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Efficient Near-Field Analysis Based on Finite-Difference Scheme and Fast Inverse Laplace Transform

D. Wu[(1)], T. Yamaguchi [(2)], and S. Ohnuki* [(1)]
(1) Nihon University, Tokyo, 101-8308 JAPAN, e-mail: ohnuki.shinichiro@nihon-u.ac.jp
(2) Tokyo Metropolitan Industrial Technology Research Institute, Tokyo, 135-0064, JAPAN

The authors propose an efficient algorithm to perform near-field analysis of electromagnetic waves around various objects. Solutions of Maxwell's equations in complex frequency domain are obtained by a finite-difference scheme and they are numerically transformed into the time domain by fast inverse Laplace transform. Using our combined technique, time and frequency responses of electromagnetic waves can be evaluated efficiently and precisely.

In our combined technique, the time dependence of Maxwell's equations is assumed to be exp (st) where the complex frequency s is given by $\sigma+j\omega$. Replacing the partial derivative with respect to time, Maxwell's equations can be discretized using a finite-difference complex-frequency-domain (FDCFD) scheme. Electromagnetic fields in complex frequency domain can be found applying the same procedure of the conventional method [1, 2].

To obtain time-domain responses, electromagnetic fields in the complex frequency domain are transformed into the time domain using fast inverse Laplace transform (FILT) [3, 4]. In this algorithm, the exponential function in the Bromwich integral is replaced by the cosine hypobaric function. Substituting this hypobaric function into the integrand and using the residue theorem, the approximated time-domain function can be computed by summing up the simple series. We perform near-field analysis of electromagnetic waves around metallic nano objects and verify reliability of our combined technique in terms of time and frequency responses.

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