Learning-Assisted Electromagnetic Inversion from Limited Aperture Measurement Based on Generative adversarial networks

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Until now. most of microwave imaging methods are performed in full-aperture measurement, which means that transmitting and receiving antennas are all around the domain of interests (DoI). However, in some engineering applications, it is not feasible to get the data with full-aperture measurement, such as mine exploration, through-wall imaging, etc. [1]. Therefore, it's necessary to study limited-aperture measurement (transmitting and receiving antennas are arranged at some angles in the DoI).

In this paper, a limited-aperture microwave imaging method is introduced through generative adversarial networks (GANs), which is very prominent in the image translation [2]. Inverse scattering problems (ISPs) usually counter two challenging: ill-posedness and nonlinearity, both of these problems are more serious in limited-aperture problems. Thus, the limited-aperture ISPs are divided into two steps to alleviate these problems. In the first step is to restore full-aperture data from limited-aperture data by GANs, where the limited-aperture data generated by the method of moment (MoM) is taken as the input of the network, and then the full-aperture data can be successfully recovered. The second step is to get preliminary images by back propagation (BP) [3]. Finally, preliminary images got by BP are taken as the input of U-net convolutional neural network (CNN) [4], and high-resolution images can be retrieved. The key in this method is the first step of the retrieval fields, which directly determines the quality of the final imaging results via CNN. Through the training process, the relationship between limited-aperture and full-aperture can be learned by the GANs, and high-resolution images can be got by U-net. Numerical simulations have validated the interests of the proposed methods, which can be depicted in Fig. 1.
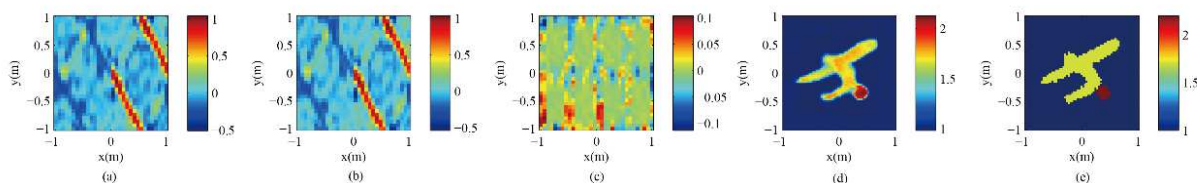

Figure 1. Numerical Results (a) the retrieval results by the GANs, (b) the exact full-aperture data, (c) the difference errors between the exact measurement field data and the retrieval one, (d) the high-resolution images got by U-net, (e) the ground-truth.

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