}^i &= \sqrt{8\pi} e^{-jk(x_i\cos\phi_o + y_i\sin\phi_o)} \\ &\quad \sum_{m=0}^{\infty} j^{-m} \left[\frac{1}{N_m^{(e)}(h_i)} Je_m(h_i, \zeta_i) Se_m(h_i, \eta_i) Se_m(h_i, \cos\phi_{0i}) \right. \\ &\quad \left. + \frac{1}{N_m^{(o)}(h_i)} Jo_m(h_i, \zeta_i) So_m(h_i, \eta_i) So_m(h_i, \cos\phi_{0i}) \right] \end{aligned} \tag{2}$$

where

$$\phi_{0i} = \phi_o - \beta_i \tag{3}$$

and $Je_m(h, \zeta)$ and $Jo_m(h, \zeta)$ are respectively the even and the odd modified Mathieu functions of the first kind and order m. Also, $Se_m(h, \eta)$ and $So_m(h, \eta)$ are respectively the even and the odd angular Mathieu functions of order m. $N_m^{(e)}(h)$ and $N_m^{(o)}(h)$ are normalized functions. The Mathieu functions arguments are $h_i = k_o d_i$, $\zeta_i = \cosh u_i$ and $\eta_i = \cos v_i$, where u_i and v_i are elliptical cylindrical coordinates defined by:

$$x_i = d_i \cosh u_i \cos v_i \quad y_i = d_i \sinh u_i \sin v_i \quad z = z_i \tag{4}$$

The approximate solution is based on a technique that was established by Karp and Russek [4] which considers the scattered field from each coated strip as a sum of scattered field from that coated strip due to a plane wave incident plus the scattered fields due to line sources of unknown intensity located at the centers of the other coated strips. The factious line sources accounts for the multiple scattering between the N coated strips. To apply this technique one needs to obtain the far scattered field from one coated strip due to both a plane wave and a line source.

2.1. Plane Wave Excitation

Consider the plane wave of Eq. (2), is incident on a coated strip located at x_i, y_i. The scattered field in the region outside the coated strip can be written as

$$E_z^{(s)} = \sqrt{8\pi} \sum_{n=0}^{\infty} A_n^{(i)} He_n^{(1)}(h_i, \zeta_i)\; Se_n(h_i, \eta_i) \tag{5}$$

while the electric field inside the coating is

$$E_z^{(I)} = \sqrt{8\pi} \sum_{n=0}^{\infty} B_n^{(i)} \left\{ Je_n(H_i, \zeta_i) - \frac{Je_n(H_i, 1)}{Ne_n(H_i, 1)} Ne_n(H_i, \zeta_i) \right\} Se_n(H_i, \eta_i) \tag{6}$$

Matching the boundary condition and multiplying both sides of the resulting equation by $Se_m(H_1, \eta_i)$ and integrating over v_i from 0 to 2π, one obtains

$$\begin{aligned} & e^{-jk(x_i \cos\phi_o + y_i \sin\phi_o)} \sum_{n=0}^{\infty} j^{-n} \left\{ \frac{1}{N_n^{(e)}(h_i)} Je_n(h_i, \zeta_{0i}) \right. \\ & \left. Se_n(h_i, \cos\phi_{0i}) M_{n,m}(h_i, H_i) \right\} + \sum_{n=0}^{\infty} A_n^{(i)} He_n^{(1)}(h_i, \zeta_{0i}) M_{n,m}(h_i, H_i) \\ & = B_m^{(i)} \left\{ Je_m(H_i, \zeta_{0i}) - \frac{Je_m(H_i, 1)}{Ne_m(H_i, 1)}\, Ne_m(H_i, \zeta_{0i}) \right\} N_m^{(e)}(H_1) \end{aligned} \tag{7}$$

Similarly matching the boundary condition corresponding to H_v, one can get

$$e^{-jk(x_i \cos\phi_o + y_i \sin\phi_o)} \sum_{n=0}^{\infty} j^{-n} \left\{ \frac{1}{N_n^{(e)}(h_i)} Je'_n(h_i, \zeta_{0i}) \right.$$

$$\left.\frac{M_{n,m}(h_i,H_i)}{N_m^{(e)}(H_1)}Se_n(h_i,\cos\phi_{0i})\right\}+\sum_{n=0}^{\infty}A_n^{(i)}He_n^{(1)\prime}(h_i,\zeta_{0i})\frac{M_{n,m}(h_i,H_i)}{N_m^{(e)}(H_1)}$$
$$=\sqrt{\varepsilon_{r_i}}B_m^{(i)}\left\{Je'_m(H_i,\zeta_{0i})-\frac{Je_m(H_i,1)}{Ne_m(H_i,1)}Ne'_m(H_i,\zeta_{0i})\right\} \quad (8)$$

