Computing the Electric and Magnetic Green's Functions in General Gyrotropic Media

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Abstract— A method for an approximate computation of the electric and magnetic Green's functions for the time-harmonic Maxwell's equations in the general gyrotropic media is proposed in this paper. The method is based on the Fourier transform with respect to space variables, matrix transformations and numerical computation of the inverse Fourier transform. The approximate computation of the inverse Fourier transform has been implemented by MATLAB tools. The computational experiments confirm the robustness of the method.

1. INTRODUCTION

The study of the electromagnetic fields in gyrotropic media is an important issue of the recent electromagnetic theory [1, 2, 6]. The electric and magnetic fluxes **D** and **B** in general gyrotropic media have the following form

$$\mathbf{D} = \varepsilon_0 \bar{\bar{\varepsilon}} \cdot \mathbf{E}, \quad \mathbf{B} = \mu_0 \bar{\bar{\mu}} \cdot \mathbf{H},$$

where **E** and **H** are electric and magnetic fields, respectively; positive constants ε_0 and μ_0 are defined as the permittivity and permeability of free space; the relative permittivity and permeability matrices $\bar{\bar{\varepsilon}}$ and $\bar{\bar{\mu}}$ have the following form (see, for example, [1–4]):

$$\bar{\bar{\varepsilon}} = \begin{pmatrix} \epsilon_{11} & \epsilon_{12} + ig_3 & \epsilon_{13} - ig_2 \\ \epsilon_{12} - ig_3 & \epsilon_{22} & \epsilon_{23} + ig_1 \\ \epsilon_{13} + ig_2 & \epsilon_{23} - ig_1 & \epsilon_{33} \end{pmatrix}, \ \bar{\bar{\mu}} = \begin{pmatrix} \mu_{11} & \mu_{12} + ih_3 & \mu_{13} - ih_2 \\ \mu_{12} - ih_3 & \mu_{22} & \mu_{23} + ih_1 \\ \mu_{13} + ih_2 & \mu_{23} - ih_1 & \mu_{33} \end{pmatrix}, \ i^2 = -1. \quad (1)$$

The main objects of our paper are the electric and magnetic Green's functions for Maxwell's partial differential equations in the general gyrotropic media. We suggest a method of an approximate (regularized) computation of the infinite-body Green's functions for the time-harmonic Maxwell's equations in the general gyrotropic media.

2. ELECTRIC AND MAGNETIC MATRIX GREEN'S FUNCTIONS

The electric and magnetic Green's functions are matrix functions

$$\begin{pmatrix} E_1^1(x) & E_1^2(x) & E_1^3(x) \\ E_2^1(x) & E_2^2(x) & E_2^3(x) \\ E_3^1(x) & E_3^2(x) & E_3^3(x) \end{pmatrix}, \begin{pmatrix} H_1^1(x) & H_1^2(x) & H_1^3(x) \\ H_2^1(x) & H_2^2(x) & H_2^3(x) \\ H_3^1(x) & H_3^2(x) & H_3^3(x) \end{pmatrix}, \quad (2)$$

whose columns $\mathbf{E^k} = (E_1^k, E_2^k, E_3^k)^T$, $\mathbf{H^k} = (H_1^k, H_2^k, H_3^k)^T$ satisfy equations

$$-\left(\frac{\omega}{c}\right)^2 \bar{\bar{\varepsilon}}\, \mathbf{E^k}(x) + \nabla \times \left(\bar{\bar{\mu}}^{-1} \nabla \times \mathbf{E^k}(x)\right) = i\omega\mu_0 \mathbf{e^k}\delta(x), \quad (3)$$

$$-\left(\frac{\omega}{c}\right)^2 \bar{\bar{\mu}}\, \mathbf{H^k}(x) + \nabla \times \left(\bar{\bar{\varepsilon}}^{-1} \nabla \times \mathbf{H^k}(x)\right) = \nabla \times (\bar{\bar{\varepsilon}}^{-1} \mathbf{e^k}\delta(x)). \quad (4)$$

Here $x = (x_1, x_2, x_3) \in \mathbb{R}^3$ is the $3D$ space variable; ω is a fixed parameter (frequency); $\mathbf{e}^1 = (1, 0, 0)^T$, $\mathbf{e}^2 = (0, 1, 0)^T$, $\mathbf{e}^3 = (0, 0, 1)^T$ are basis vectors of $\mathbb{R}^3$; i is the imaginary unit $i^2 = -1$; $\delta(x) = \delta(x_1)\delta(x_2)\delta(x_3)$, $\delta(x_j)$ is the Dirac delta function concentrated at $x_j = 0$ for $j = 1, 2, 3$.

