Reconstruction of Laser Ultrasonic Wavefield Images from Reduced Sparse Measurements Using Compressed Sensing Aided Super-resolution

Byeongjin Park and **Hoon Sohn**, Department of Civil and Environmental Engineering, KAIST, Daejeon 34141, Republic of Korea

Laser ultrasonic imaging is attractive for damage visualization because of its noncontact nature, sensitiveness to local damages, and high spatial resolution [1]. However, its field application is limited as the scanning with high spatial resolution demands a long scanning time. Recently, compressed sensing (CS) [2] and super-resolution [3] are gaining popularity in the image recovery field. CS estimates unmeasured pixels from measured parts, and SR recovers high spatial frequency information from low resolution images. Inspired by these techniques, a laser ultrasonic wavefield reconstruction technique is developed so that damage can be located and visualized with reduced number of ultrasonic measurements. First, a low spatial resolution ultrasonic wavefield image for a given inspection region is reconstructed from reduced number of ultrasonic measurements using CS. Here, the ultrasonic waves are generated using a pulsed laser, and measured at a fixed sensing point using a laser Doppler vibrometer (LDV). Then, a high spatial resolution ultrasonic wave image is recovered from the reconstructed low spatial resolution image using SR. The number of measurement points required for ultrasonic wavefield imaging is dramatically reduced. The performance of the proposed technique is evaluated through a numerical simulation and an experiment performed on a cracked aluminum plate.

References:
1. Y. An, B. Park, H. Sohn, "Complete noncontact laser ultrasonic imaging for automated crack visualization in a plate," in *Smart Materials and Structures* **22(2)**, 025022 (2013).
2. D. Donoho, "Compressed Sensing," in *IEEE Transactions on Information Theory* **52(4)**, 1289-1306 (2006).
3. C. Dong, C. Loy, K. He, X. Tang, "Learning a Deep Convolutional Network for Image Super-Resolution," in *Computer Vision – ECCV 2014*, **Part IV, LNCS 8692**, 184-199 (2015)