From Eqs. (7) and (8), one obtains:

$$\sum_{n=0}^{\infty}A_n^{(i)}\left\{\frac{He_n^{(1)}(h_i,\zeta_{0i})}{X_m(H_i)}-\frac{He_n'^{\,(1)}(h_i,\zeta_{0i})}{X'_m(H_i)}\right\}M_{n,m}(h_i,H_i)$$
$$=-e^{-jk(x_i\cos\phi_o+y_i\sin\phi_o)}\sum_{n=0}^{\infty}j^{-n}\frac{1}{N_n^{(e)}(h_i)}$$
$$\left\{\frac{Je_n(h_i,\zeta_{0i})}{X_m(H_i)}-\frac{Je'_n(h_i,\zeta_{0i})}{X'_m(H_i)}\right\}Se(h_i,\cos\phi_{0i})M_{n,m}(h_i,H_i) \quad (9)$$

where

$$X_m(H_i)=\left\{Je_m(H_i,\zeta_{0i})-\frac{Je_m(H_i,1)}{Ne_m(H_i,1)}Ne_m(H_i,\zeta_{0i})\right\}N_m^{(e)}(H_i) \quad (10)$$

$$X'_m(H_i)=\sqrt{\varepsilon_r}\left\{Je'_m(H_i,\zeta_{0i})-\frac{Je_m(H_i,1)}{Ne_m(H_i,1)}Ne'_m(H_i,\zeta_{0i})\right\}N_m^{(e)}(H_i) \quad (11)$$

$$M_{n,m}(h_i,H_i)=\int_0^{2\pi}Se_n(h_i,\eta_i)Se_m(H_i,\eta_i)dv_i \quad (12)$$

Eq. (9) can be written a matrix form as:

$$[F_{m,n}]\ [A_m]=[Y_m] \quad (13)$$

where

$$F_{m,n}=\left\{\frac{He_n^{(1)}(h_i,\zeta_{0i})}{X_m(H_i)}-\frac{He_n'^{\,(1)}(h_i,\zeta_{0i})}{X'_m(H_i)}\right\}M_{n,m}(h_i,H_i) \quad (14)$$

$$Y_m=-e^{-jk(x_i\cos\phi_o+y_i\cos\phi_o)}\sum_{n=0}^{\infty}j^{-n}\frac{1}{N_n^{(e)}(h_i)}Se_n(h_i,\cos\phi_{0i})$$
$$\left\{\frac{Je_n(h_i,\zeta_{0i})}{X_m(H_i)}-\frac{Je'_n(h_i,\zeta_{0i})}{X'_m(H_i)}\right\}M_{n,m}(h_i,H_i) \quad (15)$$

Once the coefficients are calculated the scattered electric field in the outer region is given by Eq. (5). Since $He_m^{(1)}(h,\zeta)=\frac{1}{\sqrt{h\zeta}}e^{j(h\zeta-((2m+1)/4)\pi)}$ and for large $h\zeta$ it can be represented in terms of circular cylindrical coordinates, where $h_i\zeta_i = k_o\rho_i$. In this case the total scattered field is given by:

$$E_z^{(s)} = \sqrt{8\pi}\frac{e^{jk_i\rho_o}}{\sqrt{k_o\rho_i}}\sum_{n=0}^{\infty}(-j)^n A_n^{(i)} Se_n(h_i,\eta_i) = c(k_o\rho_i)f(h_i,r_i,\phi_i,\phi_{0i}) \quad (16)$$

$$f(h_i,r_i,\phi_i,\phi_{0i}) = 2\pi\sum_{m=0}^{\infty}(-j)^m A_m^{(i)}\, Se_m(h_i,\cos\phi_i) \quad (17)$$

2.2. Line Source Excitation

Consider a line source of unit intensity placed at (x_k, y_k) with respect to the coordinates at the center of ith coated strip, then the z-component of the electric field due to such a line source can be expressed as:

$$E_z^{inc} = 4\left[\sum_{m=0}^{\infty}\frac{Se_m(h_i,\eta_{ik})}{N_m^{(e)}(h_i)}Se_m(h_1,\eta_i)\begin{Bmatrix}Je_m(h_i,\zeta_{ik})He_m^{(1)}(h_i,\zeta_i)\\ Je_m(h_i,\zeta_i)He_m^{(1)}(h_i,\zeta_{ik})\end{Bmatrix}\right.$$
$$\left.+\frac{So_m(h_i,\eta_{ik})}{N_m^{(o)}(h_i)}So_m(h_i,\eta_i)\begin{Bmatrix}Jo_m(h_i,\zeta_{ik})Ho_m^{(1)}(h_i,\zeta_i)\\ Jo_m(h_i,\zeta_i)Ho_m^{(1)}(h_i,\zeta_{ik})\end{Bmatrix}\right]\begin{matrix}u>u_{ik}\\ u<u_{ik}\end{matrix} \quad (18)$$

where k takes the values 1 to N.

