# On the Use of Spatio-Temporal Wavelet Expansions for Transient Analysis of Wire Antennas and Scatterers

Yair Shifman, *Member, IEEE,* and Yehuda Leviatan, *Fellow, IEEE*

***Abstract*—To analyze a wire antenna excited by a time varying voltage source or a wire scatterer excitated by transient electromagnetic incident wave, the problem is formulated in terms of a time-domain integral equation for the induced current. To solve the integral equation, we reduce it to matrix equation via the method of moments using the known-to-be-stable implicit scheme. However, rather than directly constructing and solving the relatively large matrix equation, we propose an iterative procedure which allows us to gradually obtain a solution of refined accuracy both everywhere and simultaneously at any time instance. To render this procedure rapidly converging, we use a basis of spatio-temporal wavelet functions. This basis facilitates a good approximation of the induced current using far less basis functions than would be needed if other expansions, such as standard-pulse or Fourier basis functions were chosen. The use of this basis further enables the iterative procedure to increase the temporal and spatial resolutions where required without unnecessarily affecting their levels elsewhere.**

moments (MoM) using an explicit scheme which lends itself to a marching-on-in-time (MOT) solution technique [11], [12]. Since the MOT is notoriously numerically instable, the use of the conjugate-gradient (CG) method, which prevents the accumulation of error with time, has been suggested in [11], [13], [14]. Later, instead of the explicit scheme, the inherently stable implicit scheme has been advocated [15].

To overcome the additional numerical complexity involved in solving the matrix equation resulting upon using the implicit scheme, we present in this paper a novel approach, which expands on a recent procedure successfully applied to several one-dimensional (1-D) scattering problems [16]–[19]. Using spatio-temporal wavelet basis functions, a reduced-rank version of the matrix equation is iteratively constructed and solved up until a desired degree of accuracy is attained simultaneously for all the