

SAR Imaging Algorithms: Innovations and Issues

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Despite the maturity of synthetic aperture radar processing algorithms for most imaging regimes, new areas of application and imaging modes continue to spawn innovations. Range-Doppler algorithms have largely been replaced by wave-domain algorithms, which were used originally in seismic processing. Wave-domain algorithms are well suited to broadside wide-beam imaging systems, rigorously mapping the space of image coordinates to the observation space. Chirp scaling has become popular as a means of replacing costly space-variable interpolations and resampling operations with efficient FFT-based convolutions in both range-Doppler and wave-domain processors, but chirp scaling can limit performance in systems requiring higher order interpolations. Innovations in burst mode processing for ScanSAR operations will become more important with the next generation of space borne radar satellites. Range-Doppler algorithms for ScanSAR are inefficient, so typically deramp-FFT approaches are used. However, as swath is increased and bursts become shorter, radiometric and phase distortions are introduced, requiring new processing approaches. New approaches to synoptic processing will be required to identify areas of interest in petabyte data sets before full resolution processing is done. These may involve burst-mode concepts. In radar interferometry, three-dimensional surface reconstruction has become common place, spawning innovations in super-resolution processing and tomographic reconstruction of surface layers. Bistatic SAR imaging is another area where little work has been done, but where free signals from space, such as GPS and TV broadcast signals, can be exploited. For future autonomous space systems where feature identification and extraction will be done on-board, new algorithms will be required to process directly from raw data to a feature type, such as localization of linear edges or moving targets.