A SPARSITY DRIVEN ALGORITHM FOR ELASTICITY IMAGING

Abdul WAHAB 1, Jaejun YOO 1, Younghoon JUNG 2, Mikyoung LIM 2 and Jong Chul YE 1

1) Bio-Imaging and Signal Processing Lab., Department of Bio and Brain Engineering, Korea Advanced Institute of Science and Technology, Daejeon 34141, KOREA
2) Department of Mathematics, Korea Advanced Institute of Science and Technology, Daejeon 34141, KOREA

Corresponding Author : Abdul WAHAB, wahab@kaist.ac.kr

ABSTRACT

A compressed sensing based algorithm is presented for efficient and accurate reconstruction of the spatial support and material parameters of multiple inhomogeneous elastic inclusions in a bounded elastic formation. Only a few measurements of the displacement field over a very coarse grid (in the sense of Nyquist sampling rate) are taken into account, on contrary to classical algorithms assuming continuous or dense grid measurements. The proposed algorithm is not only very accurate since it does not require any linearization but is also computationally efficient as it is direct. The breakthrough comes from a novel interpretation of Lippmann-Schwinger type integral representation of the displacement field in terms of unknown densities (that are linked to the internal displacement and strain fields) having common sparse support on the location of inclusions. First, the support identification problem is recast as a joint sparse recovery problem that renders such densities and the support of the inclusions simultaneously. Then, using the leverage of the learned densities and associated internal information, a linear inverse problem for quantitative evaluation of material parameters is formulated. The resulting problem is then converted to a noise robust constraint optimization problem. For numerical implementation, modified Multiple Sparse Bayesian Learning (M-SBL) algorithm and the Constrained Split Augmented Lagrangian Shrinkage Algorithm (C-SALSA) are invoked. The efficacy of the proposed framework is manifested through a variety of numerical examples. The significance of this investigation is due to its pertinence for bio-medical imaging and non-destructive testing, wherein the real physical measurements are only available on a sub-sampled coarse grid [1]. The proposed algorithm is the first one tailored for parameter reconstruction problems in elastic media using highly under-sampled data.

REFERENCES