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Moving Target Motion Parameter Estimation in Two-Channel SAR-GMTI

Abstract:
Part 1:
Two-channel SAR-GMTI systems are suboptimal for moving target motion parameter estimation. Indeed, the ATI phase estimate of a moving target across-track velocity component is biased to lower values depending on the target signal to clutter ratio and the target across-track velocity. Additional antenna diversity can introduce additional degrees of freedom that can eliminate the bias problem. Aperture Switching is an accepted method to virtually increase the number of channels without adding new hardware. Additional phase centres can also be generated from already recorded two-channel SAR data by delaying and combining the recorded two-channel measurements. The combination operation manifests not only a third phase centre halfway between the phase centres of the two-channel system, but also a different antenna length of the virtual third antenna. This three-phase-centre system is then used for DPCA-ATI processing and three-pulse-canceller processing in order to estimate the target motion. The performance is compared to ATI from the original two-channel mode using simulations and real data.

Part 2:
In an along-track interferometric SAR system, the discrete sampling of moving target signals can give rise to two types of ambiguity: Doppler ambiguity, and interferometric angle ambiguity. These ambiguities lead to ambiguities in target velocity estimation. Range cell migration of moving targets is unambiguous in target velocity. Hence, it can be used for resolving the ambiguities in target velocity estimation mentioned above. The wave number domain algorithm as well as the chirp scaling algorithm is adapted to moving target signals. In order to focus moving target signals with arbitrary velocities both approaches are extended to arbitrary Doppler frequency bands. Moving target signals distributed over two neighbouring PRF bands are especially difficult to detect and analyze because the signal splits into two parts. It is shown that the two parts appear at different positions in the SAR image and have different ATI phases. They show up as two weaker targets since the energy is split between them. It is demonstrated how the two targets can be identified as possibly the same target, and how they can be properly focussed by adaptation of the SAR focussing algorithms.