COHERENT SCATTERER IN FOREST ENVIRONMENT: DETECTION, PROPERTIES AND ITS APPLICATIONS

Koichi Iribe, Konstantinos Papathanassiou, Irena Hajnsek and Motoyuki Sato

When a radar wave strikes a target, part of the incident energy is reflected, or scattered. If the incident wave is monochromatic, if the target is unchanging, and if the radar-target aspect angle is constant, the scattered wave will also be monochromatic and completely polarized. Such a target has been called a point target. A more descriptive name is coherently scattering target. A technique to detect a "quasi-point" scatterer called *Coherent Scatterer* (CS) technique [1] was developed recently and has shown its performance over urban environment. It implies that a quasi-point scatterer is not necessary a completely coherent scattering target but a highly coherent scattering target. Depending on employed polarization channel, this technique enables the extraction of polarimetric based information from detected CSs. As another method to detect quasi-point scatterers, *Permanent Scatterer* (PS) technique [2] is widely employed. This technique involves the selection of phase stable scatterers, removal of atmospheric phase delays and estimation of terrain deformation and DEM error. While PS technique requires several SAR data over the same scene along the time to detect point-like scatterers, CS technique requires only a single SAR data. In this paper, first result of CSs detection over forested terrain is presented.

Conventionally, scatterers with high sublook coherence, which is a correlation function between two sublooks of the range spectrum of a SAR image, are associated as CSs. Different from urban scenario, man-made objects which have a potential to be CSs are not distributed so much in forest environment. In fact, the number of scatterers associated as CSs was quite less if a conventional high threshold of sublook coherence was employed. CS is characterized as a

scatterer shows high signal-to-clutter ratio. Therefore threshold is adopted so that associated CS candidates according to the threshold show high enough SCR. The suppression of false alarms induced by employing a threshold of sublook coherence which is relatively low compared to conventional one is also a main issue of this paper.

In order to suppress such false alarms, the spectral correlation in the azimuth direction is also investigated as proposed in [3] and [4] for ship detection. CS technique, which is aimed to detect point-like scatterers in urban area, is usually performed by employing spectral correlation in the range direction only. This is because it is too restrictive to take into account the spectrum correlation in azimuth as point-like scatterers are often characterized by a non-constant azimuth angular scattering pattern [5] and the integration along with a wide azimuth angle may induce spectral decorrelation in azimuth. CS in forest environment is assumed to be a dihedral structure consists of the tree trunk like a vertical cylinder and the ground surface. If so, a point-like scatterer in forest environment might be characterized by a constant azimuth angular scattering pattern and therefore it is reasonable to take into account the spectrum correlation in azimuth. Associated number of CS and the polarimetric property of such scatterers as a function of spectrum correlation are also addressed.

Multi-baseline PolInSAR P-& L-band data acquired by DLR E-SAR airborne system with repeat-pass track are employed for the demonstration. As an application of CSs, the residual motion error (RME), which is the deviation in the order of centimeters remain between nominal and the processed reference track causing undesirable phase undulations in interferograms, is estimated and compensated. Such undesirable phase undulations may easily turn out to be critical for multi-image SAR applications as represented by, for example, PolInSAR and T-SAR, and preventing the exploitation of the phase information. For this reason, a phase calibration to mitigate the impact of undesirable phase undulations on the data is strongly required [6].

Improvement of phase stability especially on shorter wavelength (L-band) data could be achieved by implementing the phase calibration employs deterministic phase of CSs.

[1]R. Z. Schneider, K. P. Papathanassiou and et al, "Polarimetric and interferometric characterization of coherent scatterers in urban areas," IEEE Trans Geosci Remote Sens., vol. 44, no4, pp 971-984, Apr. 2006.

[2] A. Feretti, C. Prati, F. Rocca, "Parmanent scatterers in SAR interferometry," IEEE Trans Geosci Remote Sens., vol 39, no1, pp 8-20, Jan. 2001.

[3]A. Arnaud, "Ship detection by SAR interferometry," in Proc. IGARSS, vol 5, Hamburg, Germany, Jun. 28-Jul. 2 1999, pp. 2616-2618.

[4]K. Ouchi, S. Tamaki and et al, "Ship detection based on coherence images derived from cross correlation of Multilook SAR images," IEEE Trans. Geosci. Remote Sens., Lett., vol. 1, no 3, pp. 184-187, Jul. 2004.

[5]K. Iribe and M. Sato, "Analysis of polarization orientation angle shifts by artificial structures," IEEE Trans Geosci Remote Sens., vol 45, no11, pp 3417-3425, Nov. 2007.

[6] S. Tebaldini and F. Rocca, "On the impact of propagation disturbances on SAR tomography: Analysis and compensation," in Radarcon 2009, Pasadena, California USA, 2009.