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MECHANICAL ENGINEERING
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DATA-DRIVEN NONLINEAR DYNAMICS

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Meeting link: https://tinyurl.com/39dn6655 (MS Teams)

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, three different examples are considered. The first example is related to extreme waves, the second example is related to chaotic dynamics, and the third example is related to COVID-19 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 extreme large wave amplitudes and extreme high-energy concentrations. As a representative case, time histories recorded for the Draupner wave and other extreme wave events are considered. 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) and experiments with harmonically forced systems are considered. It is illustrated as to how this data can be used with a neural machine to forecast chaotic dynamics. Short term and long term forecasting of COVID-19 infection dynamics is addressed. The talk will be closed with some thoughts on future directions.

ABOUT THE SPEAKER

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, 2004), a Thomson/Cengage textbook (2004, 2009) and a Cambridge University Press textbook (2018) entitled "Vibrations," 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 recently completed his terms as the Editor of the ASME Journal of Computational and Nonlinear Dynamics and Contributing Editor of the International Journal of Non-Linear Mechanics. His honors and recognitions include being a ASME Fellow, a AIAA Fellow, a Senior Member of IEEE, and the ASME Melville Award, the Den Hartog Award, and the Lyapunov Award.

Session chair: Prof. Asitava Ghosal, mecheng @ IISc