Network-Oriented Dyadic Short-Pulse Field Representations for Periodic Arrays

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Wide-band and short-pulse radiation from actual rectangular phased array antennas, infinite and truncated periodic structures, frequency selective surfaces and related applications is a topic of increasing interest. Our planned research agenda so far has dealt with investigations of basic canonical time domain (TD) dipole-excited Green's functions for infinite [L.B. Felsen and F. Capolino, *IEEE Trans. AP*, **6**, 921-931, 2000] and truncated [F. Capolino and L.B. Felsen, *IEEE Trans. AP*, **1**, 31-41, 2002] periodic line arrays, and of infinite and semi-infinite periodic planar arrays [F. Capolino and L.B.Felsen, *IEEE Trans. AP*, **12**, 2002, and *Radio Science*, in print]. The radiated field has been expressed and parameterized in terms of TD Floquet waves (FW). The Green's function for the infinite planar array of dipoles has been used advantageously in a fast TD method of moments algorithm for wide band analysis of periodic structures [N. Chen, M. Lu, B. Shanker, F. Capolino and E. Michielssen, *this conference*]. Here, a network oriented dyadic Green's function is formulated for the infinite sequentially excited planar dipole array (Fig.1). The advantage of the network approach is (a) that E (TM) and H (TE) polarized TD-FW modes are treated individually, with their field expressed in terms of TD transmission line (TL) Green's functions (Fig.2) that obey standard network theory; (b) that plane-stratified inhomogeneous media can be accommodated by the same formalism. Causality issues pertaining to the E and H mode decomposition are treated in detail. It is found that, individually, each *pq*-indexed E and H mode is noncausal, and can obtained in closed form via convolution between an auxiliary frequency domain formulation that involves characteristic noncausal functions, and the causal TL Green's functions (Fig.2). Causality on the total vector FW field is recovered by summing the E and H mode contributions. We show how the transverse TD-TL vector mode functions are defined using modal-FW scalar potentials ϕ_{pq} and ψ_{pq}, with voltage and current TL Green's functions $\hat{Z}_{pq}$ and $\hat{T}^{I}_{pq}$ (Fig.2) represented in terms of Bessel functions and incomplete Lipschitz-Hankel integrals. We also exhibit here some properties, such as orthogonality and completeness, pertaining to the TD-FW as basis sets. Asymptotic inversion from the FD yields the instantaneous frequency behavior which parameterizes the constituent TD-FWs. The localization of the synthesizing frequency spectrum around instantaneous frequencies is due to the periodicity-induced dispersive FW behavior. Numerical examples of radiation from infinite planar arrays of dipoles with short-pulse band-limited excitation are presented to demonstrate the accuracy of the TD-FW algorithm and to illustrate the rapid convergence of the (TD-FW)-based field expansion since only a few terms are required for describing the off-surface radiated field.

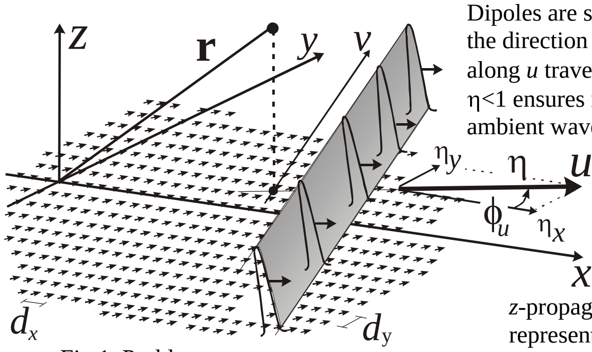

Fig.1. Problem geometry

Dipoles are sequentially excited along the direction *u*. The excitating wavefront along *u* travels with speed v=*c*/η. where η<1 ensures radiation and *c* is the ambient wave speed.

z-propagation for each TD-FW is represented by an equivalent TD-TL voltage and current Green's function.

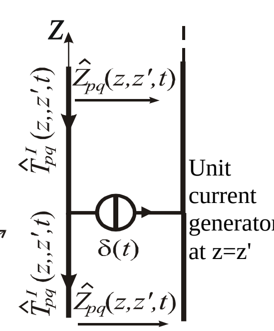

Fig.2. TD transmission line Green's Functions