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Exploring Deep Learning Methodologies for SAR Despeckling

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The interpretation of SAR images are impaired by a multiplicative noise called speckle. In the last decades many solutions have been proposed relying on model based approaches. Thanks to the impressive results of deep learning in many image processing field, in the last years we are witness of the spreading of deep learning based solutions also for SAR despeckling. The first two solutions for SAR despeckling that make use of the convolutional neural networks appeared in the 2017: SAR-CNN [1] and ID-CNN [2]. Starting from these two solutions, other methods have been proposed in the last two years such as [3] (known as SAR-DRN), [4], [5] (known as MuLoG-CNN) and [6]. The aim of this work is to compare and explore the several deep learning methods for SAR despeckling, highlighting the differences, the advantages and drawbacks of each other.
The solutions differ each other for the training dataset, the architecture and the cost function.
Regarding the training, some of them are trained on simulated dataset under the fully developed hypothesis such as ID-CNN, SAR-DRN, [4] and [6], whereas SAR-CNN make use of multitemporal SAR images in addition of the simulated one. MuLog-CNN also rely to simulation for the training dataset, but, unlike the others, it needs of very few samples for training thanks the use of a pretrained network.
Regarding the architecture, both SAR-CNN and [6] propose a seventeen layers CNN with ReLU and batch normalization. Same rationale is followed by ID-CNN that propose an eight layers CNN. SAR-DRN introduce skip connections, and [4] a U-Net architecture. Instead MuLoG-CNN relies on an adaptation of a pretrained network for AWGN noise composed of seventeen layers nested in the MuLoG framework.
Regarding the cost function, all the solution but [6] work in a residual way, that means the network predict just the speckle. ID-CNN, SAR-DRN and [4] use a mean square error (mse) between the noise-free reference and the filtered image, combined with total variation among same quantities. SAR-CNN define a statistical approach. MuLoG-CNN uses the norm L_1, while [6] proposed a cost function given by a linear combination of three terms that each of them take care of spatial details, statistical noise properties and edge preservation.
Moreover, both SAR-CNN and MuLoG-CNN rely on homomorphic approach for training, applying a log transformation of the input data.
All these aspects will be explored and analysed by visual and numerical inspection in order to have a comparison among the Stat of the Art methods for SAR despeckling based on deep learning.

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