DATA-DRIVEN NONLINEAR DYNAMICS

B. Balachandran
Minta Martin Professor
Department of Mechanical Engineering
University of Maryland, College Park, MD 20742-3035

Abstract

With the availability of extensive data from simulations and laboratory and field experiments, data-driven dynamics is playing an important role in understanding the behavior of nonlinear systems. To illustrate this role, two examples are provided in this talk. The first example is related to extreme waves and the second example is related to chaotic dynamics. Freak waves or rogue waves are waves that can appear out of nowhere in oceans as well as other systems. These waves are characterized by extremely large wave amplitudes and extremely high-energy concentrations. As a representative case, time histories recorded for the Draupner wave and other extreme wave events are considered, and based on this data and the use of the Inverse Scattering Transform, it is shown how the imminence of extreme wave formation can be picked up from the data. In the second example, time histories obtained from simulations of different prototype nonlinear systems (e.g., Lorenz'63, Lorenz'96, and Kuramoto-Sivashinsky systems) are considered and how this data can be used with a neural machine to forecast chaotic dynamics. Some thoughts on future directions will be presented to close the talk.

Biographical Sketch

Dr. Balachandran received his B. Tech (Naval Architecture) from the Indian Institute of Technology, Madras, India, M.S. (Aerospace Engineering) from Virginia Tech, Blacksburg, VA and Ph.D. (Engineering Mechanics) from Virginia Tech. Currently, he is a Minta Martin Professor of Engineering at the University of Maryland, where he has been since 1993. His research interests include nonlinear phenomena, dynamics and vibrations, and control. The publications that he has authored/co-authored include a Wiley textbook entitled "Applied Nonlinear Dynamics: Analytical, Computational, and Experimental Methods" (1995, 2006), a Thomson/Cengage textbook entitled "Vibrations" (2004, 2009), and a co-edited Springer book entitled "Delay Differential Equations: Recent Advances and New Directions" (2009). He holds four U.S. patents and one Japan patent, three related to fiber optic sensors and two related to atomic force microscopy. He has been the Editor of the *ASME Journal of Computational and Nonlinear Dynamics* since January 2016. He is a Contributing Editor of the *International Journal of Non-Linear Mechanics*. He is a Fellow of ASME and AIAA and a Senior Member of IEEE.