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In recent years the use of guided waves and nonlinear acoustic techniques has increased tremendously for structural health monitoring applications. Guided waves are being used for defect detection, acoustic source localization, and damage quantification for a wide range of structures in aerospace, civil, mechanical, electronic, and biomedical engineering. Guided waves provide an ideal compromise between sensitivity and range because they can provide small enough wavelengths to detect small damage, while exploiting the waveguide geometries to travel long distances.

Nonlinear acoustic techniques, in particular, have the potential to detect, characterize, and quantify cumulative damages. Various nonlinear acoustic techniques have been developed for detecting very small cracks or microcracks whose dimensions are well below the wavelength of the probing waves, and would therefore be undetectable by conventional linear techniques. These nonlinear techniques are useful for monitoring the material state well before macrocracks appear. Popular nonlinear acoustic techniques used for these purposes include methods based on higher harmonic and subharmonic generation, nonlinear impact resonant acoustic spectroscopy, nonlinear wave mixing, wave modulation, and side-band peak counts. These techniques help us to quantify precursors to damage states.

Selected papers related to these two fast-growing research fields are presented in this special section. The goal of this section is to give the readers a flavor of the current state of the art of the structural health monitoring research using ultrasonic guided waves and nonlinear acoustic techniques. Some of these papers were presented at the Health Monitoring of Structural and Biological Systems Conference at the 2015 SPIE Symposium on Smart Structures/NDE, in San Diego, California, during March 8–12, 2015. In addition to the selected

papers from this conference, other papers were solicited from the leading researchers in these two research fields. All papers published in this section went through the same rigorous review process that all *Optical Engineering* papers have to go through.

Two review papers written by [Pieczonka et al.](#) and [Chillara and Lissenden](#) give an overview of nonlinear ultrasonic guided wave-based nondestructive evaluation techniques and other nonlinear acoustic techniques. Two other papers by [Amjad et al.](#) and [Bagheri and Rizzo](#) describe how delamination and other hidden defects in plates in air or immersed in water can be monitored using guided waves. Chemical changes such as carbonation of cement-based materials can be also detected by nonlinear acoustic technique as described by [Eiras et al.](#) Monitoring of other types of man-made structural materials (such as composite and concrete) and naturally occurring materials like limestone has been discussed in three separate research papers written by [Memmolo et al.](#), [Bao and Chen](#), and [McGovern and Reis](#). Although these eight papers cannot cover the entire spectrum of structural health monitoring research using guided waves and nonlinear acoustic techniques they can still give the *Optical Engineering* readers a good idea about the current state of knowledge in these fields.

Tribikram Kundu is a professor at the University of Arizona. His research interest is in the NDE/SHM area. He is a fellow of SPIE, ASME, ASCE, ASA, and ASNT, and winner of the 2003 Humboldt Research Prize (Senior Scientist Award) and 1989/1996 Humboldt Fellowship awards from Germany, 2012 NDE Life Time Achievement Award from SPIE, 2015 Research Award for Sustained Excellence from ASNT, and 2008 Person of the Year Award from the *Structural Health Monitoring Journal*.

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