Topic : Deep learning for SAR image processing

Abstract :
Synthetic aperture radar (SAR) imaging is an invaluable technique for Earth observation. Thanks to its unique ability to see through clouds and its sensitivity to surface roughness and soil moisture it is a key sensor for many applications ranging from forest monitoring or biomass estimation to rapid mapping and damage assessment. Beyond providing an image of the backscattered intensities it may be used in different modalities offering additional information on the imaged surface. When using two images in an interferometric configuration, valuable information on the topography whether elevation or displacement is made available. For polarimetric mode, thanks to the wave polarization in emission and reception, information about the scattering mechanisms (single, double, triple bounces, surface or volume scattering) is acquired.
This potential relies on the coherent measurement and processing of the SAR signals. This coherent measurement comes along at a cost which is the speckle phenomenon arising in radar imaging. It is due to the constructive or destructive interferences occurring inside a resolution cell when several backscattered echoes are coherently summed. Speckle appears in SAR intensity images as strong fluctuations whose strength increases with the average of the backscattered reflectivity. For multi-channel modalities like interferometry or polarimetry it strongly corrupts the interferometric phase and the polarimetric covariance matrix making the analysis of these images and their automatic processing challenging.

This presentation will provide a review of the speckle reduction methods for single or multi-channel SAR images with a focus on the recent deep learning approaches. Beyond traditional methods based on pixel selection thanks to local window analysis or patch-based similarity, or even Bayesian and variational approaches, deep learning methods have provided unprecedented results for speckle reduction in mono-channel or multi-channel images. We will discuss the different strategies that can be applied in a deep learning frameworks ranging from the plug and play methods calling an off-the-shelf denoiser to supervised learning, semi-supervised learning or even auto-supervised learning. For all these strategies we will present how they can be efficiently extended to

multi-channel data either interferometric or polarimetric. To conclude we will illustrate how these speckle reduction methods can be helpful for other applications like segmentation or height estimation.

Biography

Florence Tupin (Senior Member, IEEE) received the engineering degree and the Ph.D. degree in signal and image processing from Ecole Nationale Superieure des Telecommunications (ENST), Paris, France, in 1994 and 1997, respectively, and the Habilitation a Diriger des Recherches degree from the University of Rennes, France, in 2007. From 1997 to 1998, she was with SAGEM, Paris, France, where she worked on fingerprint recognition. She is currently a Professor of image and signal processing with LTCI, Télécom Paris, Paris, France. From 2014 to 2020, she was the Head of the Image, Modeling, Analysis, GEometry,and Synthesis Team of LTCI. Since 2020 she has been deputy director of LTCI lab and since 2024 she has been head of the Image, Data, Signal department of Télécom Paris.

She has coauthored more than 200 papers. Her research interests include image processing and analysis, especially for remote sensing and synthetic aperture radar imaging applications, and earth observation. Pr. Tupin has been a member of several international and national technical conference committees since 2003. She was the Chair of the Urban Remote Sensing Joint Event held in Paris in 2007. She was an Associate Editor for the IEEE Transactions on Geoscience and Remote Sensing from 2007 to 2016. She was the recipient of several awards, among them the IEEE GRSS Transactions Prize Paper Award in 2016 and the IEEE GRSS Symposium Prize Paper Award in 2022 for works on speckle filtering.

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