2.1. Computing the Electric Green's Function

Let $\mathcal{F}_x$ be the operator of the Fourier transform with respect to $x = (x_1, x_2, x_3)$, i.e.,

$$\mathcal{F}_x[E(x)](\nu) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} E(x)e^{i\nu\cdot x}dx_1dx_2dx_3,$$

for the scalar integrable function $E(x)$, where $\nu = (\nu_1, \nu_2, \nu_3)$ is a $3D$ parameter of the Fourier transform; $\nu \cdot x = \nu_1 x_1 + \nu_2 x_2 + \nu_3 x_3$. The operator of the Fourier transform is defined in [8] for any generalized function (tempered distribution).

Let $\widetilde{\mathbf{E}}^{\mathbf{k}}(\nu) = (\widetilde{E}_1^k, \widetilde{E}_2^k, \widetilde{E}_3^k)$, where $\widetilde{E}_j^k = \mathcal{F}_x[E_j^k(x)](\nu)$, $j, k = 1, 2, 3$. Applying the operator of the Fourier transform $\mathcal{F}_x$ to (3) and using equality (see, [9], page 415)

$$\mathcal{F}_x\left[\nabla\times\left(\bar{\bar{\mu}}^{-1}\nabla\times\mathbf{E}^{\mathbf{k}}(x)\right)\right] = S(\nu)\bar{\bar{\mu}}^{-1}S(\nu)\widetilde{\mathbf{E}}^{\mathbf{k}}(\nu),$$

we find

$$-\left(\frac{\omega}{c}\right)^2\bar{\bar{\varepsilon}}\widetilde{\mathbf{E}}^{\mathbf{k}}(\nu) + S(\nu)\bar{\bar{\mu}}^{-1}S(\nu)\widetilde{\mathbf{E}}^{\mathbf{k}}(\nu) = i\omega\mu_0\mathbf{e}^{\mathbf{k}}, \tag{5}$$

where

$$S(\nu) = \begin{pmatrix} 0 & -\nu_3 & \nu_2 \\ \nu_3 & 0 & -\nu_1 \\ -\nu_2 & \nu_1 & 0 \end{pmatrix}. \tag{6}$$

Let ϵ be a symmetric real 3×3 matrix and g be an antisymmetric real 3×3 matrix defined by

$$\epsilon = \begin{pmatrix} \epsilon_{11} & \epsilon_{12} & \epsilon_{13} \\ \epsilon_{12} & \epsilon_{22} & \epsilon_{23} \\ \epsilon_{13} & \epsilon_{23} & \epsilon_{33} \end{pmatrix}, \quad g = \begin{pmatrix} 0 & g_3 & -g_2 \\ -g_3 & 0 & g_1 \\ g_2 & -g_1 & 0 \end{pmatrix}, \tag{7}$$

and let us assume that $\bar{\bar{\mu}}$ has an inverse matrix $\bar{\bar{\mu}}^{-1} = \bar{\mu} + i\bar{h}$.

The matrix $\bar{\bar{\varepsilon}}$ defined by (1) can be written as $\bar{\bar{\varepsilon}} = \epsilon + ig$. Further, let B and $C(\nu)$ be symmetric 6×6 matrices defined by

$$B = \begin{pmatrix} \epsilon & -g \\ g & \epsilon \end{pmatrix}, \quad C(\nu) = \begin{pmatrix} S(\nu)\bar{\mu}S(\nu) & -S(\nu)\bar{h}S(\nu) \\ S(\nu)\bar{h}S(\nu) & S(\nu)\bar{\mu}S(\nu) \end{pmatrix}. \tag{8}$$

In the paper, we suppose that B is positive definite.

