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3D imaging with single element intensity measurements

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We consider imaging using a single source-detector pair to scan a sample. The detector collects intensity-only data at different positions and for different frequencies emitted from the source. Using an appropriate illumination strategy we recover field cross-correlations over different frequencies for each scan location. The challenge is that these field cross-correlations are asynchronous and they need to be sychronized so as to image coherently. Using the algorithm proposed in [1, 2] we synchronize these field cross-correlations across the different measurement locations. The result is that we recover full field data up to a global phase that is common to all scan locations. These recovered data which are coherent over space and frequency may be used to form high-resolution 3D images.

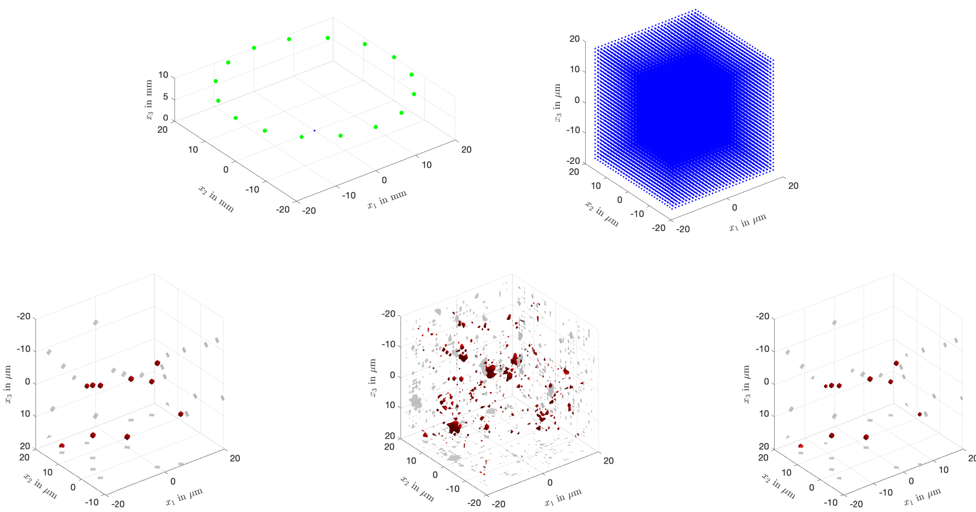

Figure 1. Example of a scanning setup and reconstruction results obtained with the proposed methodology.

Example of a scanning setup and reconstruction results obtained with the proposed methodology are shown in Figure 1. Here a single source-detector pair is conducting measurements moving along a circular trajectory (green stars) on a plane located at a distance of 1cm from the center of the IW and measures the reflected intensity. The measurements can be obtained by either moving the source-detector or the sample. The blue area depicts the imaging window IW. A zoom of the IW is shown on the top right plot. In the bottom row we plot the absolute value of the reflectivity normalized by its maximal value. From left to right the true reflectivity, ℓ^2 and ℓ^1 reconstruction results are depicted. In this example the data are corrupted with additive gaussian noise with SNR 10 dB. The ℓ_1-method recovers exactly the location of the reflectors, allowing for deep tissue high-resolution imaging, while the ℓ_2-image has non-zero values at many other pixels. These results illustrate that imaging with intensity-only data may be as good as imaging with full phase data when the proposed methodology is used.

References

[1] M. Moscoso, A. Novikov, G. Papanicolaou, and C. Tsogka, "Synthetic aperture imaging with intensity-only measurements," *EEE Trans. on Computational Imaging*, **6**, 87-94 (2020), doi: 10.1109/TCI.2019.2919272.

[2] M. Moscoso, A. Novikov, G. Papanicolaou, and C. Tsogka, "Three-dimensional imaging from single-element holographic data," *J. Opt. Soc. Am. A*, **38**, A1-A6 (2021), doi:10.1364/JOSAA.402396.