# When Strongly Disordered Medium Meets Compressive Super-resolution Imaging

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We develop a novel concept for compressive super-resolution imaging with the use of only one fixed-location sensor, which benefits from the use of strongly disordered medium.

The theory of compressive sensing (CS in short) introduces an elegant paradigm shift in signal acquisition, which provides a remarkable reduction in the number of measurements without loss of reconstruction fidelity. CS demonstrates that the reduced significantly number of measurements, accomplished by acquiring an incomplete set of pseudo-random projections, is sufficient to recover a sparse or compressible signal. We demonstrate numerically that the far-field subwavelength imaging of weakly scattering objects can be achieved by using a single antenna, which benefits from the use of the strongly disordered medium. A mathematical model has been established to solve resulting optimization problem based on the idea of sparse reconstruction. Moreover, this study leads to an important conclusion that the strongly disordered medium can serve as an efficient apparatus for the single-antenna compressive measurement, which shifts the complexity of devising compressive sensing (CS) hardware from the design, fabrication and electronic control. The proposed method and associated results can find applications in several imaging disciplines, such as optics, THz, RF or ultrasound imaging Contrary to aforementioned CS techniques, our single-antenna imaging methodology makes no use of a sequence of random patterns, thus strongly reducing acquisition time.

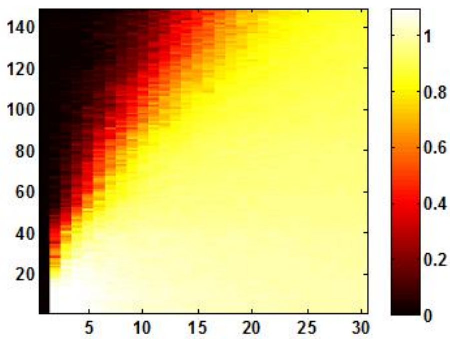


Fig. 1. The behaviors of obtained MSE as a function of the operational wavelength range centered at 688nm, R, and the number of non-zero objects, K. Note that the range of working wavelength is 688nm+[-R,R]nm.

A 2D cluster of small resonators is distributed randomly to construct the strongly disordered medium, where the resonator is consisted of a non-absorbing and high-index cylindrical scatterers with relative permittivity of 48.We investigated the capability of proposed methodology for locating the number of weak objects. Fig. 1 shows the MSEs of reconstructions as a function of the operational wavelength range R, and the number of probed objects K, which is obtained and averaged over 50 Monte-Carlo (MC) independent trials. In our MC experiments, the locations of K probed objects under test are randomly selected from the whole N pixels. From this set of results, one conclusion can be deduced that the sparse objects in the three dimensional (3D) space can be faithfully recovered in the subwavelength scale with the use of a single broadband antenna.