

**NUMERICAL RECONSTRUCTION AND APPLICATIONS OF
ACOUSTIC AND ELECTROMAGNETIC ULTRA-WIDEBAND
LOCALIZED PULSES GENERATED BY DYNAMIC
APERTURE ANTENNAS**

by

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(ABSTRACT)

A study is undertaken of the numerical reconstruction of acoustic and electromagnetic (EM) localized waves (LWs). The latter are carrier-free ultra-wideband pulses characterized by large focusing depths and extended ranges of localization. Special emphasis is placed on finite energy LWs that can be generated by dynamic aperture antennas with independently addressable elements. The reconstruction techniques are based on Huygens and Rayleigh-Sommerfeld integral I and II representations, both in the time and frequency domains. In contradistinction to the Weyl representation, they lend themselves to the physical realization of space-time aperture sources capable of generating localized wave solutions propagating away from the aperture plane. A detailed comparison of the three reconstruction techniques has been carried out in connection with LW solutions to the scalar wave equation, especially with respect to their handling of acausal components incorporated in the aperture excitation fields. In addition, a study is presented of the characteristic properties of LWs propagating through dispersive media modeled by

the Klein-Gordon equation. It is demonstrated that contrary to expectation, the depletion of the spectral components of the LW Klein-Gordon field may be slower than that associated with the free space scalar field. Previous work by Power *et al.* [73] is extended by studying the acoustic bistatic scattering of a modified power spectrum (MPS) pulse from rigid and compressible spheres. The analysis allows the extraction of the radius of a sphere from the backscattered data. Finally, a special class of electromagnetic (EM) LWs, referred to as azimuthally polarized X waves (APXWs), is derived and their reconstruction is addressed, both in the time and frequency domains.

Dedicated
to the memory of my father who encouraged
me and provided me the valuable guidance
to pursue my life and career

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