$$\zeta_{ik} = \left[\frac{1}{2}\left(\frac{s_{ik}^2}{d_i^2}+1\right)+\left(\frac{1}{4}\left(\frac{s_{ik}^2}{d_i^2}+1\right)^2-\frac{{x'_{ik}}^2}{d_i^2}\right)^{1/2}\right]^{1/2} \quad (19)$$

$$\eta_{ik} = \frac{x'_{ik}}{\zeta_{ik}d_i}, \quad \psi_{ik} = \tan^{-1}\left[\frac{y_k-y_i}{x_k-x_i}\right]-\beta_i \quad (20)$$

$$s_{ik} = \left((x_i-x_k)^2+(y_i-y_k)^2\right)^{1/2} \quad (21)$$

$$x'_{ik} = s_{ik}\cos\psi_{ik} \quad y'_{ik} = s_{ik}\sin\psi_{ik} \quad (22)$$

The scattered field in the region outside the coated cylinder can be written as

$$E_z^{(s)} = 4\sum_{n=0}^{\infty}C_n^{(i)}He_n^{(1)}(h_i,\zeta_i)\, Se_n(h_i,\eta_i) \quad (23)$$

While the electric field inside the coating is

$$E_z^{(I)} = 4\sum_{n=0}^{\infty}D_n^{(i)}\left\{Je_n(H_i,\zeta_i)-\frac{Je_n(H_i,1)}{Ne_n(H_i,1)}Ne_n(H_i,\zeta_i)\right\}Se_n(H_i,\eta_i) \quad (24)$$

Matching the boundary condition corresponding to E_z and multiply both sides of the resulting equation by $Se_m(H_1, \eta_i)$ and integrating over v_i from 0 to 2π, we get

$$\sum_{n=0}^{\infty} \frac{He_n^{(1)}(h_i, \zeta_{ik})}{N_n^{(e)}(h_i)} Je_n(h_i, \zeta_{0i}) Se_n(h_i, \eta_{ik}) M_{n,m}(h_i, H_i) + \sum_{n=0}^{\infty} C_n^{(i)} He_n^{(1)}(h_i, \zeta_{0i}) M_{n,m}(h_i, H_i) = D_m^{(i)} \left\{ Je_m(H_i, \zeta_{0i}) - \frac{Je_m(H_i, 1)}{Ne_m(H_i, 1)} Ne_m(H_i, \zeta_{0i}) \right\} N_m^{(e)}(H_1) \quad (25)$$

Similarly matching the boundary condition corresponding to H_v, one can get

$$\sum_{n=0}^{\infty} \frac{He_n^{(1)}(h_i, \zeta_{ik})}{N_n^{(e)}(h_i)} Je_n'(h_i, \zeta_{0i}) Se_n(h_i, \eta_{ik}) M_{n,m}(h_i, H_i) + \sum_{n=0}^{\infty} C_n^{(i)} He_n'^{(1)}(h_i, \zeta_{0i}) M_{n,m}(h_i, H_i) = D_m^{(i)} \left\{ Je_m'(H_i, \zeta_{0i}) - \frac{Je_m(H_i, 1)}{Ne_m(H_i, 1)} Ne_m'(H_i, \zeta_{0i}) \right\} N_m^{(e)}(H_1) \quad (26)$$

Solving (25) and (26), one gets:

$$\sum_{n=0}^{\infty} C_n^{(i)} \left\{ \frac{He_n^{(1)}(h_i, \zeta_{0i})}{X_m(H_i)} - \frac{He_n'^{(1)}(h_i, \zeta_{0i})}{X_m'(H_i)} \right\} M_{n,m}(h_i, H_i) = -\sum_{n=0}^{\infty} \frac{He_n^{(1)}(h_i, \zeta_{ik})}{N_n^{(e)}(h_i)} Se_n(h_i, \eta_{ik}) M_{n,m}(h_i, H_i) \left\{ \frac{Je_n(h_i, \zeta_{0i})}{X_m(H_i)} - \frac{Je_n'(h_i, \zeta_{0i})}{X_m'(H_i)} \right\} \quad (27)$$