Remark 1. *Positive definiteness of B is natural for a wide class of gyrotropic media because the matrix ϵ is always positive definite and the elements of matrix g essentially smaller then elements of ϵ (see, for example, [7]).*

Let us denote V_j^k as the real part of j component of $\widetilde{\mathbf{E}}^{\mathbf{k}}(\nu)$ and V_{j+3}^k as the imaginary part of j component of $\widetilde{\mathbf{E}}^{\mathbf{k}}(\nu)$, i.e., $V_j^k = \mathrm{Re}(\widetilde{E}_j^k(\nu))$ and $V_{j+3}^k = \mathrm{Im}(\widetilde{E}_j^k(\nu))$, $j = 1, 2, 3$. Then equality (5) can be written as the vector equation

$$-\left(\frac{\omega}{c}\right)^2 B\mathbf{V}^{\mathbf{k}}(\nu) + C(\nu)\mathbf{V}^{\mathbf{k}}(\nu) = \mathbf{F}^{\mathbf{k}}, \tag{9}$$

where $\mathbf{F}^{\mathbf{1}} = \omega\mu_0(0,0,0,1,0,0)^T$, $\mathbf{F}^{\mathbf{2}} = \omega\mu_0(0,0,0,0,1,0)^T$, $\mathbf{F}^{\mathbf{3}} = \omega\mu_0(0,0,0,0,0,1)^T$.

Applying technique and computational tools of [9], it is possible to compute a non-singular matrix $T(\nu)$ and diagonal matrix $D(\nu) = \mathrm{diag}(d_1(\nu), d_2(\nu), \ldots, d_6(\nu))$, such that

$$T^T(\nu)C(\nu)T(\nu) = D(\nu), \quad T^T(\nu)BT(\nu) = I.$$

The solution of (9) is determined by $\mathbf{V}^{\mathbf{k}}(\nu) = T(\nu)\mathbf{Y}^{\mathbf{k}}$, where $\mathbf{Y}^{\mathbf{k}}(\nu) = (Y_1^k(\nu), Y_2^k(\nu), \ldots, Y_6^k(\nu))$ is the vector whose components for $\left(\frac{w}{c}\right)^2 - d_l(\nu) \neq 0$ can ve written as

$$Y_l^k(\nu) = \frac{(T^T\mathbf{F}^{\mathbf{k}})_l}{-(\omega/c)^2 + d_l(\nu)}.$$

The components of $\widetilde{\mathbf{E}}^{\mathbf{k}}(\nu,\omega)$ are found by

$$\widetilde{E}_j^k = V_j^k(\nu) + iV_{j+3}^k(\nu), \quad j = 1,2,3;\ k = 1,2,3. \tag{10}$$

Finally, applying the inverse Fourier transform to (10), we find the k-column of the electric Green's function as a tempered distribution, i.e.,

$$\mathbf{E}^{\mathbf{k}}(x) = \mathcal{F}_\nu^{-1}\left[\widetilde{\mathbf{E}}^{\mathbf{k}}(\nu)\right](x), \tag{11}$$

where $\mathcal{F}_\nu^{-1}$ is the operator of the inverse Fourier transform in the space of distribution $S'(\mathbb{R}^3)$ [8]. The right hand side of (11) can be regularized by

$$\frac{1}{(2\pi)^3}\int_{-A}^{A}\int_{-A}^{A}\int_{-A}^{A}\widetilde{\mathbf{E}}^{\mathbf{k}}(\nu)\,e^{-i\nu\cdot x}d\nu_1 d\nu_2 d\nu_3, \tag{12}$$

where A is the parameter of regularization.

We take $A = N\Delta$ and approximate the integral (12) by the integral sum

$$\frac{1}{(2\pi)^3}\sum_{n=-N}^{N}\sum_{m=-N}^{N}\sum_{l=-N}^{N}\widetilde{\mathbf{E}}^{\mathbf{k}}(n\Delta, m\Delta, l\Delta)\,e^{-i\Delta(nx_1+mx_2+lx_3)}(\Delta\nu)^3,$$

for the numerical computation. The parameters N and Δ have been chosen by empirical observations, as the best parameters for the case of isotropic media for which there exists explicit formulas for the Green's functions and their Fourier images.

2.2. Computing the Magnetic Matrix Green's Function

Applying the Fourier transform with respect to x to the Equation (4) and using equalities

$$\mathcal{F}_x\left[\nabla\times\left(\bar{\bar{\varepsilon}}^{-1}\nabla\times\mathbf{H}^{\mathbf{k}}(x)\right)\right] = S(\nu)\bar{\bar{\varepsilon}}^{-1}S(\nu)\widetilde{\mathbf{H}}^{\mathbf{k}}(\nu),\ \ \mathcal{F}_x\left[\nabla\times\left(\bar{\bar{\varepsilon}}^{-1}\mathbf{e}^{\mathbf{k}}\right)\right] = S(\nu)\bar{\bar{\varepsilon}}^{-1}\mathbf{e}^{\mathbf{k}},$$

