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Beam Based Imaging and Inverse Scattering

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Abstract: We present schemes for target imaging that utilize collimated beam fields as propagators, instead of the Green's functions used in conventional schemes. The beam approach is based on a mathematical representation of the Green's functions in the medium as a superposition of beams that emerge from the source in all directions and are then tracked locally in the medium along ray trajectories. Beam-based imaging consists therefore of two phases: a preprocessing phase where the measured scattering data is transformed into the beam-domain, thus describing synthetically the scattered beams due to an incident beam field; and an imaging/inversion phase where an imaging/inversion algorithm uses the beam data to form an image of the targets. The most important property of the beam approach for imaging applications is the data localization achieved due to the fact that only those beams that pass near the targets interact with it and contribute to the scattering data. This makes it possible to calculate the local image of any sub-domain of interest (DoI) by considering only those beams that pass through or near that domain. The local imaging approach reduces the number of degrees of freedom of the problem and thereby its computation complexity, and it also reduces the noise level since data and noise arriving from other regions are a priori filtered out.

We introduce three beam-domain imaging schemes: (a) a back-propagation and correlation scheme, where beam-domain data is back-propagated and correlated with the incident beams; (b) a Multiple Signal Classification (MUSIC) scheme where sub-space methods are applied on the beam data to form the image; (c) an inverse scattering algorithm which uses beam functions to span the object, and then uses their correlations with the beam data to reconstruct the object.

Biography

Tal Heilpern received the B.Sc. degree in physics and mathematics from the Hebrew University, Jerusalem, Israel, in 1999, the M.Sc. (*cum laude*), and Ph.D. degrees in electrical engineering from Tel Aviv University, Israel, in 2004 and 2013, respectively.

He was a Postdoctoral Fellow at Tel Aviv University School of Electrical Engineering in 2013-2014. His main fields of interest are wave theory and inverse scattering, with emphasis on analytic methods and beam techniques.