VANDERBILT UNIVERSITY School of Engineering

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

Seminar

Friday,

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12:10 pm – 1:10 pm

FGH 211

"DEEP LEARNING APPROACHES FOR ULTRASONIC GUIDED WAVE BASED SHM APPLICATIONS"

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ABSTRACT

With rapid advancement in digital technology, SHM and NDT&E data is produced at an exponential rate. Such big data can offer advantages in formulating data-driven models using advanced algorithms and techniques like Machine Learning and Deep Learning. Therefore, domain knowledge in the form of physical representations, reliable big data and advance learning algorithms are becoming important for SHM and NDT&E applications. These methodologies will play an integral part in the adoption of NDE 4.0 in the industry. Ultrasonic guided wave (UGW) is one of the techniques used for both damage identification and material characterization in SHM and NDT&E applications. UGW offers advantages like traveling long distances with minimum attenuation and sensitivity towards local change in stiffness of the structure. Along with this, the UGW-based technique offers flexibility in terms of transducers, which can be removable, intact, contact, or non-contact based. This talk will emphasis on application of UGW for damage identification and material characterization in both metal and composite structures. These inverse problems are solved using state of the art deep learning techniques like Convolutional neural networks (CNN) and Recurrent neural networks (RNN). The focus of the current work is towards model-assisted and physics guided deep learning. In this approach, domain knowledge and expert-based supervision is utilized to steer the learning process. In the model-assisted based deep learning approach, we have used a parallel implementation of a reduced-order spectral finite element to solve the forward problem. We have implemented another approach for damage identification called physics guided deep learning. UGW can also be used for material characterization of composites. It is seen that such model-assisted deep networks can learn the unknown mappings and generalize well on unseen examples.

BIOGRAPHY

Professor Gopalakrishnan's areas of research include Wave Propagation in complex media, Computational Material Science, Computational Mechanics, Smart Structures, Structural Health Monitoring, MEMS and Nano Composite Structures. He has puhlished 228 international journal papers in these topics (with an h-index of 54) and 6 graduate level textbooks and two undergraduate books. He is Editor-in-Chief of the ISSS Journal for Micro and Smart Systems and Associate Editor for two other journals: Smart Materials and Structures, and Structural Health Monitoring. His awards include: International Structural Health Monitoring Person of the Year, Fellow of Indian National Academy of Engineering, Fellow of Indian Academy of Sciences, and Associate Fellow of AIAA. In addition to extensive funding from the Government of India, he has attracted $10M in funding from U.S. sources such as Boeing, Pratt & Whitney, Office of Naval Research, and the Air Force Office for Scientific Research. Prof. Gopalakrishnan obtained his Ph.D. from Purdue University.