



Biography

Gerardo Di Martino (Senior Member, IEEE) is Associate Professor of Electromagnetic Fields in the Department of Electrical Engineering and Information Technology at the University of Naples Federico II, Italy. He holds the Italian national habilitation as Full Professor of Electromagnetic Fields. His main research interests are in the field of microwave remote sensing and electromagnetics, with focus on electromagnetic scattering modeling, Synthetic Aperture Radar (SAR) system and data modeling, information extraction from SAR and polarimetric SAR data, SAR data simulation and physical-based benchmarking approaches. In the last years, he has also worked on the development of models for Earth Observation through Global Navigation Satellite System Reflectometry (GNSS-R). He is co-Editor of the book “Maritime Surveillance with Synthetic Aperture Radar”, published by IET in 2020. He authored more than 150 papers, of which about 50 published in refereed journals.

Prof. Di Martino has a broad teaching experience, spanning from basic Electromagnetic Fields bachelor classes to advanced Remote Sensing master classes. He has been invited as speaker at top-tier international symposia, such as IGARSS and PIERS, where he has also organized and chaired several sessions. He is co-organizer and presenter of technical tutorials at IEEE IGARSS 2024, IEEE ICSIDP 2024, and IET IRC 2025. He is the founding Lead Editor of the IEEE Geoscience and Remote Sensing Society (GRSS) Section within IEEE Access, and an Associate Editor of the IEEE Journal of Selected Topics on Applied Earth Observations and Remote Sensing.

Topic 1 - Synthetic Aperture Radar Acquisition Modes for Maritime Surveillance

Sea monitoring and surveillance via Synthetic Aperture Radar (SAR) is gaining an increasing interest, due to its relevance for maritime traffic, border, and fisheries control, as well as for search and rescue operations. This kind of applications call for both wide coverage and high resolution, thus also implying a huge amount of data to be stored and processed. Therefore, methods to extend the size of the range swath of SAR systems, without spatial resolution loss, and techniques able to reduce the amount of data are all of great interest in this context. Accordingly, in recent years,

different solutions have been proposed with the aim of increasing coverage: array beamforming, staggered SAR, multiple-input–multiple-output (MIMO) SAR, and SAR constellations. At the same time, some techniques to reduce data amount have been also developed, such as onboard presuming and/or prefiltering techniques, which, however, imply a resolution loss, and, more recently, compressive sensing to focus sparse targets, allowing for a reduction of data amount, possibly at the expense of a significant complication of the processing. Actually, a simple way to reduce the data amount and, at the same time, extend the range swath does exist and consists in reducing the pulse repetition frequency (PRF). However, it is well known that if the PRF is reduced to values lower than the Nyquist rate, azimuth ambiguity will arise. Nevertheless, special acquisition modes based on the use of sub-Nyquist, possibly coprime, PRFs have been proposed for ship detection and maritime surveillance applications.

Starting from the definition of the specific requirements of maritime surveillance, the lecture will focus on the main SAR acquisition modes developed in recent years for this kind of applications. Special attention will be paid to those advanced acquisition modes whose actual performance can be predicted using available SAR data acquired with traditional modes.

Topic 2 - Simulation-based benchmarking for SAR speckle filtering

Benchmarking represents a key challenge in remote sensing. In several research domains many competing techniques are being developed, making the possibility of fairly comparing them, possibly under different operating scenarios, a hot and urgent topic.

The noise associated to the data is one of the main sources of performance degradation in applicative scenarios, so that noise filtering frequently represents a mandatory preliminary step for many applications. As such, evaluation of noise filter performance is not only of interest per se, but, more importantly, in a general applicative context. However, in the case of Synthetic Aperture Radar (SAR), speckle has very peculiar characteristics, since, in principle, it cannot be regarded as noise, being an inherent, unavoidable component of the received signal. Indeed, it is the result of constructive or destructive interferences arising from the coherent nature of the return. This implies that a “clean”, speckle-free, SAR image (to be used as reference for evaluation of filter performance) does not actually exist. Therefore, special care must be taken when dealing with the problem of SAR despeckling benchmarking. In this context, SAR physical-based simulation represents a unique and meaningful solution for devising reference quality measures. In order to design a benchmark with this kind of approach a basic set of canonical test cases and appropriate performance measures must be identified, allowing for proper evaluation of the different aspects involved in the overall filter performance (e.g., speckle reduction in homogeneous areas, texture, edge, and point target preservation, etc.).

In this lecture, first the specific characteristics of speckle as “noise” are discussed. Then the construction of a simulation-based benchmarking framework for SAR despeckling is presented, including the definition of the necessary canonical scenarios, with associated appropriate reference images, and of the relevant quality measures. Finally, the extension to the case of multitemporal filtering is outlined.