

Response to Reviewer 3 comments

In the present manuscript, the Authors present a block-BiCGStab algorithm for solving three-dimensional microwave imaging problems. The paper is interesting and the topic is well suited for the Sensor journal.

We thank the reviewer for this positive feedback.

I have just some minor remarks that the Authors should consider.

-) In section 2.2, the Authors state that the vector $\mathbf{e}_{\text{scatt}}$ in eq. (6) has size N_r , i.e., equal to the number of receiving points. However, since it contains electric field samples, it should be composed by three components for every point, leading to a size $3N_r$ (as for the internal field in eq. (2)). Is it a typo, or do the Authors consider only a single field component? In the latter case this should be specified in the formulation of the method.

In our paper, N_r represents the number of measurement points, which is not necessarily the number of antennas positions. For instance, in the simulated example where only the z component is measured, N_r is equal to the number of antennas. In contrast, when dealing with the Fresnel database, we need to consider the three components of the electric field for the 81 antennas, so that $N_r = 3 \times 81 = 243$ measurement points.

We agree that the first version could have led to such ambiguity. In order to remove a possible misunderstanding, we changed notation N_R to N_M (number of measurement points), and “ N_R receivers” in section 2.2 was changed for “ N_M measurement points”.

-) How have the values of the parameters of the method used in section 4.4 and 5 (numbers of iterations in the intermediate frequency steps, regularization parameters, ...) been chosen? Usually they could significantly affect the final results, at least some discussion on their selection should be added.

We detail here the tuning of the different parameters and the corresponding modifications in the paper.

- The noise level added to initialize block-BiCGStab is introduced in order to “decorrelate” the different columns in the initial matrix $R^{\{0\}}$. Empirically, we have found that an initial perturbation with an SNR ranging from 40 to 100 dB yielded roughly the same favorable effect, while a higher level of perturbation would have the effect of slowing down the convergence, and a smaller one would produce the same behavior as no perturbation. In all experiments in this paper including such noisy initialization, the signal-to-noise ratio was always set to 50-dB.

This was made clearer in the paper (end of Section 3.2).

- Parameter δ in the regularization function was set to $1e-2$ in all our experiments (should be small but not zero in order to ensure the differentiability of the cost function).

This has been highlighted in the paper (Section 2.3).

- The regularization weight (λ in the former version, γ now) trades off between fidelity to data and regularization, which is necessary since the problem is ill-posed. It should also be small in order not to introduce too much bias in the reconstructed map. However, its value may depend on the noise level and on the problem size. This has been detailed in the paper. It was empirically

set to $1e-5$ in all experiments with the synthetic example, and to $1e-6$ for all experiments with the Fresnel database. The use of the same values throughout different experiments tends to prove that solutions are not much sensitive to their tuning.

This was made clearer in the revised version (Section 2.3), and regularization parameters are given at the beginning of Sections 4.4 and 5.

- The number of iterations for each hopping step is a trade-off between reconstruction quality and computation time. For difficult objects (high contrast, large size compared to the wavelength), the reconstruction requires more iterations to converge; it is then necessary to perform more iterations at each frequency to obtain a good initialization at the final frequency reconstruction (for which an unlimited number of iterations are run until convergence is achieved). In our experiments, 10 iterations at each frequency was enough for the simplest objects, but not for the two more complex ones (synthetic object, Cylinder). We tried applying more iterations, but no reconstruction improvement was observed on such objects, while it increased the computation time. Similarly, for the synthetic object and the Cylinder one, 20 iterations empirically resulted as the best compromise. Such comments were included in the revised version (at the beginning of Sections 4.4 and 5).

-) How has the "Subjective comparison" in Table 3 been performed? In order to be fair, it should be based on a quantitative analysis (e.g., of the reconstruction errors), otherwise I don't think it is sufficient to "strongly support" the claim that "the proposed method provides results at least similar and often superior" to the others. The Author should either provide some quantitative information to support the comparison or reformulate such sentences.

Indeed, the comparison in Table 3 is based upon our subjective, visual, evaluation of the reconstructed maps and of the geometrical structure of the objects presented in the figures of the corresponding papers. Each cell in the table contains a qualitative assessment of the comparison of our result with previously obtained ones for each object and each paper. Unfortunately, we are not able to bring any quantitative assessment of such comparisons, since very few papers dealing with objects from the Fresnel database provide quantitative results that could be compared with.

The corresponding text was reformulated in order to insist on the subjectivity of such a comparison.

We are also aware of the importance of reproducibility when publishing scientific results. Therefore, we also publish in the supplementary material the Matlab files containing our reconstructed objects together with visualization functions, so that any one can evaluate our results.

We also mention this point at this part of the paper.