Eq. (27) can be written in a matrix form similar to (13), where

$$Y_m = -\sum_{n=0}^{\infty} \frac{He_n^{(1)}(h_i, \zeta_{ik})}{N_n^{(e)}(h_i)} \left\{ \frac{Je_n(h_i, \zeta_{0i})}{X_m(H_i)} - \frac{Je_n'(h_i, \zeta_{0i})}{X_m'(H_i)} \right\} Se_n(h_i, \eta_{ik}) M_{n,m}(h_i, H_i) \quad (28)$$

Once the coefficients are calculated the scattered electric field in the outer region is:

$$E_z^{(s)} = \sqrt{8\pi} \frac{e^{jk_i\rho_i}}{\sqrt{k_o\rho_i}} \sum_{n=0}^{\infty} (-j)^n C_n^{(i)} Se_n(h_i, \eta_i) = c(k_o\rho_i) g(h_i, \phi_i, \zeta_{ik}, \eta_{ik}) \quad (29)$$

where

$$g(h_i,\phi_i,\zeta_{ik},\eta_{ik}) = \sqrt{8\pi}\sum_{m=0}^{\infty}(-j)^m C_m^{(i)}\ Se_m(h_i,\cos\phi_i) \tag{30}$$

Now consider the problem of N coated strips shown in Fig. 1. Assuming a fictitious line source C_j at the center of the jth coated strip, the far scattered field from the ith coated strip is

$$E_i^s = c(k_o\rho_i)\left[f(h_i,r_i,\phi_i,\phi_{0i}) + \sum_{j=1,i\neq j}^{N} C_j g(h_i,\phi_i,\zeta_{ij},\eta_{ij})\right],\ \ i=1,2,\ldots,N \tag{31}$$

The partial scattered field from the ith coated strip due to the scattered field from the jth coated strip can be determined by two ways. The first, at $\phi_j = \psi_{ji}$ the value of $E_j^s\,[c(k_o\rho_j]^{-1}$ can be considered as the intensity of a line source times the well-known response (29), i.e.,

$$E_i^{s(ij)} = \left[f(h_j,r_j,\psi_{ji},\phi_{0j}) + \sum_{\substack{k=1\\k\neq j}}^{N} C_k g(h_j,\psi_{ji},\zeta_{jk},\eta_{jk})\right] c(k_o\rho_i) g(h_i,\phi_i,\zeta_{ij},\eta_{ij}),\ \ j=1,2,\ldots,N \tag{32}$$

Second, this partial scattered field is given by

$$E_i^{s(ij)} = c(k_o\rho_i) C_j g(h_i,\phi_i,\zeta_{ij},\eta_{ij}),\ \ j=1,2,\ldots,N \tag{33}$$

Using equivalence between (32) and (33),

$$\sum_{i=1}^{N} f(h_j,r_j,\psi_{ji},\phi_{0j}) + \sum_{\substack{k=1\\k\neq j}}^{N}\sum_{\substack{i=1\\i\neq j}}^{N} C_k g(h_j,\psi_{ji},\zeta_{jk},\eta_{jk}) = C_j,\ \ j=1,2,\ldots,N \tag{34}$$

Eq. (34) can be written a matrix form as:

$$[Q_{m,n}]\,[C_m] = [P_m] \tag{35}$$

$$P_m = -\sum_{i=1}^{N} f(h_m,r_m,\psi_{mi},\phi_{0m}) \tag{36}$$

$$Q_{mn} = \begin{cases} \sum\limits_{i=1}^{N} g(h_m,\psi_{mi},\zeta_{mn},\eta_{mn}) & m\neq n \\ 1-N & m=n \end{cases} \tag{37}$$

Once C_m are known, one can determine the z-component of the total scattered field from the N dielectric coated strips, i.e.,

$$E_z^s = c(k_o\rho)\, P(\phi) \tag{38}$$

$$c(k\rho) = \sqrt{2/\pi k\rho} \quad e^{jk\rho}\, e^{-j\pi/4} \tag{39}$$

$$p(\phi) = \sum_{i=1}^{N} e^{-jk_o(x_i \cos\phi + y_i \sin\phi)} \left\{ f(h_i, r_i, \phi-\beta_i, \phi_{0i}) + \sum_{\substack{k=1\\k\neq i}}^{N} C_k g(h_i, \phi-\beta_i, \zeta_{ik}, \eta_{ik}) \right\} \tag{40}$$