we find

$$-\left(\frac{\omega}{c}\right)^2\bar{\bar{\mu}}\widetilde{\mathbf{H}}^{\mathbf{k}}(\nu) + S(\nu)\bar{\bar{\varepsilon}}^{-1}S(\nu)\widetilde{\mathbf{H}}^{\mathbf{k}}(\nu) = S(\nu)\bar{\bar{\varepsilon}}^{-1}\mathbf{e}^{\mathbf{k}}, \tag{13}$$

where $\widetilde{\mathbf{H}}^{\mathbf{k}}(\nu) = (\widetilde{H}_1^k, \widetilde{H}_2^k, \widetilde{H}_3^k)$, $\widetilde{H}_n^k(\nu) = \mathcal{F}_x[H_n^k(x)](\nu)$, $n = 1,2,3;$, $S(\nu)$ is defined by (6) and let μ be a symmetric real 3×3 matrix and h be an antisymmetric real 3×3 matrix defined by

$$\mu = \begin{pmatrix} \mu_{11} & \mu_{12} & \mu_{13} \\ \mu_{12} & \mu_{22} & \mu_{23} \\ \mu_{13} & \mu_{23} & \mu_{33} \end{pmatrix}, \quad h = \begin{pmatrix} 0 & h_3 & -h_2 \\ -h_3 & 0 & h_1 \\ h_2 & -h_1 & 0 \end{pmatrix},$$

and let us assume that $\bar{\bar{\varepsilon}}$ has an inverse matrix $\bar{\bar{\varepsilon}}^{-1}$.

Let $X_n^k(\nu)$, $G_n^k(\nu)$, $R_r(\nu)$ be the real parts of $\widetilde{H}_n^k(\nu)$, $(S(\nu)\bar{\bar{\varepsilon}}^{-1}\mathbf{e}^{\mathbf{k}})$, $(S(\nu)\bar{\bar{\varepsilon}}^{-1}S(\nu))$ and $X_{n+3}^k(\nu)$, $G_{n+3}^k(\nu)$, $R_i(\nu)$ be the imaginary parts of $\widetilde{H}_n^k(\nu)$, $(S(\nu)\bar{\bar{\varepsilon}}^{-1}\mathbf{e}^{\mathbf{k}})$, $(S(\nu)\varepsilon^{-1}S(\nu))$, respectively.

Denoting $\mathbf{X}^{\mathbf{k}}(\nu) = (X_1^k(\nu), X_2^k(\nu), \ldots, X_6^k(\nu))$ and $\mathbf{G}^{\mathbf{k}}(\nu) = (G_1^k(\nu), G_2^k(\nu), \ldots, G_6^k(\nu))$ the equation (13) can be written in the form

$$-\left(\frac{\omega}{c}\right)^2 K\mathbf{X}^{\mathbf{k}}(\nu) + P(\nu)\mathbf{X}^{\mathbf{k}}(\nu) = \mathbf{G}^{\mathbf{k}}(\nu), \tag{14}$$

where $P(\nu)$ and K are 6×6 symmetric matrix defined by

$$K = \begin{pmatrix} \mu & -h \\ h & \mu \end{pmatrix}, \quad P(\nu) = \begin{pmatrix} R_r(\nu) & -R_i(\nu) \\ R_i(\nu) & R_r(\nu) \end{pmatrix}. \tag{15}$$

In the paper we suppose that K is positive definite.

We note that $(S(\nu)\bar{\bar{\varepsilon}}^{-1}S(\nu)) = R_r(\nu) + iR_i(\nu)$, where

$$R_i(\nu) = \frac{1}{\xi_4}\begin{pmatrix} 0 & -a_{12} & a_{13} \\ a_{12} & 0 & -a_{23} \\ -a_{13} & a_{23} & 0 \end{pmatrix}, \quad R_r(\nu) = \frac{1}{\xi_4}\begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{12} & b_{22} & b_{23} \\ b_{13} & b_{23} & b_{33} \end{pmatrix},$$

