Filling the Gaps in SweepSAR Data

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Abstract

SAR missions usually face a tradeoff between azimuth resolution and area coverage. For example, a spotlight mode achieves increased resolution by dwelling the beam on a particular target, and wide swath modes typically reduce the dwell time in order to cover a larger area. The upcoming NASA-ISRO SAR (NISAR) mission will utilize a new mode called SweepSAR (also known as scan on receive, or SCORE) in order to simultaneously achieve high azimuth resolution and a wide image swath. This mode is possible thanks to the multi-channel reflectarray instrument design where on-board digital beamforming tracks pulse echos as they sweep across the receive elements.

Among the many challenges associated with a SweepSAR system, one is that the time required to record an echo from such a wide swath exceeds the interval between pulses (PRI). Since the radar cannot transmit and receive at the same time, the recording contains gaps associated with each transmit event. The location of these gaps is determined by the PRI, and the size of the gaps is proportional to the pulse length.

This talk will explore strategies for mitigating the performance impact of gaps in SweepSAR mode data. Special attention will be given to PRI dithering, where we intentionally perturb the PRI after every pulse. The goals of PRI dithering are to spread the gaps out evenly across the swath and to ensure that no consecutive pulses have a gap at the same range bin. Under these conditions, it is possible to fill the raw data gaps via azimuth interpolation and obtain contiguous focused imagery.

Like everything else in SAR, PRI dithering involves some performance tradeoffs compared to constant PRI data. In particular the ambiguity level increases, driven by artifacts that are qualitatively somewhat in between the typical impulse response sidelobes and antenna pattern sidelobe ambiguities in character. The talk will present theoretical and simulated performance analysis of Level~1 imagery and the strategy for providing simulated data to the NISAR science team for assessment of the impacts of PRI dithering on higher level data products.

Keywords - Calibration of future missions