The plane wave scattering properties of a two-dimensional body of infinite length are conveniently described in terms of the echo width, i.e.,

$$W(\phi) = \frac{4}{k}|P(\phi)|^2 \tag{41}$$

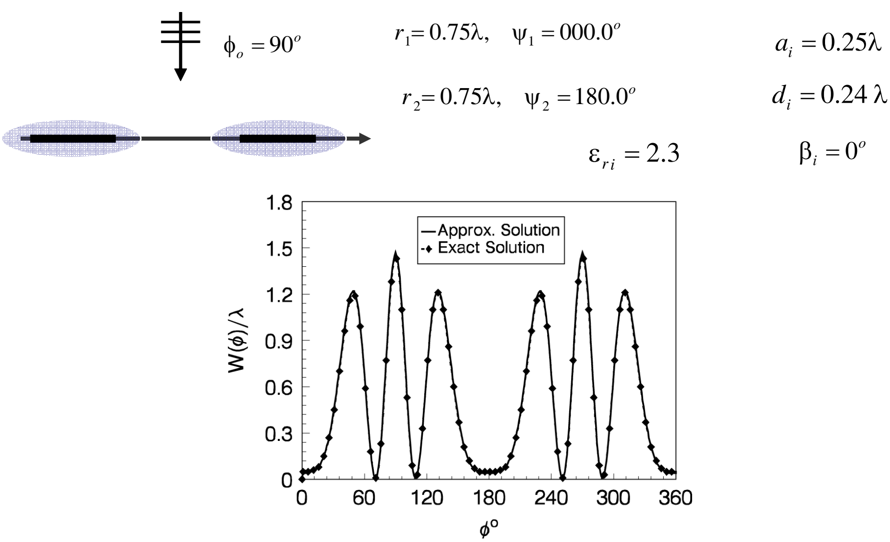

Figure 2. Comparison of the echo width patterns between exact and approximate solutions.

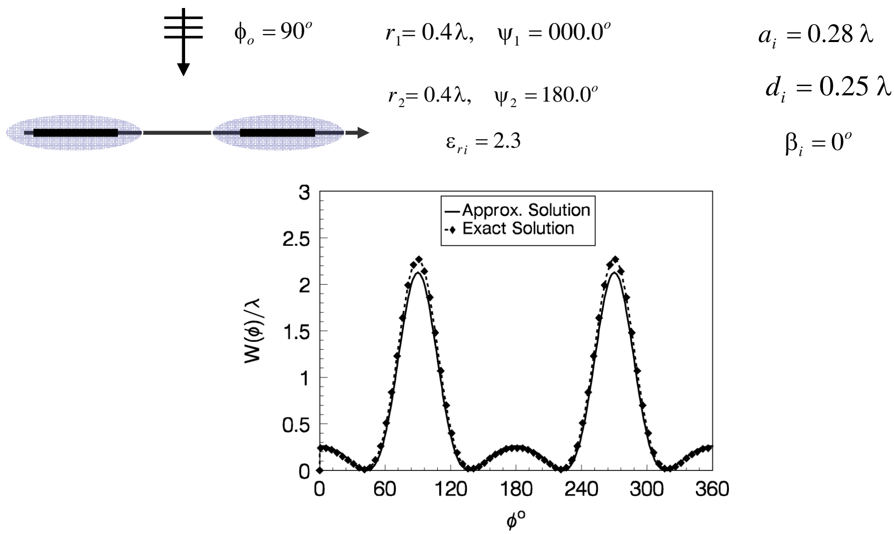

Figure 3. Comparison of the echo width patterns between exact and approximate solutions.

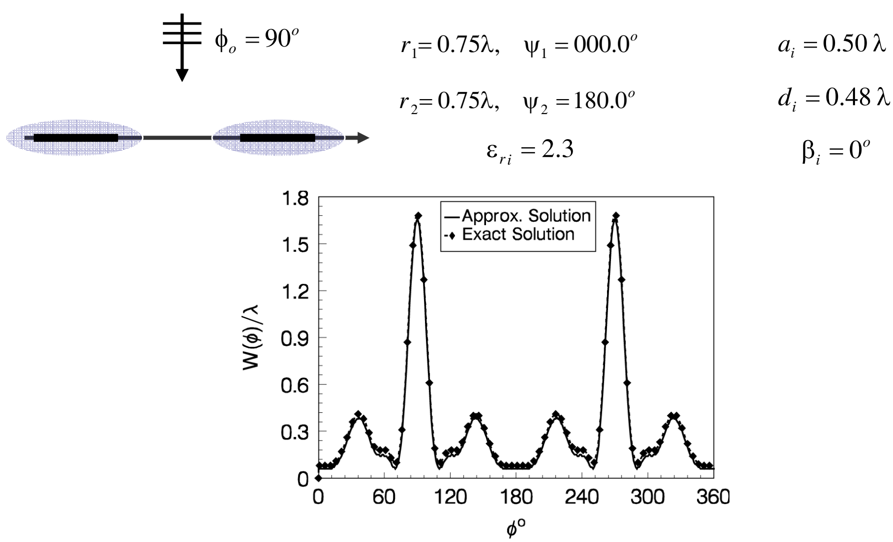

Figure 4. Comparison of the echo width patterns between exact and approximate solutions.