$$\begin{aligned}
&a_{12} = \nu_2\nu_3\xi_1 + \nu_3^2\xi_2 + \nu_1\nu_3\xi_3,\ a_{13} = \nu_2^2\xi_1 + \nu_2\nu_3\xi_2 + \nu_1\nu_2\xi_3,\ a_{23} = \nu_1\nu_3\xi_2 + \nu_1^2\xi_3 + \nu_1\nu_2\xi_1,\\
&b_{11} = -\nu_2^2\xi_5 + 2\nu_2\nu_3\xi_6 - \nu_3^2\xi_7,\ b_{12} = \nu_1\nu_2\xi_5 - \nu_1\nu_3\xi_6 - \nu_2\nu_3\xi_8 + \nu_3^2\xi_9,\\
&b_{13} = \nu_1\nu_3\xi_7 - \nu_1\nu_2\xi_6 - \nu_2^2\xi_8 - \nu_2\nu_3\xi_9,\ b_{22} = -\nu_1^2\xi_5 + 2\nu_1\nu_3\xi_8 - \nu_3^2\xi_{10},\\
&b_{23} = \nu_2\nu_3\xi_{10} - \nu_1\nu_2\xi_8 - \nu_1^2\xi_6 + \nu_1\nu_3\xi_9,\ b_{33} = -\nu_1^2\xi_7 + 2\nu_1\nu_2\xi_8 - \nu_2^2\xi_{10},\\
&\xi_1 = \epsilon_{12}g_1 + \epsilon_{22}g_2 + \epsilon_{23}g_3,\ \xi_2 = \epsilon_{13}g_1 + \epsilon_{23}g_2 + \epsilon_{33}g_3,\ \xi_3 = \epsilon_{11}g_1 + \epsilon_{12}g_2 + \epsilon_{13}g_3,\\
&\xi_4 = \epsilon_{33}\epsilon_{12}^2 - 2\epsilon_{12}\epsilon_{13}\epsilon_{23} + 2\epsilon_{12}g_1g_2 + \epsilon_{22}\epsilon_{13}^2 + 2\epsilon_{13}g_1g_3 + \epsilon_{11}\epsilon_{23}^2 + 2\epsilon_{23}g_2g_3 +\\
&+\epsilon_{11}g_1^2 + \epsilon_{22}g_2^2 + \epsilon_{33}g_3^2 - \epsilon_{11}\epsilon_{22}\epsilon_{33}, \xi_5 = \epsilon_{12}^2 + g_3^2 - \epsilon_{11}\epsilon_{22},\ \xi_6 = g_2g_3 - \epsilon_{12}\epsilon_{13} + \epsilon_{11}\epsilon_{23},\\
&\xi_7 = \epsilon_{13}^2 + g_3^2 - \epsilon_{11}\epsilon_{33},\ \xi_8 = g_1g_3 - \epsilon_{12}\epsilon_{23} + \epsilon_{13}\epsilon_{22},\ \xi_9 = g_1g_2 - \epsilon_{13}\epsilon_{23} + \epsilon_{12}\epsilon_{33},\\
&\xi_{10} = \epsilon_{23}^2 + g_1^2 - \epsilon_{22}\epsilon_{33}.
\end{aligned}$$

Using the technique, from [5] we can compute an invertible matrix $Q(\nu)$ and $M(\nu)$ such that

$$Q^T(\nu)KQ(\nu) = I, \quad Q^T(\nu)P(\nu)Q(\nu) = M(\nu),$$

where $M(\nu) = \mathrm{diag}(m_n(\nu),\ n = 1,2,3,4,5,6)$.

Let $\mathbf{Z^k}(\nu) = Q^T(\nu)\mathbf{X^k}(\nu)$, then (14) can be written in the form

$$-\left(\frac{\omega}{c}\right)^2 \mathbf{Z^k}(\nu) + M(\nu)\mathbf{Z^k} = Q^T(\nu)\mathbf{G^k}. \tag{16}$$

For $(\omega/c)^2 - m_n(\nu) \neq 0$ the solution of (16) can be found in a component form as follows

$$Z_n^k(\nu) = \frac{\left(Q^T(\nu)\mathbf{G^k}\right)_n}{-(\omega/c)^2 + m_n(\nu)}, \quad n = 1,2,\dots,6, \tag{17}$$

where $\mathbf{Z^k}(\nu) = (Z_1^k(\nu), Z_2^k(\nu), \dots, Z_6^k(\nu))$. As a result of it the solution of (13) is found by

$$\mathbf{H^k}(\nu) = \left(H_1^k(\nu), H_2^k(\nu), \dots, H_6^k(\nu)\right),\ \widetilde{H}_n^k = X_n^k(\nu) + iX_{n+3}^k(\nu),\ k = 1,2,3;\ n = 1,2,3. \tag{18}$$

Applying the inverse Fourier transform to (18), we find the k-column of the magnetic Green's function as a tempered distribution, i.e.,

$$\mathbf{H^k}(x) = \mathcal{F}_\nu^{-1}\left[\widetilde{\mathbf{H}}^\mathbf{k}(\nu)\right](x). \tag{19}$$

