Some Applications of Curve-Evolution Techniques to Inverse Scattering

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In many inverse scattering applications, aimed at retrieving geometrical and constitutive properties of targets embedded in complex environments, *object-based* reconstruction techniques are rapidly emerging as an attractive alternative to traditional *pixel-based* approaches. The motivation behind object-based techniques is to focus on robust *global* features of the target (e.g., shape, contrast, etc.), instead of trying to image the target *pointwise*. Besides mitigating the *ill-posedness* of the inverse scattering problem, these methods typically yield better estimation of key features of the target image (such as *edges*) which is highly desirable in localization/classification procedures. An important class of object-based imaging techniques is represented by *curve evolution* (CE) techniques (J. Shah, *J. Visual Comm. Image Representation*, **11**, p. 142, 2000), where a *gradient flow* is designed which attracts initial closed curves to the target boundary. Numerical implementation of such techniques is usually carried out via the *level set* method (A.D. Litman *et al.*, *Inverse Problems*, **14**, p. 685, 1998).

Our application is concerned with subsurface imaging of mine-like targets in the presence of moderately rough air-soil interfaces, for both frequency-stepped and pulsed excitations. For *low-contrast* targets, we have recently explored an *adaptive* approach based on the use of Gaussian beam fast forward scattering models. In this approach, a prior (coarse-scale) interface estimation problem is solved, with the resulting reconstructed interface profile used to correct the raw backscattered field data observed at the receivers so as to compensate for the corresponding clutter. The subsurface *target imaging* is subsequently performed by inverting a Born-approximate forward scattering model. In this connection, the use of object-based CE reconstruction techniques is explored and compared with traditional pixel-based approaches. For *high-contrast* targets, we have explored the use of CE-based imaging techniques in conjunction with the contrast source inversion method proposed in (P. van den Berg and R.E. Kleinman, *Inverse Problems*, **13**, p. 1607, 1997). Preliminary results, so far restricted to the simplest case of *homogeneous* background (i.e., no interface) look promising.