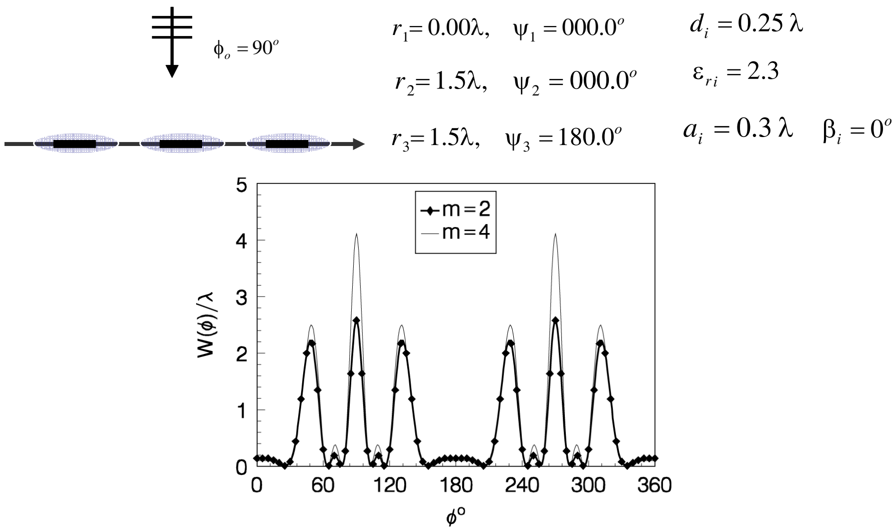

Figure 5. Effect of the number of terms "m" on the echo width pattern.

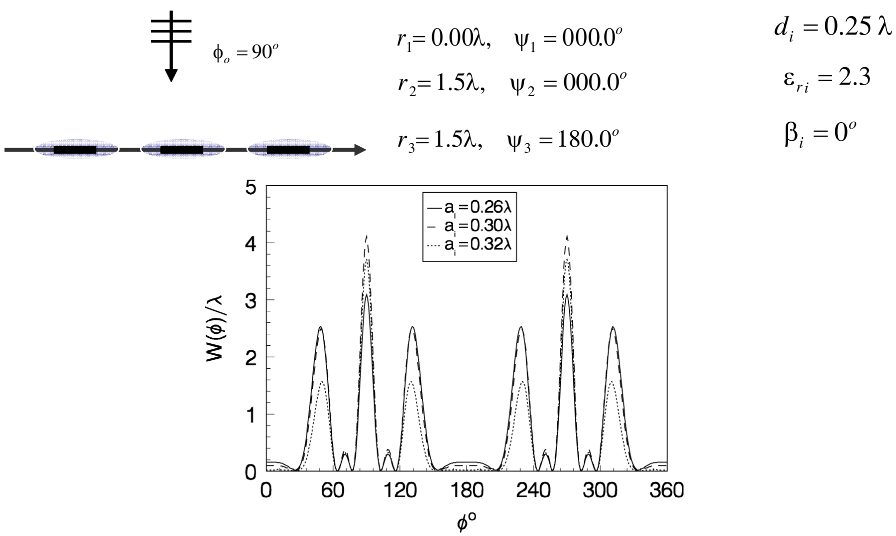

Figure 6. Echo width pattern for different dielectric thickness.

