3D Conformal Inverse Synthetic Aperture Radar (ISAR) Imaging Using Basis Pursuit

Ivan J. LaHaie[(1)], Steven M. Cossmann[(1)], Gary D. Dester[(1)], Jim Lauer[(1)], Rebecca Malinas[(1)], and Brian E. Fischer[(2)]
(1) Integrity Applications Inc., Ann Arbor, MI 48108
(2) Resonant Sciences, Beavercreek, OH 45430

In the last several years, various methods have been described for reconstructing equivalent sources (surface currents) on conformal surfaces of radiating structures from measurements of their radiated fields (see, for example, Foged, et al., Proc. AMTA 2011, 186-191). The resulting source reconstructions, or "images," can be used for antenna diagnostics and to identify and edit the sources of stray radiation. More recently, these concepts have been extended to the case of monostatic backscatter measurements using non-interacting scatterers as the sources (Schnattinger, et al., Proc. AMTA 2013, 33-36). In both cases, the sources were reconstructed using an iterative least squares (LS) technique. The images obtained from LS solvers tend to be "smooth," which is typically the case for radiating currents, but which is not necessary true of the scattering from complex targets, where the returns tend to arise from discrete, localized sources. The resulting images can suffer from poor resolution and/or artifacts if the problem is undetermined (more unknown sources than measurements) and/or the data are limited or undersampled. We present herein a 3D conformal source reconstruction technique for monostatic measurements of large radar targets that uses the basis pursuit (BP) iterative ℓ_1 minimization technique. As such, it is capable of generating highly-resolved 3D conformal images on a densely-sampled grid from a limited set of measurements. The technique has been implemented for conical or great circle collection geometries in either the near or far field using an efficient, octree-based fast multilevel algorithm. Example conformal images obtained from simulated data are presented to demonstrate the efficacy of the technique.