1. SUMMARY

Ground moving target indication (GMTI)\cite{1} is a very difficult problem, due to the difficulty of separating the signal returned from a moving target from the stationary background (clutter). A method that can be used to detect ground moving target is Along Track Interferometry (ATI). Along Track Interferometric Synthetic Aperture Radar (AT-InSAR)\cite{2-5} systems use more than one SAR antenna (typically two), mounted on the same platform and displaced along the platform moving direction. The information about the radial velocity of the moving target is estimated from the interferometric phase of the images using statistical estimation techniques based on the statistical distribution of the measured phases.

Since AT-InSAR system are based on the acquisition of two images, in this paper we propose to consider both real and imaginary part of the two SAR images instead of taking into account only the interferometric phase, i.e. the \((-\pi,\pi]\) wrapped phase of the signal obtained from the point to point correlation between the two complex images. We investigate the detection performance of AT-InSAR system in the case of a conventional interferometric approach and in the case of in-phase and quadrature components approach.

In order to evaluate the Detection Probability ($P_D$) and False Alarm Probability ($P_{FA}$) we assume the following probabilistic models: a) the SAR clutter signals can be assumed random processes, whose real and imaginary parts are mutually uncorrelated Gaussian signals, with zero mean and same variance; b) when the moving target is absent the two processes are still Gaussian with zero mean; c) when the moving target is present a deterministic model is applicable, it refers to the case of a target whose RCS can be expressed by a deterministic function of the incidence angle, which does not change in the small time required to the SAR antenna to cover the baseline length \cite{6}. Such value influences the signal to clutter ratio, and is not a priori known.

The moving object detection capability will depend essentially on the target range velocity and on three parameters: SCR (the signal to clutter ratio, defined as the ratio between the power received from the moving target and the power received from the background clutter), CNR (the clutter to noise ratio, defined as the ratio between the power received from the moving clutter and the power received from the noise) and clutter coherence that in the case of Along Track systems can be considered equal to one.
We show that combining the real and imaginary part of the two acquired images produce a sensitive reduction in the false alarm rate obtained with AT-InSAR conventional systems using only phase information. The improved performances of the proposed method respect to the interferometric phase approach are showed with numerical experiments on simulated data, and varying CNR, SCR and target velocity. The experiments show also that slow speed targets can be detected more accurately taking into account also amplitude information. We will simulate SAR data, considering a typical scenario with roads, fields and one or more vehicles moving in the scene with radial and azimuth velocity. In Fig. 1 three still vehicles are positioned on the roads, while in Fig 2 the vehicles are moving with radial and azimuth velocity and it can be seen also the azimuth displacement effect.

Fig.1: Simulated SAR data with 3 still targets, in range and azimuth plane
Fig.2: Simulated SAR data with 3 moving targets

2. REFERENCES