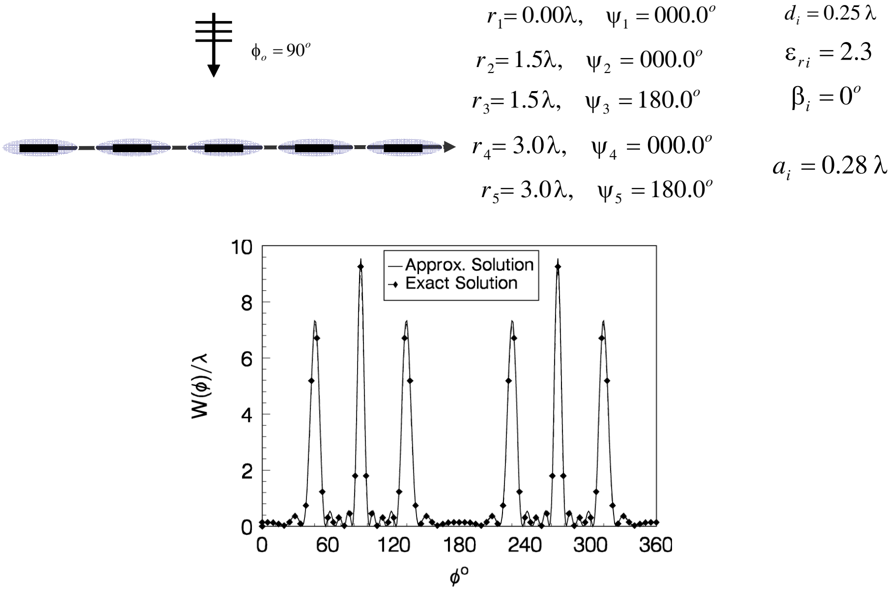

Figure 7. Comparison of the echo width patterns between exact and approximate solutions.

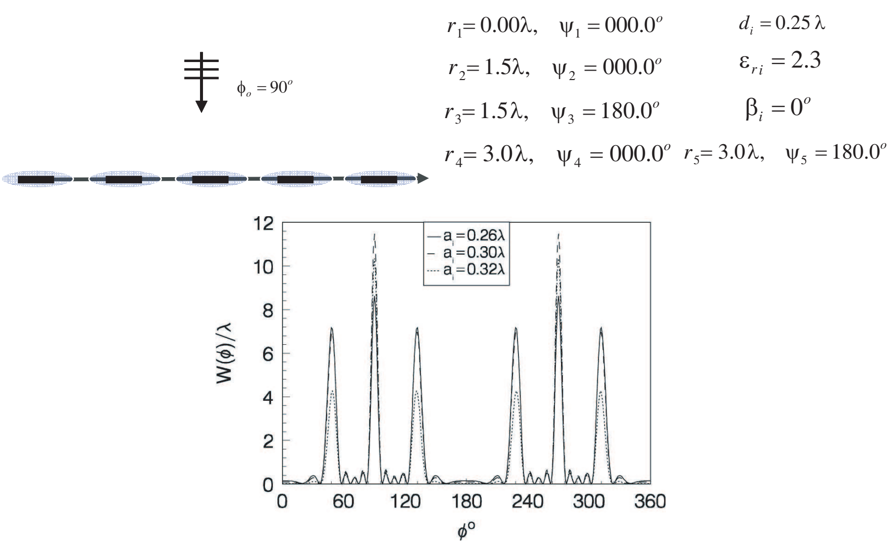

Figure 8. Echo width pattern for different dielectric thickness.

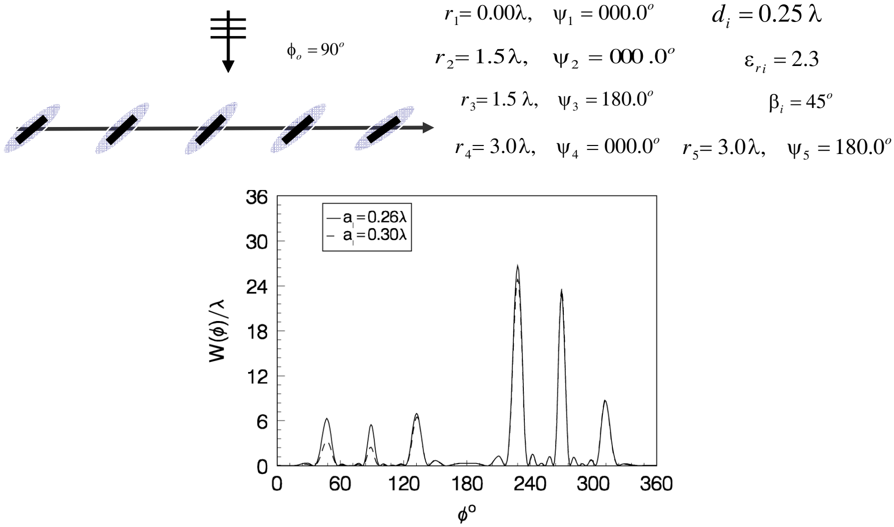

Figure 9. Echo width pattern for different dielectric thickness.