The right hand side of (19) can be regularized by

$$\frac{1}{(2\pi)^3}\int_{-A}^{A}\int_{-A}^{A}\int_{-A}^{A}\widetilde{\mathbf{H}}^\mathbf{k}(\nu)\, e^{-i\nu\cdot x}d\nu_1 d\nu_2 d\nu_3, \tag{20}$$

where A is the parameter of regularization.
We take $A = N\Delta$ and approximate the integral (20) by the integral sum

$$\frac{1}{(2\pi)^3}\sum_{n=-N}^{N}\sum_{m=-N}^{N}\sum_{l=-N}^{N}\widetilde{\mathbf{H}}^\mathbf{k}(\Delta\, n, \Delta\, m, \Delta\, l)\, e^{-i\Delta(nx_1+mx_2+lx_3)}(\Delta\nu)^3.$$

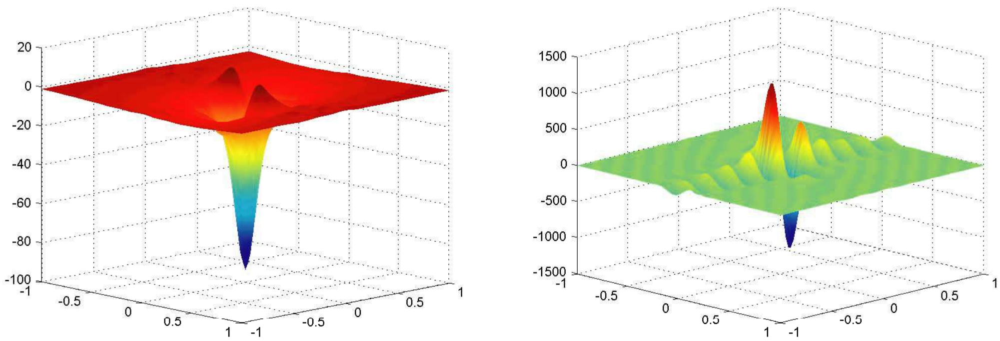
for the numerical computation. The parameters N and Δ are determined by the procedure described in Section 2.1.

3. THE APPROXIMATE COMPUTATION OF THE ELECTRIC AND MAGNETIC GREEN'S FUNCTIONS

For the computational experiment we take $\bar{\bar{\varepsilon}}$ and $\bar{\bar{\mu}}$ as follows

$$\begin{pmatrix} 30.79 & -12.73+i0.05 & -14.34-i0.04 \\ -12.73-i0.05 & 5.52 & 5.87+i0.02 \\ -14.34+i0.04 & 5.87-i0.02 & 6.75 \end{pmatrix}, \begin{pmatrix} 3 & 1+i0.01 & 2-i0.03 \\ 1-i0.01 & 5 & 4+i0.04 \\ 2+i0.03 & 4-i0.04 & 9 \end{pmatrix}.$$

The computation of electric and magnetic Green's functions have been done in MATLAB by the method of Sections 2.1 and 2.2. Some results of these computations are presented as $3D$ graphs of $\mathrm{Re}(E_3^1(x_1,x_2,0))$ and $\mathrm{Im}(H_3^1(x_1,x_2,0))$ for $\omega = 2c$ in Fig. 1(a) and Fig. 1(b) respectively. Here the horizontal axes are x_1 and x_2, respectively. The vertical axis is the magnitude of $\mathrm{Re}(E_3^1(x_1,x_2,0))$ and $\mathrm{Im}(H_3^1(x_1,x_2,0))$, respectively.



(a) (b)

Figure 1: $\omega = 2c$, (a) $3D$ plot of $\mathrm{Re}(E_1^3(x_1,x_2,0))$; (b) $3D$ plot of $\mathrm{Im}(H_1^3(x_1,x_2,0))$.

4. CONCLUSION

The method for the approximate computation of the electric and magnetic Green's functions for the time-harmonic Maxwell's equations in general gyro-electric media has been developed in the paper. The method is based on the Fourier transform meta-approach where the Fourier image of the Green's function is computed by some matrix transformations and symbolic computations in MATLAB. After that the inverse Fourier transform is computed in a regularized (approximate) form. The parameters of the regularization have been chosen by the comparison of the regularized Green's function with Green's function obtained by the explicit formula for the isotropic case. The approximate computation of the inverse Fourier transform has been implemented by MATLAB tools. The computational experiments confirm the robustness of the method.

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