# A quadratic RF Tomography inverse model for reflection configuration

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Radio Frequency (RF) tomography (L. Lo Monte, D. Erricolo, F. Soldovieri, M.C. Wicks, "Radio Frequency Tomography for Tunnel Detection," *IEEE Trans. Geoscience and Remote Sensing*, Vol. 48, No. 3, Mar. 2010, pp. 1128-1137) aims at imaging targets in a scene starting from the measurements of the scattered field under the illumination of known incident fields. Therefore, such an imaging method shares the classical issues of inverse scattering problems such as ill-posedness and non-linearity. These mathematical questions, if not properly addressed, have a detrimental effect on the reliability and accuracy of the solution by impairing the outcomes of the overall imaging procedure.

A first way to mitigate the above mentioned drawbacks is the adoption of inversion approaches based on linear models of the electromagnetic scattering (e.g. Born, Kirchhoff), which have several interesting properties as: absence of false solution, robustness with respect to noise on data and uncertainties in the scenario, computational efficiency. These properties represent the motivation for the more and more frequent exploitation of linear inverse scattering approaches in realistic applications as alternative strategies to the usual migration approaches (Solimene, R., Catapano, I., Gennarelli, G., Cuccaro, A., Dell'Aversano, A., Soldovieri, F., *Signal Processing Magazine*, **31**, 2014, pp. 90-98). As a result, linear inverse models are used even though they exhibit significant limitations in terms of the possibility to achieve quantitative reconstruction and are affected by the necessity of a smoothness constraint on the recovered solution.

Therefore, it is interesting to study non-linear inversion schemes and here we present the performance investigation of a quadratic approach, by also comparing it to a linear inverse one. The quadratic approach will be investigated in terms of its capability to (1) enlarge the set of contrast functions to be quantitatively recovered; and, (2) of spatial harmonics to be reliably retrieved. These improvements require a compromise with the problem of false solution and this entails the adoption of measurement configurations based on illumination/receiver diversity to obtain the necessary amount of independent information to mitigate/overcome the local minima problem. In particular, a reflection mode configuration will be analyzed to investigate the general considerations made above. Additionally, multi-monostatic/multi-frequency configurations will be compared with a multi view/multistatic configuration in terms of quality of the reconstruction.