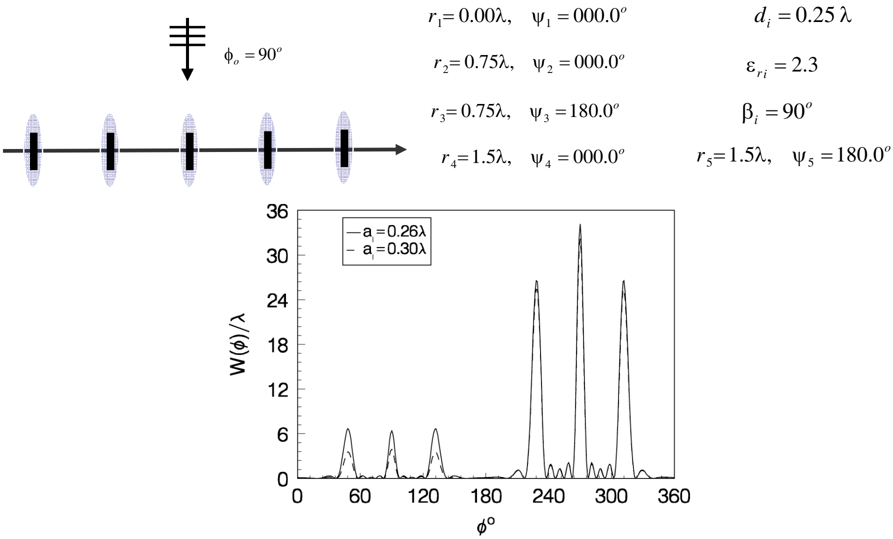

Figure 10. Echo width pattern for different dielectric thickness.

3. RESULTS AND DISCUSSION

In order to check the accuracy of our calculations the case of two dielectric coated strips is introduced. First the spacing between the two dielectric coated strips is considered 1.5λ and the echo width pattern is calculated for the input parameters given in Fig. 2, using both the exact method introduced in [10] and the approximate method introduced here. As one can see from Fig. 2 an excellent agreement is found. If the spacing between the two coated strips is decreased to less than 1.5λ the approximate method starts to fail and it gives inaccurate results as shown in Fig. 3 corresponding to spacing of 0.8λ. The effect of a dimensionally larger element on the approximate solution is addressed in the third example where the strip width is taken as 0.96λ for two elements shown in Fig. 4. As can be seen the echo width pattern is calculated using both approximate and exact methods. The agreement between the two cases is excellent. That shows the only restriction on the approximate method is the inter-element spacing. The number of elements in the present problem is designated by n while the infinite series in Eqs. (9) and (34) is truncated after m terms. In order to see the effect of the number of terms m on the echo width pattern for three elements ($n = 3$), the example of geometrical parameter shown in Fig. 5 is introduced. As one can see when $m = 4$, the solution converges and any increase in the value of m will not affect the echo width pattern. The effect of the dielectric coating thickness on the echo width pattern for a three elements case is also illustrated in Fig. 6. It indicates that the magnitude of the echo width pattern in the forward and the backward directions increases as the dielectric thickness increase then it decreases again. There should be a specific thickness at which the magnitude of the echo width is maximum in both the forward and backward directions. Comparison between approximate and exact methods is repeated again for the five element array, where the inter element spacing is 1.5λ. As one see from Fig. 7, the echo width pattern corresponding to both methods have an excellent agreement. Again that shows the number of elements has no effect on the approximate method. Once more the effect of the dielectric coating thickness on the echo width pattern for a five elements case is illustrated in Fig. 8. The same phenomenon of a maximum echo width for certain dielectric thickness is observed here again as noticed earlier in Fig. 6. The effect of rotating all elements with respect to the direction of the incident field, as shown in Figs. 9 and 10, on the echo width is investigated for different dielectric thickness. As illustrated in Fig. 9, a 45° inclination results in echo width pattern with maximum magnitude at 225° direction which is a reflection from the elements. Other peaks appear at forward direction at 270° and at 315° direction. The magnitude of the echo width in this case is observed to be high at very thin dielectric thickness. The last example is for array of elements having an element rotation of 90°. The echo width pattern for different dielectric thickness is shown in Fig. 10. The maximum magnitude of the echo width pattern is in the forward direction. The reflection in the backward direction is very small in this case. Also, the magnitude of the echo width pattern is higher for very thin dielectric thickness.

4. CONCLUSION

Approximate solution of the scattering of an electromagnetic waves by N dielectric coated conducing strips is introduced. The solution is found to give excellent results when the inter-element spacing is higher than strip width. The effect of the dielectric coating on the echo width is presented through several examples. It is found that very thin dielectric coating increases the scattering echo width in the forward and the back directions, and as the thickness increases the forward and backscattered echo width decreases. Effect of rotating the elements on the resulting echo width pattern is also investigated.

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